NW Bicester Masterplan

Masterplan Energy Strategy

north west bicester | a2dominion

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NW Bicester

Masterplan Energy Strategy

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CONTENTS

Appendices

1 Introduction

The masterplan and related documents set out the spatial vision to provide up to 6000 new homes at NW Bicester.

The North-West Bicester development (NW Bicester) is intended to provide a new form of sustainable community within Cherwell District, and to extend the benefits of this community to the existing town of Bicester. The first part of the NW Bicester development was is Exemplar Site development located in the northwest part which is currently under construction.

The Role of this Document

This strategy is one of a number of documents prepared on behalf of A2Dominion in support of the masterplan plan. The Planning Policy Statement: Eco-Towns A Supplement to Planning Policy Statement 1 (July 2009) requires the preparation and submission of a master plan to demonstrate the eco town standards, as set out in the PPS1 supplement, will be addressed.

The master plan will therefore provide the context for the formulation and preparation of subsequent planning applications. It is open to the Council to adopt the master plan for development control purposes.

The purpose of the Energy Strategy is to sets out the overarching energy strategy for the NW Bicester Masterplan. It demonstrates how the development will achieve true zero carbon as defined in the PPS1 Eco town supplement.

Arriving at the final energy strategy for NW Bicester has involved an iterative process of development and testing of proposals, discussions with Local Authority officers and consultation with wider stakeholders. The details of the strategy will continue to be confirmed as planning applications are prepared and submitted. This document represents a summary of the overarching strategy to aid understanding and consideration of the Masterplan.

2 Development Overview

2.1.1 Background and Context

In July 2009, the Department for Communities and Local Government published 'Planning Policy Statement (PPS): eco-towns' as a supplement to PPS1 Delivering Sustainable Development. The PPS1 supplement includes requirements on sustainability, waste reduction, zero carbon buildings and sustainable public transport.

Within the PPS1 supplement, eco-towns are defined as sustainable developments of at least 5,000 homes. In July 2009, four 'first wave' locations were identified with the potential to be an Eco-town; one of which was NW Bicester.

The Eco-towns PPS outlines the Government's objectives for planning that are set out in PPS1:

1. *"To promote sustainable development by:*

ensuring that eco-towns achieve sustainability standards significantly above equivalent levels of development in existing towns and cities by setting out a range of challenging and stretching minimum standards for their development, in particular by:

providing a good quantity of green space of the highest quality in close proximity to the natural environment offering opportunities for space within and around the dwellings promoting healthy and sustainable environments through 'Active Design' principles and healthy living choices enabling opportunities for infrastructure that make best use of technologies in energy generation and conservation in ways that are not always practical or economic in other developments delivering a locally appropriate mix of housing type and tenure to meet the needs of all income groups and household size, and taking advantage of significant economies of scale and increases in land value to deliver new technology and infrastructure such as for transport, energy and community facilities.

2. *To reduce the carbon footprint of development by:*

ensuring that households and individuals in eco-towns are able to reduce their carbon footprint to a low level and achieve a more sustainable way of living."

The National Planning Policy Framework (NPPF) published on 27 March 2012 replaced all the previous Planning Policy Statements, however, the eco towns supplement to PPS1 is still in existence.

The NW Bicester development lies within the jurisdiction of Cherwell District Council (CDC), and the Masterplan for the site is being progressed by A2 Dominion. Cherwell District Council granted planning permission for the Exemplar Phase of NWB for 393 new homes, local facilities and land for a primary school in 2012. This Energy Strategy is in relation to the proposed entire NW Bicester development.

2.2 Description of the Masterplan

Development Context

The town of Bicester lies approximately 24km to the north-east of Oxford, and 28km to the southeast of Banbury. The M40 runs approximately 2km to the southwest, with Junction 9 providing access to the town via the A41.

The Site lies to the north-west of Bicester, approximately 1.5km from the town centre, and comprises an area of approximately 400 ha. The villages of Bucknell and Caversfield are located to the north and east of the site respectively.

Figure 2-1 illustrates the site boundary for the Masterplan and framework of the proposed development. This site lies wholly within the area identified by CDC for the NW Bicester Eco development. The Masterplan Site boundary runs alongside the B4030, A4095 and B4100, and lies within the parish of Caversfield.

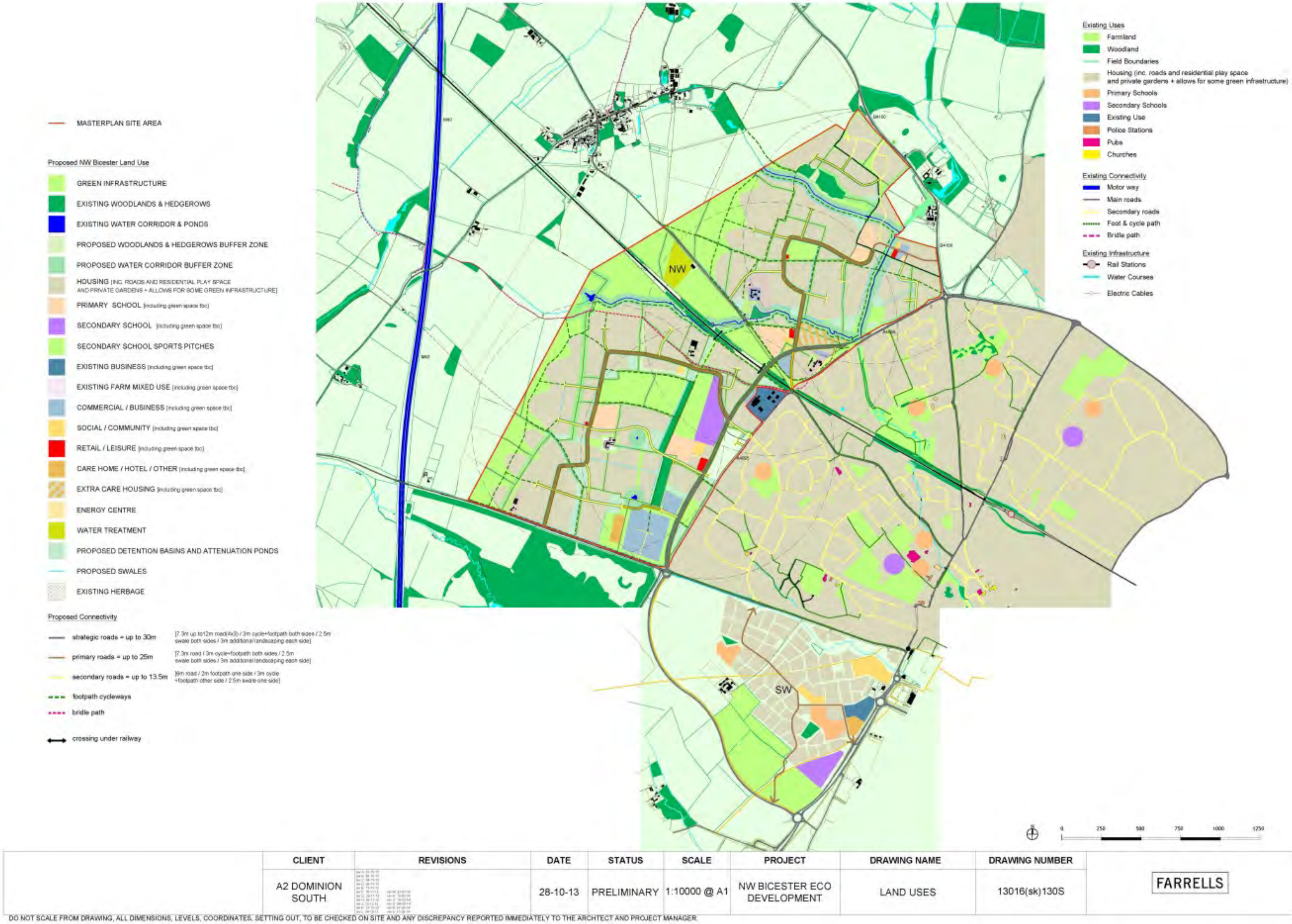
The Masterplan Site

NW Bicester is being promoted as a site for up to 6,000 new homes, after previously being identified as an Eco-town location within the Planning Policy Statement (PPS) 1 supplement entitled Eco-Towns A Supplement to Planning Policy Statement 1 (July 2009) (PPS 1 Supplement). In addition, the development proposal includes non-residential areas comprising commercial floorspace, leisure facilities and social and community facilities including office, industry, warehousing, retail, care, and hospitality and community spaces.

Forty percent of the total area of land at NW Bicester is to be allocated to green space of which half should be public spaces. A network of well-managed high quality green/open spaces which are linked to the wider countryside will be provided. Green spaces will be multifunctional: accessible for play and recreation, walking or cycling and supporting wildlife, urban cooling and flood management.

The Masterplan framework layout is shown on Figure 2-1 below.

Figure 2-1 Masterplan Framework



3 Planning Policy and Project Requirements

3.1 Introduction

This section provides a review of the relevant national, regional and local policy relative to energy and carbon emission reduction. A summary of current and future Building Regulations and the Governments approach to delivering zero carbon homes is also summarised. This is intended as an overview of the key policy and regulatory requirements that need to be met and considered as part of the scheme.

In addition, the aspirations of the client are highlighted to provide a concise and consolidated view of the targets that the scheme seeks to meet as it develops out.

This section sets out the difference between the zero carbon homes standard that the Government is developing as a minimum standard for all new homes and the true zero carbon standard set out in the PPS1 on Eco Towns that is being adopted for NW Bicester.

The policy landscape around Climate Change has been rapidly moving with many new policies and changes to existing policy over the last number of years which will influence the way in which the energy strategy for the scheme may come forward. It is also safe to suggest that policy will continue to evolve over the period in which the development will comes forward; and therefore maintaining flexibility in any strategy is crucial to facilitating continued sustainable development.

The Government is committed to ensure that as a minimum standard for the building industry, all new domestic buildings should be zero carbon (defined as regulated energy only) compliant by 2016 and, similarly, that all new non-domestic buildings should be zero carbon from 2019. This effectively means that the Government's zero carbon standards should be in place and apply to all new homes by the time any construction of NW Bicester homes begin. The Government's commitment to achieving zero carbon is based on the following hierarchical approach to achieving zero carbon targets:

- Ensure energy efficiency by energy efficient building design and fabric efficiency (expressed in terms of energy demand (kWh/m2/year)

- Reduce carbon emissions through on-site low carbon and renewable energy technologies and near-site heat networks; referred to as on-site carbon compliance (expressed as $kgCO_2/m^2$/year).

- Reduce the remaining carbon emissions to zero; through further low carbon and renewable energy technologies and/or the use of allowable solutions.

However, NW Bicester remains listed in the PPS1 Eco town planning document, which remains current, and sets a unique precedent for this development.

3.2 National Planning and Policy Requirements

3.2.1 The Climate Change Act (2008)

The Climate Change Act 2008 introduced a legally binding target to reduce the UK's greenhouse gas (GHG) emissions to at least 80 per cent below 1990 levels by 2050. It also provides for a Committee on Climate Change (CCC) which sets out carbon budgets binding on the Government for 5 year periods.

In Budget 2009 the first three carbon budgets were announced which set out a binding 34% CO2 reduction by 2020 and the Government has now proposed that the fourth carbon budget will be a 50% CO2 reduction by 2025. The CCC also produces annual reports to monitor progress in meeting these carbon budgets. As a result of the Climate Change Act, a raft of policy at national and local level has been developed aimed at reducing carbon emissions.

The levels of the first three carbon budgets were set in fiscal budget 2009 at the "interim" level recommended by the CCC prior to global agreement on emissions reductions. The carbon budgets require a reduction in greenhouse gas emissions of 34%, against 1990 levels, by 2020. The fourth carbon budget level was set in June 2011. The carbon budget for the 2023–2027 budgetary period is 1,950,000,000 tonnes of carbon dioxide equivalent.

3.2.2 UK Low Carbon Transition Plan (2009)

The previous Government launched the UK Low Carbon Transition Plan on 15th July 2009. The Plan includes the Renewable Energy Strategy (white paper) and Low Carbon Industrial Strategy. The UK Low Carbon Transition Plan is a Government white paper that sets out policies required to ensure that the UK meets its legally binding commitment to reduce carbon emissions by 34% by 2020. Policies contained in the documents include:

- Getting 40% of our electrical energy from low and zero carbon sources by 2020
- Rolling out smart meters in every home by 2020

3.2.3 National Planning Policy Framework

As of 27th March 2013 (12 months from the day of publication), Annex 1 of the NPPF confirms that due weight should be given to relevant policies in existing plans according to their degree of consistency with the NPPF (the closer the policies in the plan to the policies in the Framework, the greater the weight that may be given). It also confirms that, from the day of publication, decision-takers may also give weight to relevant policies in emerging plans according to:

- the stage of preparation of the emerging plan (the more advanced the preparation, the greater the weight that may be given);
- the extent to which there are unresolved objections to relevant policies (the less significant the unresolved objections, the greater the weight that may be given); and
- the degree of consistency of the relevant policies in the emerging plan to the policies in the NPPF (the closer the policies in the emerging plan to the policies in the NPPF, the greater the weight that may be given).

The NPPF was designed to make the planning system more user friendly and transparent. The framework's primary objective is sustainable development, focussing on the 3 pillars of sustainability: planning for prosperity (Economic), planning for people (Social) and planning for places (Environmental).

At the heart of the NPPF is a presumption in favour of sustainable development. The NPPF identifies 12 principles that should be at the core of land use planning; these include:

- "support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)"

Further guidance within the NPPF is given under the heading "Meeting the challenge of climate change, flooding and coastal change"; including:

- supporting the delivery of renewable and low carbon energy infrastructure; and
- reduce greenhouse gas emissions

3.3 Planning Policy Statement 1 Eco town supplement

NW Bicester (NWB) is identified in the supplement to PPS1 entitled 'The Planning Policy Statement: Eco-Towns A Supplement to Planning Policy Statement 1' (July 2009) as one of four locations for an Eco Town. The principle of the development is supported by Cherwell District Council ('the Council') and the land to the north west of Bicester ('the Site') is identified in the emerging Local Plan as the area within which a development following eco-town principles and the standards in PPS1 Supplement could be developed.

It is anticipated that the current Government will cancel the current PPS Supplement in due course. Notwithstanding, the requirements of the Supplement to PPS1 will be carried over by Cherwell (subject to review and amendments as necessary) into the Local Plan. The Council has already set out its policy position in respect of NWB in the emerging Local Plan and granted planning permission for the Exemplar Phase of NWB for 393 new homes, local facilities and land for a primary school.

The PPS 1 Eco-town supplement defines zero carbon under paragraph ET 7.1 as:

"*over a year the net carbon dioxide emissions from all energy use within the buildings on the eco-town development as a whole are zero or below*".

Paragraph ET 7.2 of PPS 1 Eco-town provides further clarification and states

"*This standard will take effect in accordance with a phased programme to be submitted with the planning application. It excludes embodied carbon and emissions from transport but includes all buildings – not just houses but also commercial and public sector buildings which are built as part of the eco-town development. The calculation of net emissions will take account of:*

(a) emissions associated with the use of locally produced energy

(b) emissions associated with production of energy imported from centralised energy networks, taking account of the carbon intensity of those imports as set out in the Government's Standard Assessment Procedure, and

(c) emissions displaced by exports of locally produced energy to centralised energy networks where that energy is produced from a plant (1) whose primary purpose is to support the needs of the eco

town and (2) has a production capacity reasonably related to the overall energy requirement of the eco town."

The Town and Country Planners guidance for the development of energy efficient and zero carbon strategies for eco-towns, December 2009, encourage eco-towns to follow best practice to achieve zero carbon as Exemplar developments.

3.4 Building Regulations

Currently, Part L 2010 requires all new buildings to calculate their carbon dioxide emissions from fixed building services (regulated emissions). It is proposed that future revisions to this regulation will use the same model, but will ask for a higher reduction in carbon dioxide emissions compared to the previous version of the building regulations.

Up until 2006 it has been possible to meet the carbon targets by using efficient conventional systems. The 2010 CO_2 emissions targets can still be largely met by an energy efficient approach to design although additional low carbon or renewable systems may be needed (or preferred) in some buildings.

The further changes that will be brought in under the 2013 Building Regulations (to be implemented in April 2014) will likely make low carbon and renewable systems necessary in virtually all new buildings; along with the enhanced fabric efficiency.

The jump to zero carbon planned for 2016 represents a major step change and will almost certainly require a change in approach to how Part L is implemented. The traditional approach of building regulations is to assess the performance of a building considering only the energy use of the building and only those technologies attached to it and so directly affecting its carbon performance. If this approach were taken to zero carbon buildings, around half would not be able to meet the target and many of those that could meet the target would be extremely costly. This is because if the target were implemented in this way it would rely on small scale renewable electricity generation which is commonly expensive.

Current thinking is that the minimum performance standards required for individual buildings will remain similar between 2013 and 2016. There will be an option for some sites to further improve their on-site carbon performance and reduce emissions but there will also be alternative approaches (referred to as allowable measures) to reducing carbon by other means including:

- Remote wind turbines (or other forms of renewable electricity generation) with some form of long-term legal association to the development

- Extension of onsite low carbon heating systems to replace high carbon heating systems in existing buildings on neighbouring sites

- Programmes of improvement works to remote buildings (e.g. insulating cavity wall and lofts or installing external insulation on hard to treat solid walled rural homes)

The recent revision of building regulations and the announcement of Part L 2013 identify further improvement in carbon dioxide emissions of around 6% for domestic buildings and 9% (on aggregate) for non-domestic buildings. The tendency of carbon reduction will continue until a zero carbon target is adopted. It is anticipated that the zero carbon target will come into force in 2016 for domestic buildings and in 2019 for non-domestic buildings (2018 for public buildings).

This trajectory to zero carbon was first announced by the government in 2006 and there is still a considerable amount of work to be done to make it a reality. The current understanding of the trajectory to zero carbon for domestic and non-domestic buildings is presented in Table 3-1.

Table 3-1 Carbon reduction requirements based on Part L revisions 2006

Buildings type	2010	2013 (now April 2014)	2016	2018	2019
Domestic	25%	31% (6% improvement to 2010 BR)	Zero Carbon	Zero Carbon	Zero Carbon
Non – domestic	25%	34% (9% aggregated improvement to 2010 BR)	further improvement	Zero Carbon (Public Buildings)	Zero Carbon

3.5 Achieving Zero Carbon

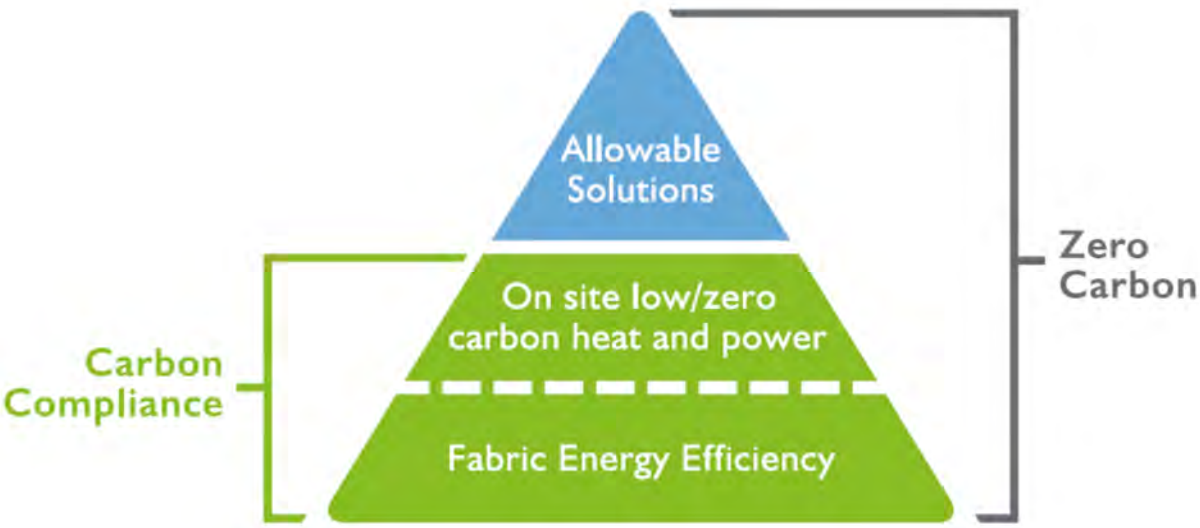
The Government has announced its commitment to ensure that all domestic buildings should be zero carbon compliant. The Government has an ambition to make all new non-domestic buildings should be zero carbon from 2019.

In the 2011 Budget 'The Plan for Growth' document, the Government set out its new definition of "zero carbon" to be limited to regulated energy only (i.e. excluding unregulated energy – appliances and cooking). This means that the zero carbon definition is now only to include the regulated emissions covered by Building Regulations (heating, fixed lighting, hot water and building services). Emissions from cooking and appliances, such as computers and televisions, are excluded from the definition. This will be achieved by progressive tightening of standards with final enforcement expected through 2016 and 2019 Building Regulations respectively.

The Government's commitment to achieving zero carbon is based on the following hierarchical approach to achieving zero carbon targets (as presented in Figure 3-1 below):

- Ensure energy efficiency by energy efficient building design.
- Reduce carbon emissions through on-site low carbon and renewable energy technologies and near-site heat networks; referred to as on-site carbon compliance.
- Mitigate the remaining carbon emissions through use of allowable solutions.

Figure 3-1 Approach to achieving Zero Carbon homes



Following a study by the Zero Carbon Hub in which further consultations were undertaken with house builders, consultants and other key stakeholders, it is suggested that the 70% level initially proposed for minimum carbon compliance may be difficult to achieve for many houses and developments.

As a result, the Zero Carbon Hub have produced an Interim Report, dated December 2010, in which further amendments to the level of carbon compliance, which are considered to be more achievable, are suggested. Further, differing levels are proposed for 3 basic different dwelling types – detached house; end terrace house and low rise apartment block.

In addition, it was considered that the previous method of calculating carbon compliance level was confusing and now suggest that an absolute limit in terms of kWh/m2/yr and $kgCO_2$ /m2/yr is set (see Figure 3-2 and Table 3-2 below).

Figure 3-2 ZCH unit type showing Fabric Efficiency Standard

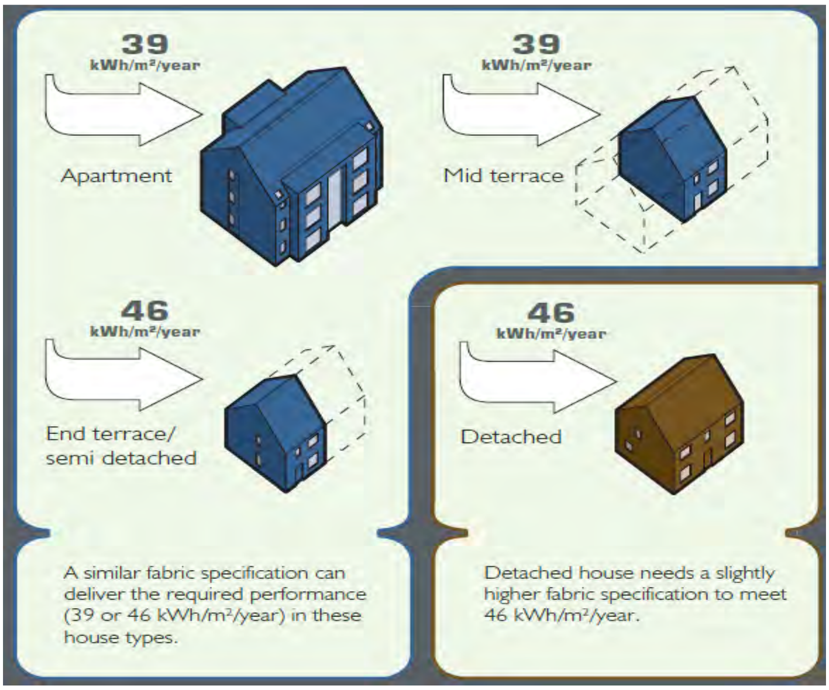


Table 3-2 Fabric Efficiency & Carbon Compliance targets

Built Form	Fabric Standard (kWh/m2/yr)	Carbon Compliance (kgCO2/m2/yr)
Detached houses	46	10
Semi-detached houses	46	11
End of terrace	46	11
Mid terrace	39	11
Apartment block	39	14

3.5.1 Allowable Solutions

Allowable solutions have been introduced to offer flexibility to developers, providing them with an option to offset remaining emissions, when other on-site options are not considered technically and commercially feasible.

Allowable solutions are to become central to the overall policy of ensuring that achieving zero carbon is affordable.

The Government has not yet defined the scope or price of allowable solutions. It is also unclear as to how allowable solutions may be delivered. However, Zero Carbon Hub has recently announced its proposals for a framework for allowable solutions which provide some indication of what might be expected from the final policy.

According to these proposals, the allowable solutions are split into three areas:

1. On-site allowable solutions – This might include measures such as smart appliances, site-based heat storage, electricity storage, waste management systems, LED street lights, flexible demand systems, etc

2. Near-site allowable solutions - This might include measures such as retrofitting low/zero carbon technologies to communal buildings, creation of local sustainable energy projects/infrastructure such as district heating or wind turbines, communal waste management, local energy storage, electric vehicle charging, etc.

3. Off-site allowable solutions - This might include measures such as investing in energy from waste plants, low carbon electricity generation, district heating pipe-work, low carbon cooling, energy storage, flexible demand projects to counterbalance intermittent renewable energy provision, etc.

Allowable solutions will need to deliver the residual carbon emissions equal to that emitted by any new development. It is understood that the housing developers would pay an allowable solutions provider to deliver the required reductions. Recent DCLG consultation document discusses potential price cap strategy; of which some options would encourage competition between allowable solution providers ensuring that money is invested in the most cost-effective solutions. At present, a price cap has not been defined, however the DCLG consultation document proposes costs of between £36/tCO_2 to £90/$tCO_{2;}$ which can make considerable difference to the total cost of zero carbon and the final energy strategy for the development.

Based on the available information, it can be concluded that allowable solutions may be an important part in achieving a developments zero carbon target. Again, the extent to which allowable solutions may be implemented within the development will be determined in the detail design stage of the development, since it will then be possible to establish more accurate energy demands for the buildings.

At this stage, the option to consider the future incorporation of "Allowable Solutions" in the resulting energy strategy is consistent with the overall strategy and appropriate for this stage in the design of the development.

3.6 Local Policy

The existing Cherwell Local Plan 1996, saved polices do not specifically consider energy and carbon emissions.

The following policies are contained within the emerging Cherwell Local Plan 2006 - 2031 that was submitted to the Secretary of State for Examination in Public on 31st January 2014; and as such have yet to be formally adopted.

Policy ESD 2 - Energy Hierarchy

"*In seeking to achieve carbon emissions reductions, we will promote an 'energy hierarchy' as follows:*

- *Prioritise being LEAN - use less energy, in particular by the use of sustainable design and construction measures*
- *Then CLEAN - supply energy efficiently and give priority to decentralised energy supply, and*
- *Then GREEN - use renewable energy.*

The Council's approach to the use of allowable solutions will be developed through the Development Management DPD and the Sustainable Buildings SPD."

Policy ESD 3 - Sustainable Construction

"*All new homes will be expected to meet at least Code Level 4 of the Code for Sustainable Homes with immediate effect, unless exceeded by the standards set for NW Bicester eco-town (See Policy Bicester 1).*

Achieving higher Code levels in the water and energy use categories will be particularly encouraged.

All new non-residential development will be expected to meet at least BREEAM 'Very Good' with immediate effect.

On the strategic sites allocated for development in this Local Plan, the Council expects to see the achievement of higher levels of on-site "carbon compliance" (carbon emissions reductions through energy efficiency and the use of renewable energy) than required through national building regulations.

Proposals for conversion and refurbishment will be expected to show high quality design and high environmental standards, demonstrating sustainable construction methods including but not limited to:

- *Minimising both energy demands and energy loss*
- *Maximising passive solar lighting and natural ventilation*
- *Maximising resource efficiency*
- *Incorporating the use of recycled and energy efficient materials*
- *Reducing waste and pollution and making adequate provision for the recycling of waste*
- *Making use of sustainable drainage methods*
- *Reducing the impact on the external environment and maximising opportunities for cooling and shading (by the provision of open space and water, planting, and green roofs, for example); and*
- *Making use of the embodied energy within buildings wherever possible and re-using materials where proposals involve demolition or redevelopment.*

Should the promoters of development consider that individual proposals would be unviable with the above requirements, 'open-book' financial analysis of proposed developments will be expected so that an in house economic viability assessment can be undertaken. Where it is agreed that an external economic viability assessment is required, the cost shall be met by the promoter."

Policy ESD 4 - Decentralised Energy Systems

"*The use of decentralised energy systems, providing either heating (District Heating (DH)) or heating and power (Combined Heat and Power (CHP)) will be encouraged in all new developments.*

A feasibility assessment for DH/CHP, including consideration of biomass fuelled CHP, will be required for:

- *All residential developments for 400 dwellings or more*
- *All residential developments in off-gas areas for 50 dwellings or more*
- *All applications for non domestic developments above 1000m2 floorspace*

The feasibility assessment should be informed by the renewable energy map at Appendix 5 'Maps' and the national mapping of heat demand densities undertaken by the Department for Energy and Climate Change (DECC) (see Appendix 3: Evidence Base).

Where feasibility assessments demonstrate that decentralised energy systems are deliverable and viable, such systems will be required as part of the development unless an alternative solution would deliver the same or increased benefit."

Policy ESD 5 - Renewable Energy

The Council supports renewable and low carbon energy provision wherever any adverse impacts can be addressed satisfactorily. The potential local environmental, economic and community benefits of renewable energy schemes will be a material consideration in determining planning applications.

Planning applications involving renewable energy development will be encouraged provided that there is no unacceptable adverse impact, including cumulative impact, on the following issues, which are considered to be of particular local significance in Cherwell:

- Landscape and biodiversity including designations, protected habitats and species, and Conservation Target Areas
- Visual impacts on local landscapes
- The historic environment including designated and non designated assets and their settings
- The Green Belt, particularly visual impacts on openness
- Aviation activities
- Highways and access issues, and
- Residential amenity.

A feasibility assessment of the potential for significant on site renewable energy provision (above any provision required to meet national building standards) will be required for:

- All residential developments for 400 dwellings or more
- All residential developments in off-gas areas for 50 dwellings or more
- All applications for non-domestic developments above 1000m2 floorspace

Where feasibility assessments demonstrate that on site renewable energy provision is deliverable and viable, this will be required as part of the development unless an alternative solution would deliver the same or increased benefit. This may include consideration of 'allowable solutions' as Government Policy evolves.

Policy Bicester 1 - North West Bicester Eco-Town

This policy contains a number of elements that directly relate to the use of energy and resultant carbon emissions from the NW Bicester site; these are abstracted from the policy below:

"Development Description*: A new exemplar zero carbon (as defined in the Eco-Towns Supplement to PPSS1) eco development will be developed on land identified at NW Bicester."*

"New non-residential buildings will be BREEAM excellent."

"Homes to be constructed to a minimum of Level 5 of the Code for Sustainable Homes including being equipped to meet the water consumption requirement of Code Level 5."

"Have real time energy monitoring systems, real time public transport information and high speed broadband access, including next generation broadband where possible. Consideration should also be given to digital access to support assisted living and smart energy management systems."

"*Utilities – Utilities and infrastructure which allow for zero carbon and water neutrality on the site and the consideration of sourcing waste heat from Ardley Energy from Waste facility."*

"Zero Carbon (see PPS definition) water neutral development is sought."

"High quality exemplary development and design standards including zero carbon development, Code Level 5 for dwellings at a minimum and the use of low embodied carbon in construction materials."

In addition to the above, CDC has confirmed their expectation that the PPS1 Eco town zero carbon target will be primarily met through on-site measures; and that significant reliance upon Allowable Solutions should not form part of the energy strategy.

4 Baseline Energy Demand and Carbon Emissions

To determine the baseline energy demand for the proposed NW Bicester development a series of building performance energy models were undertaken (see Technical Note ref 5020-UA005241-ESD-R-1, presented in Appendix A).

Whilst the PPS1 Eco town supplement requires that all homes achieve CSH level 4, with associated FEE standards; due to the anticipated progressive improvements in Building Regulations planned by 2016, it was considered more appropriate, as well as a client aspiration, to target these planned FEE standard. As such the adopted standards for NW Bicester are equivalent to the CSH level 5/6 FEE standards for residential dwellings as a minimum and effectively set the baseline energy demands for the NW Bicester site.

The baseline energy demand based for both residential and commercial units are presented in Table 4-1 below (based on the number of residential units and types of commercial development in masterplan schedule 13016(sk) 130L v6 dated 24-12-13).

Table 4-1 Energy Demand

	Energy Demand Section		
	Residential (Level 5/6 option)	Commercial	Total
Regulated Electricity Demand	3,195,610 kWh	4,722,889 kWh	7,918,498 kWh
Unregulated Electricity Demand	17,563,741 kWh	5,189,988 kWh	22,753,729 kWh
Total Electricity Demand	**20,759,351 kWh**	**9,912,876 kWh**	**30,672,227 kWh**
Regulated Gas Demand	27,398,887 kWh	11,770,040 kWh	39,168,927 kWh
UnRegulated Gas Demand	-	3,997,125 kWh	
Total Thermal Demand	**27,398,887 kWh**	**15,767,165 kWh**	**43,166,052 kWh**
Total Energy Demand	**48,158,238 kWh**	**21,682,916 kWh**	**69,841,154 kWh**
Regulated Energy Demand	30,594,496 kWh	16,492,929 kWh	47,087,425 kWh

The corresponding carbon emissions are presented in Table 4-2 below.

Table 4-2 Carbon Emissions

	Carbon Emissions Section		
	Residential (Level 5/6 option)	Commercial	Total
Regulated Electricity	1,659 tonnes CO2	2,451 tonnes CO2	4,110 tonnes CO2
Unregulated Electricity	9,116 tonnes CO2	2,694 tonnes CO2	11,809 tonnes CO2
Total Electricity	10,774 tonnes CO2	5,145 tonnes CO2	15,919 tonnes CO2
Regulated Gas	5,918 tonnes CO2	2,542 tonnes CO2	8,460 tonnes CO2
Unregulated Gas	-	863 tonnes CO2	-
Total Thermal	5,918 tonnes CO2	3,406 tonnes CO2	9,324 tonnes CO2
Total Energy	16,692 tonnes CO2	7,687 tonnes CO2	24,379 tonnes CO2
Sub Total Regulated Energy	7,577 tonnes CO2	4,994 tonnes CO2	12,570 tonnes CO2

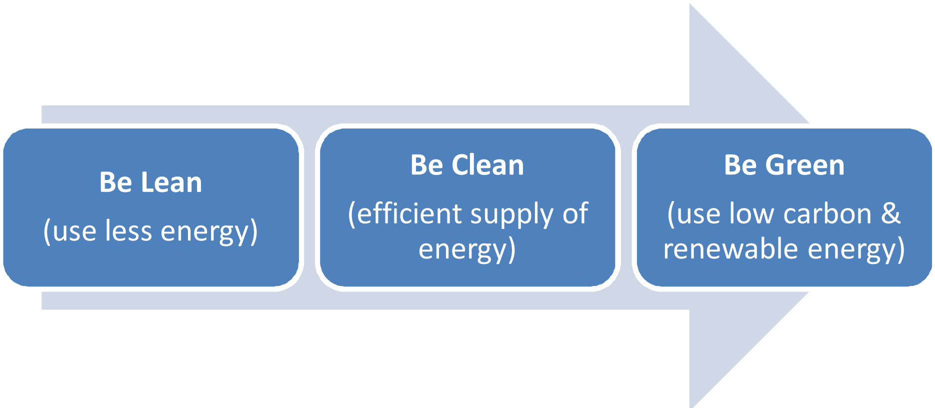
5 Approach to Energy and Carbon Emission Reduction

This report considers the strategic low and zero carbon energy strategies that may be adopted at the site to meet policy and regulatory requirements as well as client aspiration. The proposed technologies and approaches considered seek to meet the energy and carbon requirements, and describe the technical feasibility and economic viability of meeting the required targets. The strategies considered follow the energy hierarchy principles; which are:

Be Lean: Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures;

Be Clean: Supply energy efficiently. Reduce energy consumption through use of low-carbon technology; and

Be Green: Use renewable energy systems.



The first principle stresses the primacy of seeking to reduce energy consumption. Within the built environment this comprises adopting energy efficiency measures in both the design and construction of new buildings. The second principle addresses the 'clean' supply of energy issue. This will require 'decarbonising' and improving efficiency in the generation and distribution of energy. The third principle comprises the use of 'green' energy systems. These are renewable sources of energy with low or zero carbon emissions and include, amongst others, solar generated heat and power, wind energy and biomass.

5.1 Lean Energy

Part L of the 2006 Building Regulations for domestic dwellings highlights the need to ensure energy efficiency in design. The introduction of the Code for Sustainable Homes in 2007 has moved this agenda further forward and has focused on ensuring buildings are well insulated and airtight (as far as practically possible), to retain warmth and reduce the need for heating.

The NW Bicester development will adopt appropriate Code for Sustainable Homes and BREEAM building standards to ensure energy efficiency is the first priority in achieving its zero carbon sustainability objectives.

A range of measures to reduce carbon emissions and increase resilience to climate change can be incorporated into building design; some of these are outlined in Table 5-1 below.

Table 5-1 – Building Energy Efficiency Measures

Design Feature	Adaptation Measure	Technology
Air tightness	Green roofs	A rated appliances
Insulation	Passive cooling	Automatic controls and monitoring
Reduce thermal bridging	High performance glazing	Energy management systems
Passive solar orientation		Energy efficient lighting
Solar shading		Mechanical ventilation
Use of natural daylight		
Natural ventilation		

5.2 Clean and Green Energy

Utilising energy generated locally reduces energy lost through transmission and distribution, and can often take advantage of more advanced generating technologies that combine to provide energy more efficiently. Local generation, or decentralised generation, is produced on a smaller scale nearer to the point of consumption and can offer a number of benefits, including:

- Using generated energy more efficiently by reducing distribution losses
- Contributing to security of energy supply by increasing local energy production

- Increasing reliability of supply providing the opportunity to operate 'on or off grid'
- Reducing carbon emissions through more efficient use of fossil fuels and greater use of locally generated renewable energy
- Provides the opportunity to create stronger links between energy production and consumption.
- Can be linked to fund complementary programmes of work, such as retrofitting micro generation equipment in existing housing stock.
- Provides a visible message of commitment to sustainable energy

Zero Carbon or renewable energy comes from harnessing natural energy flows from the sun, wind, or rain. Many such as solar wind and hydro, directly produce energy and do no emit any carbon dioxide in the process. Others such as biomass, use solar energy to grow renewable plant material that can subsequently be used for energy. Examples here are wood, straw, etc. However, biomass use still generates carbon dioxide when it is burnt. The difference being that this carbon is only that taken from the atmosphere when the plant grew. This is unlike carbon emissions from fossil fuels that are essentially new to the atmosphere, causing increases in atmospheric carbon dioxide levels and climate change. Therefore, when used to replace fossil fuels, biomass leads to a net reduction in carbon emissions; particularly where local supply chains can provide a sustainable supply of biomass.

Energy from waste is considered to be low carbon. While municipal waste combustion contains small elements of things like plastics, the bulk of the material is still organic in nature. Some energy from waste processes can be completely zero carbon, for instance the anaerobic digestion of organic wastes to biogas.

Of the available renewable energy technologies, some are 'intermittent' in nature, such as solar and wind. Others such as biomass, ground source heat pumps and anaerobic digestion can service baseload duties.

To achieve these carbon emission reductions low carbon and/or renewable energy generation options and approaches will need to be utilised. The table (Table 5-2) below identifies those options that are feasible relative to the NW Bicester site; those that are questionable and those that are not. Some technologies can be applied at the building scale (micro), whilst others are larger scale (macro) by their nature.

Table 5-2 Feasible Macro and Micro scale LZC technologies

Macro Solutions (typically district scale or larger)	Feasible	Micro Solutions (typically building related)	Feasible
Anaerobic Digestion CHP	?	Air source heat pumps	Y
Energy from Waste CHP	Y	Ground source heat pumps	Y
Gas CHP	Y	Solar Thermal (building mounted)	Y
Biomass CHP	Y	Solar Photovoltaic (building mounted)	Y
Large scale PV array	Y	Wind energy (building mounted)	Y
Large scale wind energy	?		
Hydro power (wave, tidal or flow)	N		

These options have been considered in the Strategic Options Appraisal report (see Appendix B: Strategic Energy Options Appraisal, February 2014, Report No.: 5021-UA005241-ESD-R-2) which concluded that whilst certain technologies may go a considerable way to meeting demands and creating carbon savings; no one technology can fulfil the site's total energy demand and carbon reduction target. Therefore a combined technology solution will be required.

6 NW Bicester Energy Strategy

The following strategy identifies the approach that is envisaged to be adopted at NW Bicester. This strategy has been derived following consultation with the client and Cherwell District Council relative to what may be considered acceptable.

The strategy follows the energy hierarchy, firstly considering energy efficiency followed by the incorporation of low and zero carbon technologies.

6.1 Be Lean - Energy Efficiency Strategy

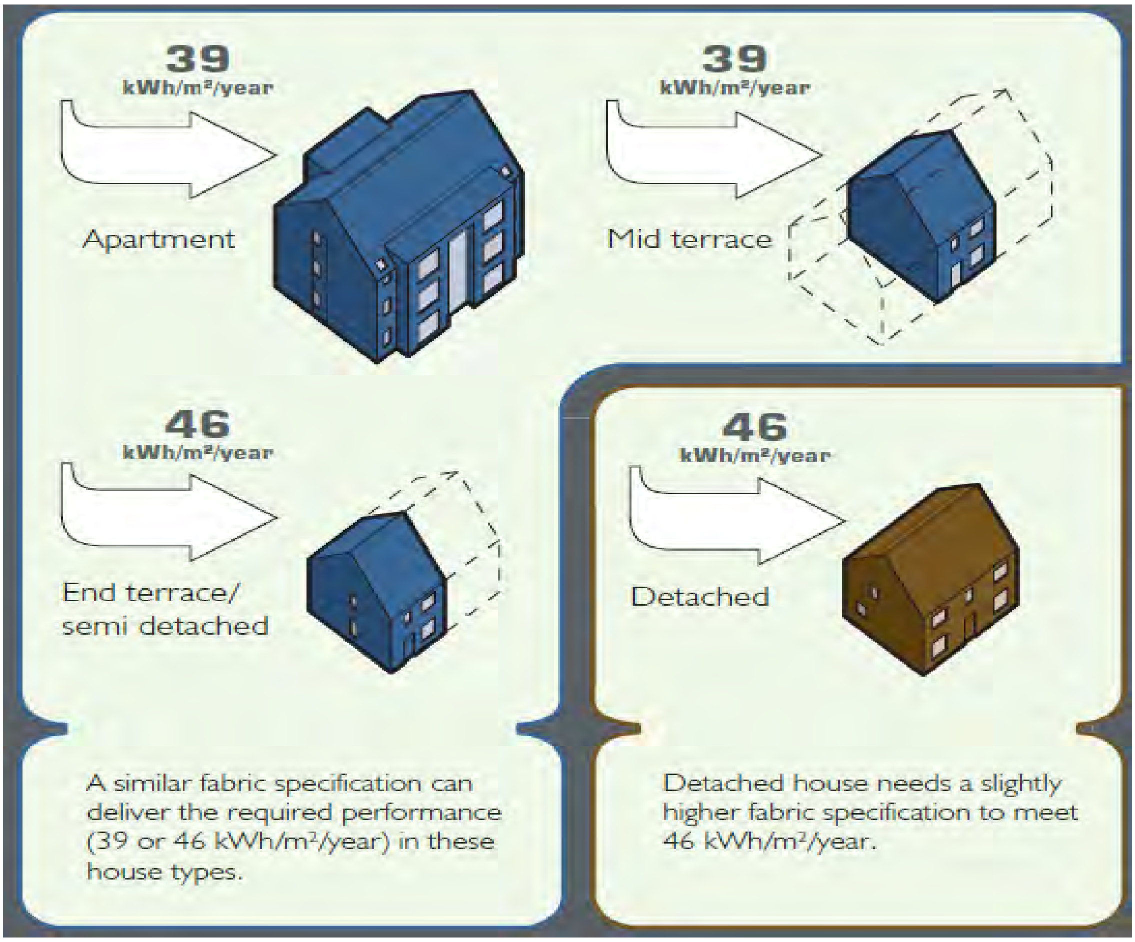
Enhanced Fabric Energy Efficiency (FEE) Standard have been developed specifically in response to developing a strategy for the 2016 zero carbon homes requirement by the Zero Carbon Hub in 2009. This FEE methodology was adopted within the Code for Sustainable Homes (November 2010 version) under Energy section Ene2, with up to 9 credits available for achievement of a range of specific fabric performance levels.

The FEE methodology considers minimising the space heating and cooling (if any) demands of a dwelling through the improvement in building fabric efficiency. This includes enhanced improvements in the following construction procedures to achieve the required FEE levels:

- Building fabric U-values
- Thermal bridging
- Air permeability
- Thermal mass
- Features which affect lighting and solar gains

The FEE is measured in kWh/m²/yr (as shown in Figure 6-1 below), and is not influenced by building services, for example heating system, fixed lighting or ventilation strategy. It is a performance standard, meaning that different combinations of fabric specification can be used to reach a particular level. This allows flexibility when developing a fabric specification. There are different FEE standards proposed in building regulations for different types of dwelling, i.e. detached, semi-detached, end terrace and mid terrace dwellings.

Figure 6-1 ZCH unit type showing Fabric Efficiency Standard



The PPS1 Eco town supplement requires that all homes achieve CSH level 4 including its associated FEE standards. However, with the progressive improvements in Building Regulations planned by 2016, it would be more appropriate to target a higher FEE standard as previously discussed in section 4. Therefore, the adopted building fabric standards will be equivalent to the CSH level 5/6 FEE standards.

Designing to Passihaus standards is another, alternative, approach. The Passivhaus FEE standards reduce the space heating energy demand to below 15kWh/m2/yr. On face value this is significantly lower than the shared CSH 5/6 and 2016 Building Regulation standards; which range from 39 to 46 kWh/m2/yr; however Passivhaus can introduces a 15kWh/m2/yr typical demand relative to cooling; which may be required during the summer months.

It is clear that progressive savings in regulated energy demand can be obtained from adopting higher FEE standards over existing building regulations standards (see Figure 6-2 below) and CSH level 4 FEE (see Figure 6-3 below).

Figure 6-2 shows progressive energy demand savings over Building Regulation 2010 relative to CSH FEE level 4 (17.70%), CSH FEE level 5/6 (23.77%) and Passivhaus FEE (49.50%) standards.

Figure 6-3 shows progressive energy demand savings over CSH FEE level 4 relative to, CSH FEE level 5/6 (7.39%) and Passivhaus FEE (38.65%) standards.

Figure 6-2 Improvements in reduced energy demand relative to BR 2010

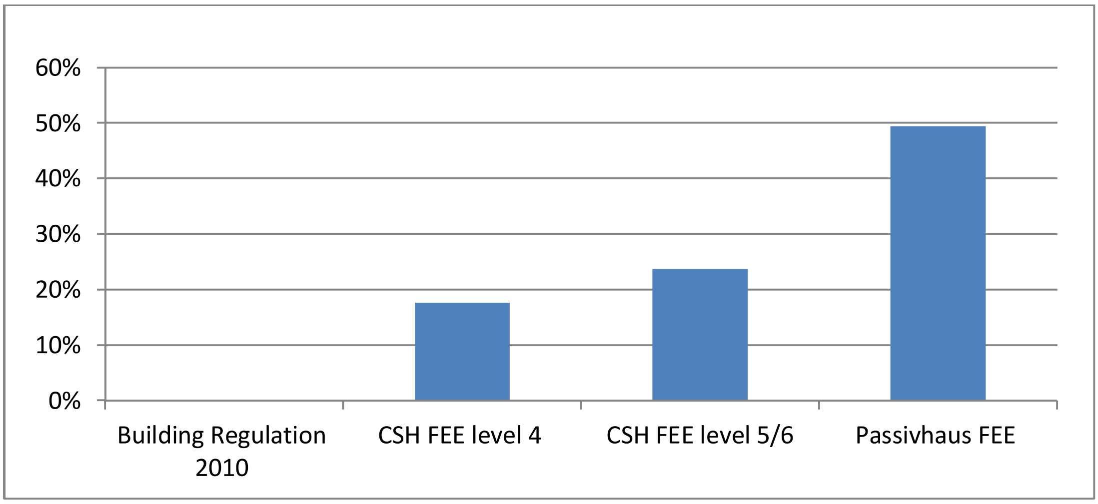
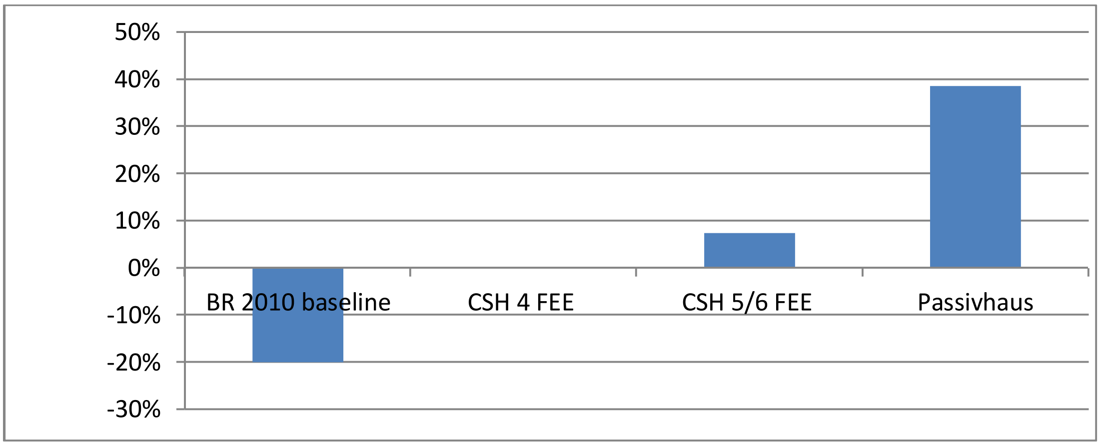


Figure 6-3 Improvements in reduced energy demand relative to CSH level 4 FEES



However, as increased building fabric would result in increased build costs and in some instances additional energy may be required to mechanically ventilate buildings that would otherwise be able to rely on natural ventilation.

As identified above, whilst the PPS1 Eco town supplement requires that all homes achieve CSH level 4; due to the anticipated progressive improvements in Building Regulations planned by 2016 for residential and 2019 for commercial, it is considered more appropriate to target these anticipated FEE standard as a minimum, which are equivalent to the CSH level 5/6 FEE standards.

In addition, the client has derived significant experience with regard to this level of fabric efficiency, as the first phase of NW Bicester has been designed to these standards. Taking the learning and experience from this first phase will be beneficial for the remaining masterplan area.

As such, the remaining carbon emissions across the masterplan will be circa 24,379 tonnes CO2.

6.2 Clean and Green – Low & Zero Carbon Technology Strategy

This energy strategy builds on the Strategic Options Appraisal report (ref: Strategic Energy Options Appraisal, February 2014, Report No.: 5021-UA005241-ESD-R-2) which concluded that whilst certain technologies may go a considerable way to meeting demands and creating carbon savings; no one technology can fulfil the site's total energy demand and carbon reduction target. Therefore a combined technology solution will be required.

The sections below identify various combined technology solutions that seek to achieve the zero carbon target. As previously discussed, they are focused on primarily achieving this target through predominantly on-site and/or direct near site technology rather than a significant reliance on off-site/off-set allowable solution.

Whilst the options below are strategic in nature, they are considered robust enough to demonstrate how the relevant carbon emissions can be achieved. Refinement of these options will be subject to detailed design, testing and optimisation which will be undertaken in tandem with the further development of the masterplan as the scheme progresses towards submission of outline and reserved matter planning applications.

As refinement and optimisation of the options will continue to progress, we have not sought, at this stage, to provide detailed design justification for each element of each option; due to the fact that detailed design has not yet been progressed. Rather the options adopt a strategic approach relative to determination of such elements, such as engine sizing and roof area available for PV etc.

In addition to these energy generating technology options, further exploration of SMART grid technology will continue as the masterplan develops; to explore ways in which energy generated on site can be stored, balanced and used most efficiently, getting maximum benefit from investments in on site generation and minimising the impact of NW Bicester on the local grid.

6.2.1 Option 1 – DHN powered by Biomass CHP, Gas CHP and Gas Boiler plus Building PV

This option is based on the following elements:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Site wide District Heat Network – providing all thermal demand across the site
- Biomass CHP – sized to provide circa 60% of the thermal demand
- Gas CHP – sized to provide circa 30% of the thermal demand
- Gas boiler – sized to provide circa 10% of thermal demand (primarily peak / top up and back up)
- Thermal demand regulated by inclusion of thermal stores
- Plus 50% residential and 60% non-residential of total roof space to be used for PV(orientated in southerly direction)

The table below (Option 1) shows the energy generation and carbon emission savings from this approach.

Option 1 - Biomass CHP, Gas CHP, Boiler and Roof PV (50% Resi, 60% Non-resi)

Energy Demand Section

Technologies	Thermal Generation Capacity	Electrical Generation Capacity	% Total Thermal demands	% Total Electrical demands
Biomass CHP	12,949,816 kWh	6,166,579 kWh	30%	20%
Gas CHP	25,899,631 kWh	11,935,314 kWh	60%	39%
Gas Boiler	4,316,605 kWh	0 kWh	10%	0%
Building Scale PV (50% roof)	0 kWh	22,076,458 kWh	0%	72%
Totals	**43,166,052 kWh**	**40,178,351 kWh**	**100%**	**131%**

Carbon Emissions Section

Technologies	Total Carbon Savings	% Total *(Regulated & Un-Regulated)* Emissions Savings	% Regulated Emissions Savings
Biomass CHP (sized to meet % ofthermal demands)	5,820 tonnes CO2	24%	46%
Gas CHP (sized to meet % ofthermal demands)	7,037 tonnes CO2	29%	56%
Gas Boiler	0 tonnes CO2	0%	0%
Building Scale PV (50% of Roof space)	11,458 tonnes CO2	47%	91%
Total Carbon Saving	**24,315 tonnes CO2**	**100%**	**193%**

As can be seen, this option achieves the true zero carbon emission reduction through the use of on-site LZC alone.

6.2.2 Option 2 – DHN powered by connection to Ardley EfW and Gas Boiler plus Building PV

This option is based on the following elements:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Site wide District Heat Network – providing all thermal demand across the site
- Connection of DHN to Ardley EfW waste heat – assumed to provide circa 90% of the thermal demand
- Gas boiler – sized to provide circa 10% of thermal demand (primarily peak / top up and back up)
- Thermal demand regulated by inclusion of thermal stores
- Plus 50% residential and 60% non-residential of total roof space to be used for PV(orientated in southerly direction)

The table below (Option 2) shows the energy generation and carbon emission savings from this approach.

Option 2 - EfW, Boiler Roof and PV (50% Resi, 60% Non-resi)

Energy Demand Section				
Technologies	**Thermal Generation Capacity**	**Electrical Generation Capacity**	**% Total Thermal demands**	**% Total Electrical demands**
Ardley (EfW)	38,849,447 kWh	0 kWh	90%	0%
Gas Boiler	4,316,605 kWh	0 kWh	10%	0%
Building Scale PV (50% roof)	0 kWh	22,076,458 kWh	0%	72%
Totals	**43,166,052 kWh**	**22,076,458 kWh**	**100%**	**72%**

Carbon Emissions Section			
Technologies	**Total Carbon Savings**	**% Total *(Regulated & Un-Regulated)* Emissions Savings**	**% Regulated Emissions Savings**
Ardley (EfW)	8,391 tonnes CO2	34%	67%
Gas Boiler	0 tonnes CO2	0%	0%
Building Scale PV (50% roof)	11,458 tonnes CO2	47%	91%
Total Carbon Saving	**19,849 tonnes CO2**	**81%**	**158%**
Residual Emissions:	4,530 tonnes CO2		

As can be seen, this option does not achieve true zero carbon emission reduction through the use of on-site LZC alone. The remaining residual carbon emissions from this option would therefore need to be off-set through additional means, such as a near site PV land array and/or other form of allowable solution.

6.2.3 Option 3 - CSH level 5/6 FEES, Biomass boiler, Gas CHP and Gas boiler with Building PV

This option is based on the following elements:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Site wide District Heat Network – providing all thermal demand across the site
- Biomass boiler – sized to provide circa 30% of the thermal demand
- Gas CHP – sized to provide circa 60% of the thermal demand
- Gas boiler – sized to provide circa 10% of thermal demand (primarily peak / top up and back up)
- Thermal demand regulated by inclusion of thermal stores
- Plus 50% residential and 60% non-residential of total roof space to be used for PV(orientated in southerly direction)

The table below (Option 3) shows the energy generation and carbon emission savings from this approach.

Option 3 - Biomass boiler, Gas CHP, Gas Boiler and Roof PV (50% Resi, 60% Non-resi)

Energy Demand Section				
Technologies	**Thermal Generation Capacity**	**Electrical Generation Capacity**	**% Total Thermal demands**	**% Total Electrical demands**
Biomass Boiler	8,633,210 kWh	0 kWh	20%	0%
Gas CHP	30,216,236 kWh	13,924,533 kWh	70%	45%
Gas Boiler	4,316,605 kWh	0 kWh	10%	0%
Building Scale PV (50% roof)	0 kWh	22,076,458 kWh	0%	72%
Totals	**43,166,052 kWh**	**36,000,991 kWh**	**100%**	**117%**

Carbon Emissions Section			
Technologies	**Total Carbon Savings**	**% Total *(Regulated & Un-Regulated)* Emissions Savings**	**% Regulated Emissions Savings**
Biomass Boiler	1,702 tonnes CO2	7%	14%
Gas CHP	8,210 tonnes CO2	34%	65%
Gas Boiler	0 tonnes CO2	0%	0%
Building Scale PV (50% roof)	11,458 tonnes CO2	47%	91%
Total Carbon Saving	**21,370 tonnes CO2**	**88%**	**170%**
Residual Emissions	3,009 tonnes CO2		

As can be seen, this option does not achieve true zero carbon emission reduction through the use of on-site LZC alone. The remaining residual carbon emissions from this option would therefore need to be off-set through additional means, such as a near site PV land array and/or other form of allowable solution.

6.2.4 Option 4 – CSH level 5/6 FEES, Gas CHP and Gas boiler with Building PV

This option is based on the following elements:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Site wide District Heat Network – providing all thermal demand across the site
- Gas CHP – sized to provide circa 90% of the thermal demand
- Gas boiler – sized to provide circa 10% of thermal demand (primarily peak / top up and back up)
- Thermal demand regulated by inclusion of thermal stores
- Plus 50% residential and 60% non-residential of total roof space to be used for PV(orientated in southerly direction)

The table below (Option 4) shows the energy generation and carbon emission savings from this approach.

Option 4 - Gas CHP, Gas boiler and Roof PV (50% Resi, 60% Non-resi)

Energy Demand Section

Technologies	Thermal Generation Capacity	Electrical Generation Capacity	% Total Thermal demands	% Total Electrical demands
Gas CHP	38,849,447 kWh	17,902,971 kWh	90%	58%
Gas Boiler	4,316,605 kWh	0 kWh	10%	0%
Building Scale PV (50% roof)	0 kWh	22,076,458 kWh	0%	72%
Totals	**43,166,052 kWh**	**39,979,429 kWh**	**100%**	**130%**

Carbon Emissions Section

Technologies	Total Carbon Savings	% Total *(Regulated & Un-Regulated)* Emissions Savings	% Regulated Emissions Savings
Gas CHP	10,556 tonnes CO2	43%	84%
Gas Boiler	0 tonnes CO2	0%	0%
Building Scale PV (50% roof)	11,458 tonnes CO2	47%	91%
Total Carbon Saving	**22,014 tonnes CO2**	**90%**	**175%**
Residual Emissions	2,366 tonnes CO2		

As can be seen, this option does not achieve true zero carbon emission reduction through the use of on-site LZC alone. The remaining residual carbon emissions from this option would therefore need to be off-set through additional means, such as a near site PV land array and/or other form of allowable solution.

6.2.5 Option 5 – CSH level 5/6 FEES, Individual unit Biomass Boiler & Mono pitch roof with PV

This option is a radical departure from the current design ethos but is included to demonstrate how other approaches may be used. This option is based on the following elements:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Mono pitch residential roof design to enable 70% of total roof space, plus 60% non-residential of total roof space to be used for PV (orientated in southerly direction)
- Individual (domestic and non-domestic) biomass boilers installed in all buildings

The table below (Option 5) shows the energy generation and carbon emission savings from this approach. The below table also shows a secondary option based on using individual unit high efficiency gas boilers (5a).

Option 5 (& 5a) - Level 5/6 Standards, mono pitch roof PV (70% Resi, 60% Non-resi) & individual Biomass boilers

Energy Demand Section				
Technologies	**Thermal Generation Capacity**	**Electrical Generation Capacity**	**% Total Thermal demands**	**% Total Electrical demands**
Building Scale PV (70% roof)	0 kWh	28,381,159 kWh	0%	93%
Biomass Boiler (to meet thermal demands)	43,166,052 kWh	0 kWh	100%	0%
Totals	**43,166,052 kWh**	**28,381,159 kWh**	**100%**	**93%**
Total (with standard gas boilers)	**43,166,052 kWh**	**28,381,159 kWh**	**100%**	**93%**

Carbon Emissions Section				
Technologies	**Total Carbon Savings**	**% Total *(Regulated & Un-Regulated)* Emissions Savings**	**% Regulated Emissions Savings**	
Building Scale PV (70% roof)	14,730 tonnes CO2	60%	117%	
Biomass Boiler (to meet thermal demands)	8,511 tonnes CO2	35%	68%	
Total Carbon Saving	**23,241 tonnes CO2**	**95%**	**185%**	
Carbon Saving (with standard gas boilers)	**14,730 tonnes CO2**	**60%**	**117%**	
Residual Emissions	1,138 tonnes CO2		**Residual with gas boiler**	9,650 tonnes CO2

As can be seen, this option does not achieve true zero carbon emission reduction through the use of on-site LZC alone. The remaining residual carbon emissions from this option would therefore need to be off-set through additional means, such as a near site PV land array and/or other form of allowable solution.

6.2.6 Option 6 – Passivhaus standards, Individual unit Biomass Boiler & Mono pitch roof with PV

This option is a further radical departure from the current design ethos but is included to demonstrate how other approaches may be used. This option is based on the following elements:

- All residential units are built to Passihaus FEE design standards – this results in a reduction in total carbon emission from 24,622 tonnes CO2 to 22,705 tonnes CO2
- Mono pitch residential roof design to enable 70% of total roof space, plus 60% non-residential of total roof space to be used for PV (orientated in southerly direction)
- Individual (domestic and non-domestic) biomass boilers installed in all buildings

The table below (Option 6) shows the energy generation and carbon emission savings from this approach. The below table also shows a secondary option based on using individual unit high efficiency gas boilers (6a).

Option 6 (& 6a) - Pasivhaus Standards, mono pitch roof PV (70% Resi, 60% Non-resi) & individual Biomass boilers

Energy Demand Section				
Technologies	**Thermal Generation Capacity**	**Electrical Generation Capacity**	**% Total Thermal demands**	**% Total Electrical demands**
Building Scale PV (70% roof	0 kWh	28,381,159 kWh	0%	88%
Biomass Boiler (sized to meet thermal demands)	27,805,909 kWh	0 kWh	100%	0%
Totals	**27,805,909 kWh**	**28,381,159 kWh**	**100%**	**88%**
Total (with standard gas boilers)	**27,805,909 kWh**	**28,381,159 kWh**	**100%**	**88%**

Carbon Emissions Section				
Technologies	**Total Carbon Savings**	**% Total *(Regulated & Un-Regulated)* Emissions Savings**	**% Regulated Emissions Savings**	
Building Scale PV (70% of Roof space)	14,730 tonnes CO2	65%	135%	
Biomass Boiler (sized to meet thermal demands)	5,483 tonnes CO2	24%	50%	
Total Carbon Saving	**20,212 tonnes CO2**	**89%**	**186%**	
Carbon Saving (with standard gas boilers)	**14,730 tonnes CO2**	**65%**	**135%**	
Residual Emissions	2,493 tonnes CO2		**Residual with gas boiler**	7,975 tonnes CO2

As can be seen, this option does not achieve true zero carbon emission reduction through the use of on-site LZC alone. The remaining residual carbon emissions from this option would therefore need to be off-set through additional means, such as a near site PV land array and/or other form of allowable solution.

6.3 Summary of Options

The below table summarises the strategic options identified in the preceding sections.

	Energy Demands				Carbon Emissions			
Options:	Thermal Generation Capacity	Electrical Generation Capacity	% Total Thermal demands	% Total Electrical demands	Total Carbon Savings	% Total *(Regulated & Un-Regulated)* Emissions Savings	% Regulated Emissions Savings	Residual emissions
Option 1 - Biomass CHP, Gas CHP, Boiler and Roof PV (50% Resi, 60% Non-resi)	43,166,052 kWh	40,178,351 kWh	100%	131%	24,315 tonnes CO2	100%	193%	0 tonnes CO2
Option 2 - EfW, Boiler Roof and PV (50% Resi, 60% Non-resi)	43,166,052 kWh	22,076,458 kWh	100%	72%	19,849 tonnes CO2	81%	158%	4,530 tonnes CO2
Option 3 - Biomass boiler, Gas CHP, Gas Boiler and Roof PV (50% Resi, 60% Non-resi)	43,166,052 kWh	36,000,991 kWh	100%	117%	21,370 tonnes CO2	88%	170%	3,009 tonnes CO2
Option 4 - Gas CHP, Gas boiler and Roof PV (50% Resi, 60% Non-resi)	43,166,052 kWh	39,979,429 kWh	100%	130%	22,014 tonnes CO2	90%	175%	2,366 tonnes CO2
Option 5 - Level 5/6 Standards, mono pitch roof PV (70% Resi, 60% Non-resi) & individual	43,166,052 kWh	28,381,159 kWh	100%	93%	23,241 tonnes CO2	95%	185%	1,138 tonnes CO2
Option 5a - as above but with individual Gas boilers	43,166,052 kWh	28,381,159 kWh	100%	93%	14,730 tonnes CO2	60%	117%	9,650 tonnes CO2
Option 6 - Pasivhaus Standards, mono pitch roof PV (70% Resi, 60% Non-resi) & individual	27,805,909 kWh	28,381,159 kWh	100%	88%	20,212 tonnes CO2	89%	186%	2,493 tonnes CO2
Option 6a - as above but with individual Gas boilers	27,805,909 kWh	28,381,159 kWh	100%	88%	14,730 tonnes CO2	65%	135%	7,975 tonnes CO2

The above summary identifies that some options contribute to meeting total energy demands more thoroughly than other options, in relation to total electrical demands. These options also perform better in relation to their total carbon emission savings contribution (namely option 1 and 4).

All of the options meet all regulated emission savings, however, only one option clearly meets all regulated and unregulated emission savings – that is option 1. However, as mentioned earlier, it is recognised that a process of refinement, optimisation and further detailed design will need to be applied as the masterplan progresses toward outline and reserved matters planning application stage.

6.4 Preferred Strategic Approach

The above option scenarios identify various combined technology approaches that seek to achieve the zero carbon target. This recognises that whilst certain technologies may go a considerable way to meeting demands and creating carbon savings; no one technology can fulfil the site's total energy demand and carbon reduction target. Therefore a combined technology solution will be required. As previously discussed, these options are focused on primarily achieving this target through predominantly on-site technology rather than a significant reliance on off-site/off-set allowable solutions.

The above technology combination options demonstrate that true zero carbon can be met through the application of predominantly on-site technology.

Recognising that further optimisation of the available technical solutions will continue as detailed design progresses; such as refinement of available roof area for PV, selection and sizing of CHP engines and associated thermal store to optimise delivery of the thermal demand carbon emission reductions; the preferred approach to enable the true zero carbon target to be met for the NW Bicester development will be based on the following:

- Enhanced fee standards,
- Site wide District Heat Network – providing all thermal demand across the site; linked to Energy Centres,
- On-site Energy Centres – that include LZC technologies that will meet thermal demands and provide sufficient carbon emissions reduction to meet zero carbon target; in combination with,
- Roof mounted PV – optimised relative to layout and building design.

This approach will enable the true zero carbon target to be met predominantly on-site. The technology combinations presented in Section 6.2 above have identified that Option 1 is able to achieve the true zero target without the need to off-set any residual carbon emissions. This option includes:

- Enhanced FEE Standards (equivalent to CSH level 5/6 for residential)
- Site wide District Heat Network – providing all thermal demand across the site

- Biomass CHP – sized to provide circa 60% of the thermal demand
- Gas CHP – sized to provide circa 30% of the thermal demand
- Gas boiler – sized to provide circa 10% of thermal demand (primarily peak / top up and back up)
- Thermal demand regulated by inclusion of thermal stores
- Plus 50% residential and 60% non-residential of total roof space to be used for PV(orientated in southerly direction)

As mentioned above, with continued refinement and optimisation of technology combinations other options are also anticipated to be able to meet the true zero carbon target. This anticipation stems from the experience and learning from the first phase Exemplar site of NW Bicester, which effectively utilises the approach considered under Option 4 in Section 6.2 above.

The strategic approach has been selected because:

- Technically it can achieve the true zero carbon target (i.e. delivering carbon emission savings relative to both regulated and unregulated emissions).
- Ability to be delivered entirely on-site and therefore not have any reliance on any third party agreements.
- Experience of delivering a similar solution, utilising DHN and Energy Centre with LZC, on the first phase Exemplar site of NW Bicester.
- Ability to deliver homes that maintain a traditional design approach.
- Inclusion of a DNH within the preferred option enables future proofing relative to new technology (which can be plugged into the energy centres) and/or potential connection to waste heat from the Ardley EfW facility.

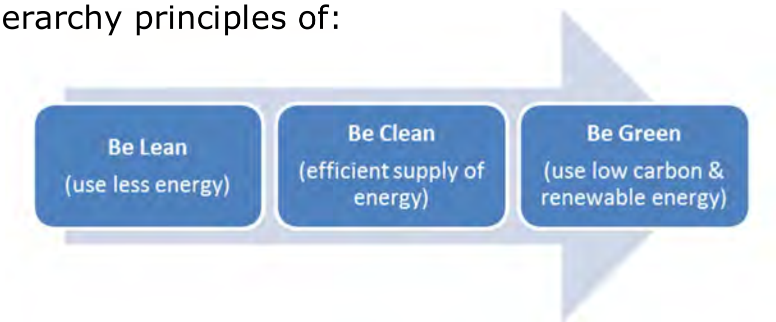
7 Summary

NW Bicester will be required to meet PPS 1 Eco-town supplement zero carbon target; which states that "*over a year the net carbon dioxide emissions from all energy use within the buildings on the eco-town development as a whole are zero or below*".

This means that NW Bicester has to consider both the regulated and unregulated energy use within buildings; which is beyond that required under the current national zero carbon definition that only considers the regulated energy. In addition, discussion with CDC has confirmed their expectation that this target will be primarily met through on-site / near site measures rather than a significant reliance upon off-site / Allowable Solutions.

Together, these aspects make NW Bicester unique in its aspiration to achieve true zero carbon through mainly on-site measures. To achieve this target the NW Bicester masterplan energy strategy follows the energy hierarchy principles of:

- Be Lean
- Be Clean
- Be Green



This energy strategy tested a number of technology solutions. The preferred approach includes building homes and non-domestic buildings to enhanced fabric energy efficiency standards, continuing to develop an on-site heat network across the site powered by a series of on-site energy centres incorporating various low and zero carbon technologies, together with the provision of roof mounted PV on every building. The key elements of this strategy are summaries below:

- Enhanced fee standards,
- Site wide District Heat Network – providing all thermal demand across the site; linked to Energy Centres,
- On-site Energy Centres – that include LZC technologies that will meet thermal demands and provide sufficient carbon emissions reduction to meet zero carbon target; in combination with,
- Roof mounted PV – optimised relative to layout and building design.

This approach is favoured due to a number of factors; these being:

- Technically it can achieve the true zero carbon target (i.e. delivering carbon emission savings relative to both regulated and unregulated emissions).
- Ability to be delivered entirely on-site and therefore not have any reliance on any third party agreements.
- Experience of delivering a similar solution, utilising DHN and Energy Centre with LZC, on the first phase Exemplar site of NW Bicester.
- Ability to deliver homes that maintain a traditional design approach.
- Inclusion of a DNH within the preferred option enables future proofing relative to new technology (which can be plugged into the energy centres) and/or potential connection to waste heat from the Ardley EfW facility.

Appendix A

Energy Strategy

Baseline Energy Demand

Report ref: 5020-UA005241-ESD-R-1

Technical Note

Date	09 September 2013
Reference	5020-UA005241-ESD-R-1
From	Hyder Consulting (UK) Ltd.
To	A2 Dominion, NW Bicester project team
Author	Umer Uzair
Approver	Philip Harker

Subject Baseline Energy Demand

This technical note presents the **baseline energy demand** for the NW Bicester Masterplan for Residential and Commercial Units; based on current energy demands. The baseline is set against compliance with building regulations, calculated using Standard Assessment Procedures (SAP) for residential and the Chartered Institute of Building Services Engineers (CIBSE) energy benchmarks for commercial, without projections for energy efficiencies and future energy use trends.

Further energy demand scenarios are then provided relative to achieving:

- Code for Sustainable Homes (CSH) level 4 fabric energy efficiency (FEE) standards
- CSH level 5&6 FEE
- Passivhaus FEE
- Predicted commercial energy efficiency savings

1 Background:

The baseline energy demands for the proposed NW Bicester master plan site; is based on 5,607 Residential units with various Commercial units. The energy demand calculations are area weighted and mainly dependent upon building area, hence this report utilises the unit areas from the NW Bicester master plan proposed option 6 – Masterplan 13016(sk) 110 REV F V2 11/07/2013 (see table 1 below)

Table 1-1 Bicester Master plan Proposed Options Table

NW BICESTER MASTERPLAN LAND USES						FARRELLS
OPTION 6 - MASERPLAN 13016(sk) 111 REV F						
V2 11/07/2013						
AREAS	EMPLOYMENT	NON RES NIA m2	NON RES GIA m2	Houses	SITE AREA (ha)	NOTES
						(based on density 35/ha & population 2.6/house)
housing	1354			6022	**179.4**	Home working at 17.75% - SQW June 13 jobs budget
secondary school	45.00		4500.00		4.5	
primary school	61.88		16500.00		**8.3**	8-9 CLASSES / YEAR jobs etc to be confirmed
care home / hotel in hubs	75.00		7500.00		1.25	based on 20m2 per resident and one job per 100 m2
care home	90.00		9000.00		2.5	based on 20m2 per resident and one job per 100 m2
B 1 office in hubs	127.06	640.00	2000.00		**0.3**	assumed on one job per 12m2 NIA
Eco business in hubs	325.16	2880.00	5400.00		**0.9**	assumed one job per 15.5m2 NIA
B1 office	1080	12960.00	16200.00		**2.7**	assumed based on one job per 12m2 NIA
B2 B8 commercail	995		35805.00		**6.2**	assumed based on one job per 36m2 GIA
retail in hubs	222.22	1920.00	4400.00		1.10	assumed based on one job per 25m2 NIA
other retail leisure	133.33	1920.00	2400.00		0.6	assumed based on one job per 25m2 NIA
Mixed commercial existing farms	108.44		4880.00		4.88	assumed based on one job per 45 m2
nursery community centre in hubs	36.00		3600.00		0.6	assumed based on one jpb per 100m2
other community	123.00		12300.00		2.05	assumed based on one job per 100 m2
energy centre in hubs	14.00		2800.00		0.6	assumed based on one job per 200m2
Energy water infrastructure					2.1	
Road Infrastructure					12	
GREEN I NFRASTRUCTURE					151.7538	
public amenity and recreation greenspace						
private amenity and recreation greenspace						
TOTAL WITHOUT GREEN INFRASTRUCTURE					229.93	
TOTAL DEVELOPEMNT SITE AREA	4789		127285		381.6838	

[Note: the residential dwelling number has been changed to 5607 units; to reflect a 6000 unit scheme minus the existing Exemplar site (393 units)].

Calculation of the baseline energy demand for Residential units has utilised the SAP 2009 version 9.90 methodologies for the different unit types; from 1 bedroom to 5 bedrooms detached / semi-detached and terrace dwellings. Further energy demand scenarios based upon the Code for Sustainable Homes (CSH) and Passivhaus Fabric Energy Efficiency (FEE) levels for all the residential unit types have also been undertaken to advise on the different energy demands at different FEE levels. The Commercial units energy demands derives from the Chartered Institute of Building Services Engineers (CIBSE) Energy Benchmarks published under reference document TM46 version 2008. A further commercial energy demand scenario has also been modelled taking account of improvements that have occurred between the 2006 and 2010 building regulation.

The above methodologies have been utilised and the results have been taken to estimate the likely energy demands in terms of electricity and fossil fuel (i.e. gas) for the masterplan area. The aim of this note is to demonstrate the energy demand requirements, at a compliance level, without the inclusion of additional energy efficiency, passive measures and/or the application of Low or Zero Carbon technologies etc.

Further energy efficiency scenarios have been calculated, including the CSH level 4 FEE, in recognition that the PPS1 requires all dwellings to meet this level as a minimum and therefore effectively sets the baseline demands of CSH level 4 as the NW Bicester baseline compliance standard.

2 Methodology:

To estimate the energy demands for the proposed Bicester Eco Town we have adopted the following compliance methodologies,

a The Government's Standard Assessment Procedure (SAP) for Energy Rating of Dwellings.

b CIBSE Energy Benchmark TM 46 - 2008

2.1 Standard Assessment Procedure (SAP)

The Standard Assessment Procedure (SAP) is adopted by Government as the UK compliance methodology for calculating the energy performance of dwellings. The calculation is based on the energy balance taking into account a range of factors that contribute to energy efficiency, including:

- Material Used for construction of the dwelling
- Thermal insulation of the building fabric
- Ventilation characteristics of the dwelling and ventilation equipment
- Efficiency and control of the heating systems
- Impact of Solar gain through the opening
- Impact of fuel utilised to provide space heating , hot water, ventilation and lighting
- Impact of Renewable energy technologies

The procedure used for calculation is based on the BRE Domestic Energy Model (BREDEM) which provides a framework for the calculation of energy use in dwellings. The procedure is consistent with the standard BS EN ISO 13790.

The current version of SAP document is SAP 2009 version 9.90 which was published in March 2010 with the Reduced Data SAP applied in April 2011. This document is the compliance tool and mainly utilised within the industry for calculating energy use and the carbon dioxide emissions along with the associated running cost based upon the fuel type to be used by the proposed dwelling.

For the purpose of this baseline we have modelled one, two, three, four and five bedrooms mid terrace, detached and semi-detached dwellings by utilising the SAP compliance software. We have estimated the number of units of each house type based upon the percentage of each dwelling type; and have appraised on the basis of unit type typical size. The table (Table 2.1) below presents the breakdown of dwelling types and their associated areas; assuming a total of 5607 Residential units.

Table 2-1 Breakdown of Unit Areas and percentage of housing mix at Eco Town

Unit Type	% of Unit Type	Total No. of Unit Type	Unit Area (m2)	Total Unit Area (per Unit Type) (m2)
1bed	12%	672.84	62.99	42,382
2beds	40%	2242.80	82.63	185,323
3beds	35%	1962.45	97.54	191,417
4beds	9%	504.63	113.34	57,195
5beds	4%	224.28	150.00	33,642

The above typical unit areas are taken from the NW Bicester Exemplar housing mix and the percentage of each type have been taken from various workshop/meetings discussions; and which are currently the best known working mix for the proposed masterplan. The above areas and percentages are indicative and can be updated when a final unit type and mix are decided.

The above methodology has been adopted to estimate the likely energy demands from the proposed 5607 residential units in compliance with Building Regulations Part L1A. The calculation details and relevant results are provided within the following sections of this report.

2.2 CIBSE Energy Benchmark

The Chartered Institute of Building Services Engineers (CIBSE) describes the statutory building energy benchmarks prepared to complement the Operational Rating procedure developed by the Department of Communities and Local Government (CLG) for Display Energy Certificates (EPC) for use in England, Wales and Northern Ireland.

CIBSE carried out various studies and develop the benchmark proposals based upon CIBSE Guide F and Energy Consumption guide ECG19. There are currently 29 benchmark categories listed under this document, which also sets the energy consumption benchmarks of a typical building type. The benchmarks are expressed in terms of delivered energy used per unit of floor area, (i.e. kWh/m^2) for both electrical and fossil fuel of energy use. This generally covers lighting, heating, cooling, appliances, standard IT and small tea rooms/spaces.

The typical areas of differing commercial classification types are provided within the NW Bicester masterplan 13016(sk) 110REV F V2 proposed option 6 total – v2 -11-07-13. These have reproduced in accordance with building classifications and converted from hectares into square meters; table 2.2 below lists all the proposed commercial classification types and their corresponding areas,

Table 2-2 Breakdown of Electricity and Fossil Fuel Demands for whole Eco Town

Building Classification	Area (ha)	Area (m^2)
Secondary School	4.5	45,000.00
Primary School	8.3	83,000.00
Care home/ hotel in hubs	1.25	12,500.00
Care home	2.5	25,000.00
B1 Office in hubs	0.3	3,000.00
Eco business in hubs	0.9	9,000.00
B1 Office	2.7	27,000.00
B2 to B8 Commercial	6.2	62,000.00
Retail Hubs	1.1	11,000.00
Other Retail Leisure	0.6	6,000.00
Nursery Community centre in hubs	0.6	6,000.00
other community	2.05	20,500.00
energy centre in hubs	0.6	6,000.00

CONVERSION FACTOR: 1 HECTARE = 10,000M2

The areas listed in Table 2.2 have been utilised to estimate the commercial uses energy demands on the basis of CIBSE TM46. The TM46 document sets the benchmarks against various commercial buildings and. listed benchmark figures covers all the building types listed above and considered within NW Bicester masterplan.

The section below provides detail of the calculations undertaken to estimate the total energy demand for the proposed NW Bicester development.

3 Baseline Energy Demand – Building Regulations Part L Compliance

3.1 Residential Dwellings:

This section describes the potential energy demand profiles for the proposed 5,607 residential units. As discussed above we have utilised SAP calculation methodology for the residential units to estimate the energy demands, the demand includes the lighting, pumps & fans, space heating and hot water. To get these demands we have modelled 1 to 5 bedroom detached and semi-detached houses on the basis of typical dwelling areas. To demonstrates the building regulations compliance we have established the following key performance criteria for each house type and predicts the energy demand on this basis,

Table 3-1 SAPs building Regulations Part L1A compliance Scenario

		1 Bedroom	2 Bedroom	3 Bedroom	4 Bedroom	5 Bedroom
Fabric U Values (W/m^2 K)	External Wall	0.25	0.25	0.25	0.20	0.20
	Party Wall	0.00	0.00	0.00	0.00	0.00
	Roof	0.20	0.20	0.20	0.20	0.20
	Floor	0.24	0.24	0.24	0.20	0.20
	Door	1.40 Solid	1.40 Solid	1.40 Solid	1.40 Solid	1.40 Solid
	Window Glazing	1.50 Double Glazed	1.50 Double Glazed	1.50 Double Glazed	1.50 Double Glazed	1.50 Double Glazed
Thermal Bridging (Y Value) (W/m^2 K)		0.08	0.10	0.08	0.10	0.08
Air Leakage m^3/h/m^2@50Pa		6.1				
Lighting		100% Energy Efficient				
Ventilation		Natural				
Heating	Fuel Type	Natural Gas Boiler				
	Efficiency	88.8%	88.8%	88.8%	88.8%	88.8%
	Controls	Time and Temperature Zone Control, Weather Compensator				
Hot Water	Hot Water Cylinder Size	130	145	150	175	215
	Insulation Thickness (mm)	65	65	65	65	65

The above combinations have been used within the calculation software which produces the SAP worksheet reports, to predict the regulated energy demands, i.e. heating, hot water, pumps & fans and lighting for each of the house type and the CO2 emissions for the unregulated (Appliances and Cooking). From this calculation we have taken the total baseline (Building Regulations Compliance) energy demand for the residential component of the NW Bicester master plan.

The SAP output provides the overall annual regulated energy demands in kWh for each house type. The regulated energy demand includes the energy required for running the lighting, pumps & fans, heating and hot water systems within the proposed dwelling. Table 3-2 below shows the breakdown of energy demand for each house type along with the total demand for all 5,607 units,

Table 3-2 Regulated energy demand for 5,607 Units

			ANNUAL REGULATED DEMAND SECTION								
Type	**Units Break down**	**Total Housing Unit area (m^2)**	**Area Weighted Pumps & Fans Demand (kWh/m^2)**	**Pumps & Fans Demand (kWh)**	**Area Weighted Lighting Demand (kWh/m^2)**	**Lighting Demand (kWh)**	**Area Weighted Space Heating Demand (kWh/m^2)**	**space Heating Demand (kWh)**	**Area Weighted Hot Water Demand (kWh/m^2)**	**Hot Water Demand (kWh)**	**Total Demand (kWh)**
1bed	673	42,382	2.79	118,367.12	4.51	191,254.21	51.24	2,171,853.97	33.19	1,406,722.16	3,888,197.45
2beds	2243	185,323	2.11	390,740.35	4.54	841,208.14	44.68	8,279,899.57	27.64	5,121,980.75	14,633,828.81
3beds	1962	191,417	1.79	343,428.75	4.09	782,311.07	47.43	9,079,019.81	24.41	4,672,573.83	14,877,333.45
4beds	505	57,195	1.54	88,310.25	4.54	259,384.87	47.90	2,739,464.70	21.40	1,223,969.97	4,311,129.78
5beds	224	33,642	1.17	39,249.00	4.03	135,572.77	51.17	1,721,378.16	15.77	530,386.32	2,426,586.25
Total	**5607**	**509958.89**	**9.41**	**980,095.46**	**21.70**	**2,209,731.06**	**242.42**	**23,991,616.19**	**122.41**	**12,955,633.02**	**40,137,075.74**

Table 3-2 presents the regulated demands of each residential unit type; providing the area weighted demand and the overall demand of electricity and fossil fuel for each residential units. The total energy demand for all residential units is summarised below,

- Fossil Fuel / Gas = 36,947,249.22 kWh (this includes space heating and hot water)
- Electricity = 3,189,826.52 kWh (this includes lighting, pumps and fans)

The SAP worksheets are provided under Appendix A of this report.

Estimate of the annual unregulated demands, i.e. from appliances and cooking; have been calculated on the basis of SAP methodology and derived from the formula below,

A. Calculate the non-regulated carbon emissions (appliances & cooking) by:

i. For elec oven, elec hob:

$\{275 + (55 \times N) + 207.8 \times (N \times TFA)^{0.4714}\} \times 0.527$

ii. For elec oven, gas hob:

$\{137.5 + (27.5 \times N) + 207.8 \times (N \times TFA)^{0.4714}\} \times 0.527 + \{280.5 + (48.15 \times N)\} \times 0.227$

iii. For gas oven, gas hob:

$\{481 + (96.3 \times N)\} \times 0.227 + \{207.8 \times (N \times TFA)^{0.4714}\} \times 0.527$

Where N = number of occupants, defined in SAP2009 (Table 1b) by:

THE ABOVE FORMULA HAS BEEN TAKEN FROM CARBON COMPLIANCE ZERO CARBON HUB'S DOCUMENT, MODELLING 2016 USING SAP 2009 TECHNICAL GUIDE

The above depicts differing scenarios which have been adopted to estimate the unregulated energy demands relevant to appliances and cooking. We have separated these out to provide the following:

- Electrical appliances
- Cooking – three options:
  - electric oven / electric hob,
  - electric oven / gas hob and
  - gas oven / gas hob.

Tables 3.3 to 3.6 below show the results for each of the above scenarios,

Table 3-3 Electrical Appliances demand for 5,607 Units

House Type	TFA	Total Electric Appliances Demand (kWh/m2)	Total Electric Appliances Demand (kWh)
1bed	42,382	32.67	1384436.88
2beds	185,323	31.13	5769996.83
3beds	191,417	29.56	5658081.92
4beds	57,195	27.86	1593235.66
5beds	33,642	24.42	821523.82
Total	**509,959**	**145.64**	**15,227,275.11**

THE ABOVE TABLE IS BASED UPON 207.8X(NXTFA)^0.4714 X 0.517

Table 3.3 shows that the total unregulated electrical demand for Appliance for all 5607 units = 15,227,275.11 kWh

Table 3-4 Electric Oven & Electric Hob Demand for 5,000 Units

House Type	TFA	Total Cooking (All Electric) (kWh/m2)	Total Cooking (All Electric) (kWh)
1bed	42,382	6.16	261108.35
2beds	185,323	5.00	927289.02
3beds	191,417	4.35	832781.36
4beds	57,195	3.80	217416.05
5beds	33,642	2.91	97871.53
Total	**509,959**	**22.23**	**2,336,466.31**

THE ABOVE TABLE IS BASED UPON (275+(55X N))X0.517

Table 3.4 shows that the total unregulated cooking demand based upon an all-electric scenario = 2,336,466.31 kWh

Table 3-5 Electric Oven & Gas Hob Demand

House Type	TFA	Total Cooking (half electric, half gas) (kWh/m2)	Total Cooking (half electric, half gas) (kWh)
1bed	42,382	9.10	385888.05
2beds	185,323	7.26	1344834.90
3beds	191,417	6.29	1204807.99
4beds	57,195	5.49	314100.40
5beds	33,642	4.20	141229.68
Total	**509,959**	**32.35**	**3,390,861.02**

THE ABOVE TABLE IS BASED UPON (137.5+(27.5XN)X0.517)+(280.5+(48.15XN)X0.198)

Table 3.5 shows that the total unregulated cooking demand based upon electric oven, gas hob scenario = 3,390,861.02 kWh

Table 3–6 Gas Oven & Gas Hob

House Type	TFA	Total Cooking (All Gas) (kWh/m2)	Total Cooking (All Gas) (kWh)
1bed	42,382	10.78	456840.56
2beds	185,323	8.75	1622477.38
3beds	191,417	7.61	1457143.22
4beds	57,195	6.65	380423.42
5beds	33,642	5.09	171252.01
Total	**509,959**	**38.89**	**4,088,136.60**

THE ABOVE TABLE IS BASED UPON (481+ (96.3XN) X0.198

Table 3.6 shows that the total unregulated cooking demand based upon an all gas scenario = 4,088,136.60 kWh

The above scenarios shows the unregulated energy demands of appliances and cooking based upon the proposed NW Bicester masterplan option of 5607 residential units. Below is the summary of the unregulated energy demands:

- Total unregulated appliance demands = 15,227,275.11 kWh
- Total unregulated cooking demand (all electric) = 2,336,446.31 kWh
- Total unregulated cooking demand (electric oven, gas hob) = 3,390,861.02 kWh
- Total unregulated cooking demand (all gas) = 4,088,136.60 kWh

3.2 Commercial Properties:

The NW Bicester masterplan includes range of commercial buildings and this section describes the potential energy demands for the baseline scheme based upon established energy benchmarks. Table 3-7 below lists the anticipated energy demands taken from CIBSE TM46 document which are consistent with Building Regulations Part L 2006.

Table 3-7 Commercial Units Area breakdown

Building Classification	Fossil Fuel Benchmark (kWh/m^2) PA	Electricity Benchmark (kWh/m^2) PA
A1 – Retail Hub	105	400
A1 – Other Retail Leisure	170	70
B2 – B8 Commercial	120	95
B1 Office in Hubs	120	95
Eco Business in Hubs	120	95
B1 Office	120	95
Care Home/ Hotel in hubs	330	105
Care Home	420	65
Primary Schools	150	40
Secondary School	150	40
Nursery Community Centre in Hubs	200	70
Other Community	105	20
Energy Centre in Hubs	180	35

The above benchmarks have been used within the calculations to estimate the energy demands of each of the above commercial building. The above fossil fuel and electricity benchmarks and based upon the annual benchmarks and are indicative at this stage. However, as these are based on values consistent with 2006 Building Regulations it is likely that the NW Bicester eco development demands would be lower than the above estimated. This is further discussed in Section 4.

Table 3-8 below, lists the proposed building gross external areas of the commercial building types that are anticipated to form part of the masterplan; and are therefore included within the energy demand assessment.

Table 3-8 Breakdown of Areas for Commercial Units

Building Classification	Area (ha)	Area (m^2)
Secondary School	4.5	45,000.00
Primary School	8.3	83,000.00
Care home/ hotel in hubs	1.25	12,500.00
Care home	2.5	25,000.00
B1 Office in hubs	0.3	3,000.00
Eco business in hubs	0.9	9,000.00
B1 Office	2.7	27,000.00
B2 to B8 Commercial	6.2	62,000.00
Retail Hubs	1.1	11,000.00
Other Retail Leisure	0.6	6,000.00
Nursery Community centre in hubs	0.6	6,000.00
other community	2.05	20,500.00
energy centre in hubs	0.6	6,000.00

CONVERSION FACTOR: 1 HECTARE = 10,000M2

The above gross external areas have been taken from the NW Bicester Masterplan options schedule (see Table 1) and also utilised within the calculations to estimate the commercial buildings energy demands. As the energy benchmark data is provided in the form of fossil fuel and electricity; the energy estimation is in line with the above standard.

The following table 3-9 shows the fossil fuel and electricity demands of each of the building type,

Table 3-9 Baseline Electricity and Fossil Fuel Demands for Commercial Units

Building Classification	Description	Total Proposed Site Area (m^2)	GIA Area (m^2)	Typical Annual Electricity Benchmarks (kWh/m^2)	Typical Annual Electricity Demand (kWh)	Typical Annual Fossil Fuel Benchmarks (kWh/m^2)	Typical Annual Fossil Fuel Demand (kWh)
A1	**Shops**						
	Retail Hub	11,000	4,400	400	1,760,000	105	392,700
	other Retail Leisure	6,000	2,400	70	168,000	170	346,800
B2 to B8	Commercial	62,000	35,805	95	3,401,475	120	3,652,110
B1	**Offices**						
	B1 Office in hubs	3,000	2,000	95	190,000	120	204,000
	Eco business in hubs	9,000	5,400	95	513,000	120	550,800
	B1 Office	27,000	16,200	95	1,539,000	120	1,652,400
C2	**Residential Institutions**						
	Care home/ hotel in hubs	12,500	7,500	105	787,500	330	2,103,750
	Care home	25,000	9,000	65	585,000	420	3,213,000
	Public Buildings						
	Primary Schools	83,000	16,500	40	660,000	150	2,103,750
	Secondary School	45,000	4,500	40	180,000	150	573,750
	Others Non Residential Buildings						
	Nursery Community centre in hubs	6,000	3,600	70	252,000	200	612,000
	Other Community	20,500	12,300	20	246,000	105	1,097,775
	energy centre in hubs	6,000	2,800	35	98,000	180	428,400
		Total	**122,405**		**10,379,975**		**16,931,235**

THE HEATING DEMAND HAS BEEN CALCULATED BY UTILISING 85% BOILER EFFICIENCY FACTOR

The above benchmarks have been taken from “CIBSE TM 46 - table 1” Benchmark categories and the Gross internal areas are taken from the NW Bicester master plan proposed options 6 – v2 -01-07-2013. The above table list the total energy demands of each of the building types and also the total for the total commercial aspect of the NW Bicester eco development. The total demands are summarised below:

- Typical Annual total Electricity Demand = 10,379,975 kWh
- Typical Annual total Fossil Fuel Demand = 16,931,235 kWh
- Hence the total energy demand of the total commercial development = 27,311,210 kWh

The above energy demand is indicative and based upon the areas listed above however if the proposed areas change then the annual demand should also be changed.

4 Enhanced Fabric Energy Efficiency (FEE) Standards

As mentioned previously the baseline has been considered to demonstrate compliance with current (2010) Building Regulations. However to meet the PPS 1 planning requirement; CSH level 4 FEE criteria should be adopted. In addition, understanding the extent to which differing FEE standards influence the total energy demand from the development forms an integral part of determining which zero carbon solution may be adopted.

4.1 CSH Level 4 FEE standards

To demonstrate the CSH FEE level compliance for CSH level 4, we have followed the requirements of the CSH Technical Guidance (2010); as shown below.

Criteria			
Dwelling Type*[1]			
Apartment Blocks, Mid-Terrace	End Terrace, Semi-Detached & Detached		
Fabric Energy Efficiency kWh/m²/year		Credits*[2]	Mandatory Levels
≤ 48	≤ 60	3	
≤ 45	≤ 55	4	
≤ 43	≤ 52	5*[3]	
≤ 41	≤ 49	6	
≤ 39	**≤ 46**	**7**	**Levels 5 & 6**
≤ 35	≤ 42	8	
≤ 32	≤ 38	9	
Default Cases			
None			

To enable the above FEE standards to be met (Apartment blocks and Mid terrace dwellings =≤43 kWh/m2/year and End Terrance, Semi Detached and Detached =≤52 kWh/m2/year); we have established the following key performance criteria for each house type and predict the energy demand on this basis.

Table 4-1 SAPs CSH FEE Level 4 compliance scenario

		1 Bedroom	2 Bedroom	3 Bedroom	4 Bedroom	5 Bedroom
Fabric U Values (W/m² K)	External Wall	0.18	0.18	0.2	0.18	0.18
	Party Wall	0	0	0	0	0
	Roof	0.13	0.13	0.18	0.18	0.18
	Floor	0.15	0.15	0.2	0.2	0.2
	Door	1.2 Solid	1.2 Solid	1.4 Solid	1.4 Solid	1.4 Solid
	Window Glazing	1.4 Double Glazed	1.4 Double Glazed	1.4 Double Glazed	1.4 Double Glazed	1.5 Double Glazed
Thermal Bridging (Y Value) (W/m2 K)		0.08	0.04	0.06	0.08	0.04
Air Leakage m3/h/m2@50Pa		4.8	4.8	5.1	4.8	5.8

The above combinations have been used within the calculation software which produces the SAP worksheet reports, to predict the regulated energy demands, i.e. heating, hot water, pumps & fans and lighting for each house type. From this calculation we have taken the total CSH Level 4 compliance energy demand for the residential component of the NW Bicester masterplan based on 5607 units.

The SAP output provides the overall annual regulated energy demands in kWh, for each house types. The regulated energy demand includes the energy required for running the lighting, pumps & fans, heating and hot water systems within the proposed dwelling to meet the CSH level 4 FEE compliance. Table 4-2 below shows the breakdown of energy demand for each house type along with the total demand based on 5,607 units.

Table 4-2 Regulated energy demand for 5,607 Units to meet the CSH level 4 FEE Compliance

			ANNUAL REGULATED DEMAND SECTION								
Type	**Units Break down**	**Total Housing Unit area (m^2)**	**Area Weighted Pumps & Fans Demand (kWh/m^2)**	**Pumps & Fans Demand (kWh)**	**Area Weighted Lighting Demand (kWh/m^2)**	**Lighting Demand (kWh)**	**Area Weighted Space Heating Demand (kWh/m^2)**	**space Heating Demand (kWh)**	**Area Weighted Hot Water Demand (kWh/m^2)**	**Hot Water Demand (kWh)**	**Total Demand (kWh)**
1bed	673	42,382	2.79	118,367.12	4.51	191,254.21	27.80	1,178,131.59	33.40	1,415,758.65	2,903,511.55
2beds	2243	185,323	2.11	390,740.35	4.54	841,208.14	27.33	5,064,776.36	27.80	5,151,610.03	11,448,334.88
3beds	1962	191,417	1.79	343,428.75	4.09	782,311.07	36.91	7,065,918.97	24.41	4,671,945.84	12,863,604.63
4beds	505	57,195	1.54	88,310.25	4.54	259,384.87	38.30	2,190,684.62	21.50	1,229,576.41	3,767,956.15
5beds	224	33,642	1.17	39,249.00	4.03	135,572.77	39.95	1,344,094.34	15.83	532,463.15	2,051,379.26
Total	**5607**	**509958.89**	**9.41**	**980,095.46**	**21.70**	**2,209,731.06**	**170.30**	**16,843,605.88**	**122.94**	**13,001,354.08**	**33,034,786.48**

Table 4-2 presents the regulated demands of each residential unit type; providing the area weighted demand and the overall demand of electricity and fossil fuel. The total energy demand for all residential units is summarised below:

- Fossil Fuel / Gas = 29,844,959.95 kWh (this includes space heating and hot water)
- Electricity = 3,189,826.52 kWh (this includes lighting, pumps and fans)

The above table shows that the overall energy demand has been reduced from a Building Regulation 2010 baseline of 40,137,075.74kWh to 33,034,786.18kWh due to the improvements of fabric efficiency, air tightness and ventilation standards. This equates to an overall reduction in energy demand of **17.70%** been achieved by adopting a CSH FEE level 4 compliant building fabric.

Copies of the CSH compliance SAP worksheet are provided under Appendix B of this report.

4.2 CSH Level 5/6 FEE standards

To demonstrate the CSH FEE level compliance for CSH level 5/6, we have followed the requirements of the CSH Technical Guidance (2010); as shown below.

Criteria			
Dwelling Type*[1]			
Apartment Blocks, Mid-Terrace	End Terrace, Semi-Detached & Detached		
Fabric Energy Efficiency kWh/m²/year		Credits*[2]	Mandatory Levels
≤ 48	≤ 60	3	
≤ 45	≤ 55	4	
≤ 43	≤ 52	5*[3]	
≤ 41	≤ 49	6	
≤ 39	**≤ 46**	**7**	**Levels 5 & 6**
≤ 35	≤ 42	8	
≤ 32	≤ 38	9	
Default Cases			
None			

To enable the above FEE standards to be met (Apartment blocks and Mid terrace dwellings =≤39 kWh/m2/year and End Terrance, Semi Detached and Detached =≤46 kWh/m2/year); we have established the following key performance criteria for each house type and predict the energy demand on this basis.

Table 4-3 SAPs CSH FEE Level 5 & 6 compliance scenario

		1 Bedroom	2 Bedroom	3 Bedroom	4 Bedroom	5 Bedroom
Fabric U Values (W/m^2 K)	External Wall	0.15	0.15	0.15	0.15	0.15
	Party Wall	0.00	0.00	0.00	0.00	0.00
	Roof	0.13	0.13	0.13	0.13	0.13
	Floor	0.15	0.15	0.18	0.15	0.15
	Door	1.2 Solid	1.2 Solid	1.40 Solid	1.40 Solid	1.40 Solid
	Window	1.0 Triple Glazed	1.20 Double Glazed	1.4 Double Glazed	1.4 Double Glazed	1.20 Double Glazed
Thermal Bridging (Y Value) (W/m2 K)		0.04	0.05	0.08	0.05	0.04
Air Leakage m3/h/m2@50Pa		4.8	4.8	4.8	4.8	4.8

The above table 4-3 lists the proposed u values improvements for each of the dwelling types to meet the CSH level 5/6 compliance. Table 4.4 on next page shows the results obtained from the change of the above fabric efficiencies within the SAP model.

The SAP output provides the overall annual regulated energy demands in kWh, for each house types. The regulated energy demand includes the energy required for running the lighting, pumps & fans, heating and hot water systems within the proposed dwelling to meet the CSH level 5/6 FEE compliance. Table 4-4 below shows the breakdown of energy demand for each house type along with the total demand based on 5,607 units,

Table 4-4 Regulated energy demand for 5,607 Units to meet the CSH level 5/6 FEE Compliance

			ANNUAL REGULATED DEMAND SECTION								
Type	**Units Break down**	**Total Housing Unit area (m^2)**	**Area Weighted Pumps & Fans Demand (kWh/m^2)**	**Pumps & Fans Demand (kWh)**	**Area Weighted Lighting Demand (kWh/m^2)**	**Lighting Demand (kWh)**	**Area Weighted Space Heating Demand (kWh/m^2)**	**space Heating Demand (kWh)**	**Area Weighted Hot Water Demand (kWh/m^2)**	**Hot Water Demand (kWh)**	**Total Demand (kWh)**
1bed	673	42,382	2.79	118,367.12	4.65	197,037.28	23.78	1,008,054.95	33.53	1,420,939.74	2,744,399.09
2beds	2243	185,323	2.11	390,740.35	4.54	841,208.14	23.52	4,359,389.56	27.90	5,170,588.85	10,761,926.90
3beds	1962	191,417	1.79	343,428.75	4.09	782,311.07	31.28	5,987,140.58	24.51	4,691,295.60	11,804,176.00
4beds	505	57,195	1.54	88,310.25	4.54	259,384.87	32.50	1,858,890.39	21.58	1,234,203.87	3,440,789.38
5beds	224	33,642	1.17	39,249.00	4.03	135,572.77	33.71	1,134,219.84	15.88	534,163.19	1,843,204.81
Total	**5607**	**509958.89**	**9.41**	**980,095.46**	**21.84**	**2,215,514.14**	**144.80**	**14,347,695.33**	**123.39**	**13,051,191.25**	**30,594,496.18**

Table 4-4 presents the regulated demands of each residential unit type; providing the area weighted demand and the overall demand of electricity and fossil. The total energy demand for all residential units is summarised below:

- Fossil Fuel / Gas = 27,398,886.58 kWh (this includes space heating and hot water)
- Electricity = 3,195,609.60 kWh (this includes lighting, pumps and fans)

The above slight increase in electricity demand occurs due to the replacement of double glazed window to triple glazed in 1 bedroom dwellings, which reduces natural day lighting and thus increases artificial lighting demands.

The overall energy demand has been reduced from a Building Regulation 2010 baseline of 40,137,075.74kWh to 30,594,496.18kWh. This equates to an overall reduction in energy demand of **23.77%** been achieved from compliance to CSH FEE level 5/6. Reduction in energy demand between CSH FEE level 4 compliance of 33,034,786.48kWh to CSH FEE level 5/6 of 30,594,496.18kWh equals **7.39%.**

Copies of the CSH compliance SAP worksheet are provided under Appendix C of this report.

4.3 Passivhaus FEE standards

We have further assessed the dwelling for Passivhaus standards and obtained the following results by further improving the fabric efficiencies, air tightness and ventilation standards, The table below is set of U values and other measures have been used within the SAP model to meet the passivhaus compliance standards,

Table 4-5 SAPs Passivhaus compliance scenario

		1 Bedroom	2 Bedroom	3 Bedroom	4 Bedroom	5 Bedroom
Fabric U Values (W/m^2 K)	External Wall	0.15	0.15	0.15	0.15	0.15
	Party Wall	0.00	0.00	0.00	0.00	0.00
	Roof	0.15	0.15	0.15	0.15	0.15
	Floor	0.15	0.15	0.15	0.15	0.15
	Door	1.2 Solid	1.2 Solid	1.2 Solid	1.2 Solid	1.2 Solid
	Window	0.80 Triple Glazed	0.80 Triple Glazed	0.80 Triple Glazed	0.80 Triple Glazed	0.80 Triple Glazed
Thermal Bridging (Y Value) (W/m2 K)		0.04	0.04	0.04	0.04	0.04

The above table 4-5 lists the proposed u values improvements for each of the dwelling types to meet the passivhaus compliance. The table on next page shows the results obtained from the change of the above fabric efficiencies within the SAP model.

The SAP output provides the overall annual regulated energy demands in kWh, for each house types. The regulated energy demand includes the energy required for running the lighting, pumps & fans, heating and hot water systems within the proposed dwelling to meet the passivhaus compliance. Table 4-6 below shows the breakdown of energy demand for each house type along with the total demand for the whole 5,607 units,

Table 4-6 Regulated energy demand for 5,607 Units to meet the Passivhaus Compliance

			ANNUAL REGULATED DEMAND SECTION								
Type	**Units Breakdown**	**Total Housing Unit area (m^2)**	**Area Weighted Pumps & Fans Demand (kWh/m^2)**	**Pumps & Fans Demand (kWh)**	**Area Weighted Lighting Demand (kWh/m^2)**	**Lighting Demand (kWh)**	**Area Weighted Space Heating Demand (kWh/m^2)**	**space Heating Demand (kWh)**	**Area Weighted Hot Water Demand (kWh/m^2)**	**Hot Water Demand (kWh)**	**Total Demand (kWh)**
1bed	673	31,495	4.65	197,037.28	4.65	197,037.28	4.54	192,512.28	34.49	1,461,691.85	2,048,278.70
2beds	2243	123,945	4.17	772,281.55	4.67	866,059.23	3.87	716,930.39	28.77	5,331,216.62	7,686,487.79
3beds	1962	195,080	3.55	679,125.45	4.15	794,988.50	4.20	803,701.77	25.43	4,868,308.59	7,146,124.30
4beds	505	85,005	3.56	203,880.61	4.65	266,091.40	7.88	450,917.18	22.28	1,274,261.40	2,195,150.59
5beds	224	37,500	3.45	116,206.20	4.13	138,925.76	11.58	389,442.03	16.26	546,886.59	1,191,460.59
Total	**5607**	**473025**	**19.38**	**1,968,531.09**	**22.26**	**2,263,102.17**	**32.07**	**2,553,503.66**	**127.22**	**13,482,365.05**	**20,267,501.97**

Table 4-6 presents the regulated demands of each residential unit type; providing the area weighted demand and the overall demand of electricity and fossil fuel for each residential units. The total energy demand for all residential units is summarised below,

- Fossil Fuel / Gas = 16,035,868.71kWh (this includes space heating and hot water)
- Electricity = 4,231,633.26 kWh (this includes lighting, pumps and fans)

The above increase in electricity demand occur due to the replacement of double glazed window to triple glazed in all the dwelling types, as due to reduced natural day lighting the lighting demands have increased; plus mechanical ventilation the pumps & fans demand has also been increased.. The fossil fuel demand is generally only for the hot water demand (with very limited heating demand) and therefore represents a decrease in overall demand from the previous scenarios.

The overall energy demand has been reduced from a Building Regulation 2010 baseline of 40,137,075.74kWh to 20,267,501.97 kWh. This equates to an overall reduction in energy demand of **49.50%** been achieved from compliance to CSH FEE level 5/6. Reduction in energy demand between CSH FEE level 4 compliance of 33,034,786.48kWh to passivhaus FEE standards of 20,267,501.97 kWh equals 38.65%.

Copies of the passivhaus compliance SAP worksheet are provided under Appendix D of this report.

4.4 Summary of Enhanced FEE Scenarios

The regulated energy demand of each dwelling type have been assessed on the basis of differing CSH and Passivhaus FEE standards to establish the likely improvements above baseline demands. The savings in regulated energy demand shown are through in improvements in the fabric efficiency, ventilation, thermal bridging and air tightness proposed.

The charts below shows the impact of each change with regards to the % improvement in overall energy demands relative to Building regulation 2010 compliance (Chart 1) and against CSH level 4 FEE standards (Chart 2); which is effectively the baseline for the NW Bicester eco-development.

Chart 1 - Showing improvement relative to BR 2010 baseline

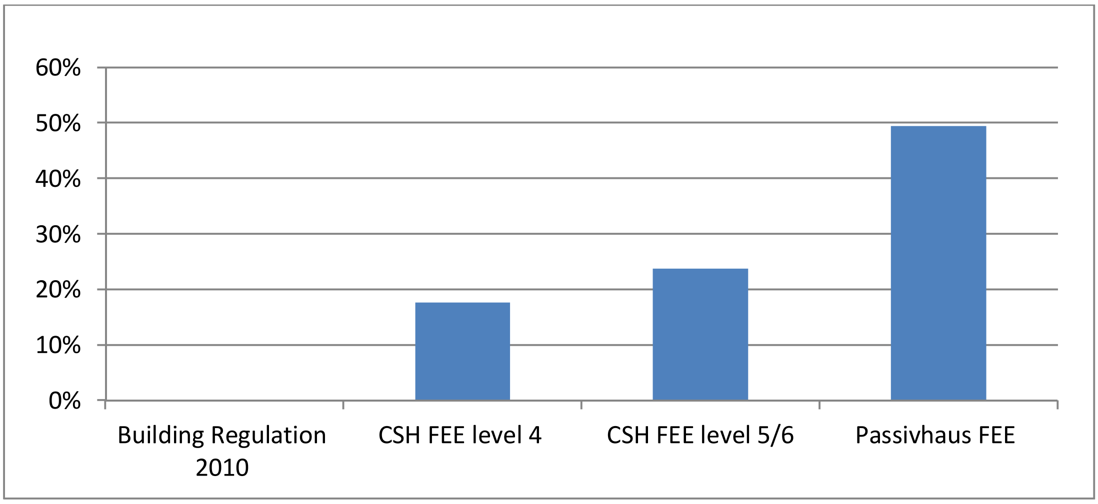


Chart 1 shows progressive energy demand savings over Building Regulation 2010 relative to CSH FEE level 4 (17.70%), CSH FEE level 5/6 (23.77%) and Passivhaus FEE (49.50%) standards.

Chart 2 – Showing improvement relative to CSH level 4 (effective site baseline)

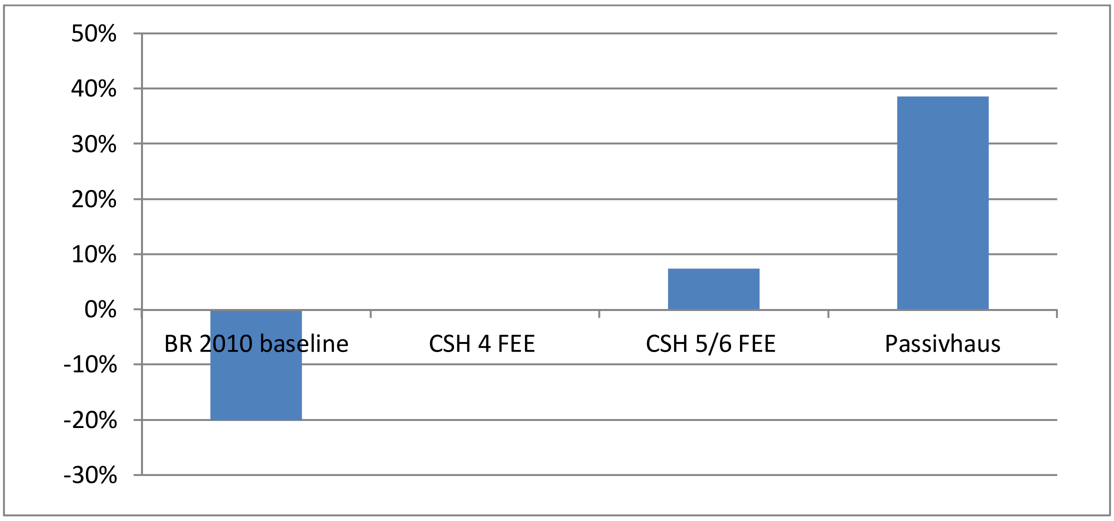


Chart 2 shows progressive energy demand savings over CSH FEE level 4 relative to, CSH FEE level 5/6 (7.39%) and Passivhaus FEE (38.65%) standards.

The above charts have been produce to highlight the potential improvements of adopting differing fabric efficiency standards for NW Bicester eco development; to attain appropriate compliance to achieve improved environmental savings.

5 Summary

The residential demand has been calculated through SAP 2009 version 9.90 methodology and the commercial demands have been estimated on the basis of CIBSE TM46 benchmarks. Both of these methods have been used to derive the baseline compliance relative to Building Regulation 2010. This building regulation baseline is presented in Table 5.1 below.

Table 5-1 Baseline Energy Demands relative to Building Regulation 2010

Energy Demands	Residential (kWh)	Commercial (kWh)
Total Electricity Regulated Demand	3,189,826.52	
Total Electricity Unregulated (Appliances) Demand	15,227,275.11	
Sub Total Electricity Demands	**18,417,101.63**	**10,379,975**
Total Fossil Fuel/Gas Regulated Demand	36,947,249.22	
Total Fossil Fuel/Gas Unregulated (All Gas Cooking) Demand	4,088,136.60	
Sub Total Fossil Fuel Demands	**41,035,385.82**	**16,931,235**
Total Energy Demand	59,452,487.45	27,311,210.00
Total Energy Demand (Electric & Gas) (kWh)	**86,763,697.45**	
Total Energy Demand (Electric & Gas) (MWh)	**86,763.70**	

In addition, a series of improved fabric efficiency scenarios have been modelled. In accordance with the PPS1 Ecotown required, all residential dwellings should achieve a minimum of CSH level 4; and therefore this may be regarded as the NW Bicester eco development site based baseline. This is presented in Table 5.2 below.

The difference in total energy demand between the building regulation baseline and the CSH FEE level 4 baseline is 7,108 MWh. It should be remembered that whilst the regulated energy component may have reduced by 17.70%, the unregulated energy component will not have altered. Therefore the overall difference is only 8.19%.

Also refer to table 5-3 the difference in total energy demand between the building regulation baseline and the CSH FEE level 5/6 is 9,542 MWh. It should be remembered that whilst the regulated energy component may have reduced by 23.77%, the unregulated energy component will not have altered. Therefore the overall difference is only 11%.

Table 5-2 Baseline Energy Demands relative to CSH FEE Level 4

Energy Demands	Residential (kWh)	Commercial (kWh)
Total Electricity Regulated Demand	3,189,826.52	
Total Electricity Unregulated (Appliances) Demand	15,227,275.11	
Sub Total Electricity Demands	**18,417,101.63**	**10,379,975**
Total Fossil Fuel/Gas Regulated Demand	29,844,959.95	
Total Fossil Fuel/Gas Unregulated (All Gas Cooking) Demand	4,088,136.60	
Sub Total Fossil Fuel Demands	**33,933,096.55**	**16,931,235**
Total Energy Demand	52,350,198.18	27,311,210.00
Total Energy Demand (Electric & Gas) (kWh)	**79,661,408.18**	
Total Energy Demand (Electric & Gas) (MWh)	**79,661.41**	

Table 5-3 Baseline Energy Demands relative to CSH FEE Level 5/6

Energy Demands	Residential (kWh)	Commercial (kWh)
Total Electricity Regulated Demand	3,195,609.60	-
Total Electricity Unregulated (Appliances) Demand	15,227,275.11	-
Sub Total Electricity Demands	**18,422,884.71**	**10,379,975**
Total Fossil Fuel/Gas Regulated Demand	27,398,886.58	-
Total Fossil Fuel/Gas Unregulated (All Gas Cooking) Demand	4,088,136.60	-
Sub Total Fossil Fuel Demands	**31,487,023.18**	**16,931,235**
Total Energy Demand	49,909,907.89	27,311,210.00
Total Energy Demand (Electric & Gas) (kWh)	77,221,117.89	
Total Energy Demand (Electric & Gas) (MWh)	77,221.12	

The Appendix below contain the copies of supporting SAP 2009 calculations, the Unregulated emissions calculations, the copy of TM46 tables and the relevant calculations as listed throughout this document to estimate the demands.

Baseline SAP 2009 Worksheets for 1 to 5 Bedroom

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	75	(1a)	x	2.5	(2a)	=	187.5	(3a)
First floor	75	(1b)	x	2.5	(2b)	=	187.5	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	150	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	375	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		6.1	(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 on which sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.41	0.39	0.39	0.34	0.31	0.3	0.28	0.28	0.32	0.34	0.37	0.39

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	0.58	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.57	0.58	(24d)

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

(25)m=	0.58	0.58	0.58	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.57	0.58	(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	x	1.4	=	2.8			(26)
Windows			6.25	x1/[1/(1.5)+ 0.04]		=	8.84			(27)
Floor Type 1			75	x	0.2	=	15			(28)
Floor Type 2			75	x	0.2	=	15			(28)
Walls	150.18	14.5	135.68	x	0.2	=	27.14			(29)
Roof	75	0	75	x	0.2	=	15			(30)
Total area of elements, m²			375.18							(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) = 92.62 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 40329.1986 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 30.01 (36)

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

Total fabric heat loss (33) + (36) = 122.64 (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=	72.37	71.23	71.23	69.16	67.92	67.35	66.8	66.8	68.22	69.16	70.16	71.23	(38)

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

(39)m=	195	193.87	193.87	191.8	190.56	189.99	189.44	189.44	190.86	191.8	192.8	193.87

Average = Sum(39)$_{1…12}$ /12= 191.94 (39)

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

(40)m=	1.3	1.29	1.29	1.28	1.27	1.27	1.26	1.26	1.27	1.28	1.29	1.29

Average = Sum(40)$_{1...12}$ /12= 1.28 (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 2.9342 (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) + 36 109.3547 (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=	120.29	115.92	111.54	107.17	102.79	98.42	98.42	102.79	107.17	111.54	115.92	120.29	
										Total = Sum(44)$_{1...12}$ =		1312.2566	(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=	178.81	156.39	161.38	140.7	135	116.5	107.95	123.88	125.35	146.09	159.47	173.17	
										Total = Sum(45)$_{1...12}$ =		1724.6917	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	26.82	23.46	24.21	21.1	20.25	17.47	16.19	18.58	18.8	21.91	23.92	25.98	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15

Output from water heater (annual)$_{1...12}$ 2089.4221 (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=	84.24	74.38	78.44	70.76	69.67	62.72	60.68	65.97	65.66	73.36	77.01	82.36	(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=	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	(66)

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

(67)m=	85.57	76	61.81	46.79	34.98	29.53	31.91	41.48	55.67	70.69	82.5	87.95	(67)

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

(68)m=	478.39	483.36	470.85	444.22	410.6	379	357.89	352.93	365.44	392.07	425.69	457.28	(68)

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

(69)m=	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	(71)

Water heating gains (Table 5)

(72)m=	113.22	110.69	105.43	98.28	93.64	87.11	81.55	88.67	91.2	98.6	106.95	110.7	(72)

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

(73)m=	801.41	794.27	762.31	713.52	663.44	619.86	595.58	607.3	636.53	685.58	739.36	780.16	(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	0.77	x	6.25	x	47.32	x	0.76	x	0.7	=	218.09	(78)
South	0.9x	0.77	x	6.25	x	77.18	x	0.76	x	0.7	=	355.69	(78)
South	0.9x	0.77	x	6.25	x	94.25	x	0.76	x	0.7	=	434.33	(78)
South	0.9x	0.77	x	6.25	x	105.11	x	0.76	x	0.7	=	484.41	(78)
South	0.9x	0.77	x	6.25	x	108.55	x	0.76	x	0.7	=	500.25	(78)
South	0.9x	0.77	x	6.25	x	108.9	x	0.76	x	0.7	=	501.85	(78)
South	0.9x	0.77	x	6.25	x	107.14	x	0.76	x	0.7	=	493.74	(78)
South	0.9x	0.77	x	6.25	x	103.88	x	0.76	x	0.7	=	478.74	(78)

South	0.9x	0.77	x	6.25	x	99.99	x	0.76	x	0.7	=	460.8	(78)
South	0.9x	0.77	x	6.25	x	85.29	x	0.76	x	0.7	=	393.06	(78)
South	0.9x	0.77	x	6.25	x	56.07	x	0.76	x	0.7	=	258.39	(78)
South	0.9x	0.77	x	6.25	x	40.89	x	0.76	x	0.7	=	188.44	(78)

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

(83)m=	218.09	355.69	434.33	484.41	500.25	501.85	493.74	478.74	460.8	393.06	258.39	188.44	(83)

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

(84)m=	1019.49	1149.97	1196.64	1197.93	1163.69	1121.71	1089.32	1086.04	1097.33	1078.64	997.76	968.6	(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	1	1	0.99	0.92	0.7	0.7	0.94	0.99	1	1	(86)

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

(87)m=	20.17	20.26	20.41	20.56	20.76	20.93	20.99	20.99	20.91	20.67	20.36	20.19	(87)

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

(88)m=	19.84	19.85	19.85	19.86	19.87	19.87	19.87	19.87	19.87	19.86	19.86	19.85	(88)

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

(89)m=	1	1	1	0.99	0.97	0.83	0.52	0.52	0.87	0.99	1	1	(89)

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

(90)m=	18.75	18.89	19.11	19.33	19.63	19.83	19.87	19.87	19.8	19.49	19.04	18.78	(90)

fLA = Living area ÷ (4) = 0.33 (91)

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

(92)m=	19.23	19.35	19.54	19.74	20.01	20.2	20.25	20.25	20.17	19.88	19.48	19.25	(92)

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

(93)m=	19.08	19.2	19.39	19.59	19.86	20.05	20.1	20.1	20.02	19.73	19.33	19.1	(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	1	1	0.99	0.97	0.84	0.55	0.55	0.88	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1019.17	1148.96	1193.62	1190.05	1127.91	947.57	602.23	602.16	966.62	1066.05	996.88	968.34	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2842.39	2752.91	2441.73	2089.24	1554.48	1034.61	605.35	605.34	1092.03	1713.01	2376.46	2753.1	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1356.47	1077.85	928.59	647.42	317.37	0	0	0	0	481.33	993.29	1327.86	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 7130.2 (98)

Space heating requirement in kWh/m²/year 47.53 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	1356.47	1077.85	928.59	647.42	317.37	0	0	0	0	481.33	993.29	1327.86		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	1460.14	1160.23	999.56	696.9	341.63	0	0	0	0	518.12	1069.21	1429.35		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													7675.13	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15		
Efficiency of water heater													82.8	(216)
(217)m=	91.41	91.27	91	90.59	89.17	82.8	82.8	82.8	82.8	89.95	91.12	91.41		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	229.51	202	211.39	188.39	186.15	176.9	167.79	187.02	187.6	196.85	207.91	223.32		
Total = Sum(219a)$_{1...12}$ =													2364.84	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			7675.13	
Water heating fuel used			2364.84	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			604.48	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	237.929	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	73.31	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	69.27	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			506.5673	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.221	(257)
SAP rating (Section 12)		82.9676	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	1519.68	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	468.24	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1987.91	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	312.52	(268)
Total CO2, kg/year			sum of (265)…(271) =		2390.9	(272)
CO2 emissions per m²			(272) ÷ (4) =		15.94	(273)
EI rating (section 14)					84	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	7828.63	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2412.14	(264)
Space and water heating	(261) + (262) + (263) + (264) =				10240.77	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	1765.08	(268)
'Total Primary Energy			sum of (265)…(271) =		12516.85	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		83.45	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2009
Software Version: Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	56.67	(1a)	x	2.5	(2a)	=	141.675	(3a)
First floor	56.67	(1b)	x	2.5	(2b)	=	141.675	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.34	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	283.35	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		6.1	(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 on which 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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.38	0.36	0.36	0.32	0.29	0.28	0.26	0.26	0.3	0.32	0.34	0.36

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	0.54	0.54	0.53	0.53	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	0.56	0.56	0.55	0.54	0.54	0.53	0.53	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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(1.5)+ 0.04]		=	14.33			(27)
Floor Type 1			56.67	x	0.2	=	11.334			(28)
Floor Type 2			56.67	x	0.2	=	11.334			(28)
Walls	113.52	12.12	101.39	x	0.2	=	20.28			(29)
Roof	56.67	0	56.67	x	0.2	=	11.33			(30)
Total area of elements, m²			283.53							(31)
Party wall			10	x	0	=	0			(32)

** 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) =	71.41	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	27842.1791	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: High	450	(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		22.68	(36)

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

Total fabric heat loss	(33) + (36) =	94.09	(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

SAP WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	53.53	52.8	52.8	51.46	50.66	50.29	49.94	49.94	50.86	51.46	52.11	52.8	(38)

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

(39)m=	147.63	146.89	146.89	145.55	144.75	144.38	144.03	144.03	144.95	145.55	146.2	146.89	

Average = Sum(39)1…12 /12= 145.65 (39)

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

(40)m=	1.3	1.3	1.3	1.28	1.28	1.27	1.27	1.27	1.28	1.28	1.29	1.3	

Average = Sum(40)1…12 /12= 1.28 (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 2.8335 (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) + 36 106.8364 (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=	117.52	113.25	108.97	104.7	100.43	96.15	96.15	100.43	104.7	108.97	113.25	117.52	

Total = Sum(44)1…12 = 1282.037 (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=	174.7	152.79	157.67	137.46	131.89	113.81	105.47	121.02	122.47	142.72	155.8	169.18	

Total = Sum(45)1…12 = 1684.9743 (45)

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

(46)m=	26.2	22.92	23.65	20.62	19.78	17.07	15.82	18.15	18.37	21.41	23.37	25.38	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

SAP WorkSheet: New dwelling design stage

Primary circuit loss (annual) from Table 3	360	(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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	

Output from water heater (annual)$_{1\ldots12}$ 2049.7047 (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=	82.55	72.9	76.88	69.38	68.31	61.51	59.53	64.7	64.39	71.92	75.47	80.71	(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=	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	(66)

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

(67)m=	72.76	64.63	52.56	39.79	29.74	25.11	27.13	35.27	47.34	60.11	70.15	74.79	(67)

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

(68)m=	412.34	416.62	405.84	382.88	353.91	326.68	308.48	304.2	314.99	337.94	366.92	394.15	(68)

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

(69)m=	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	(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=	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	(71)

Water heating gains (Table 5)

(72)m=	110.95	108.48	103.34	96.36	91.82	85.44	80.01	86.96	89.43	96.66	104.82	108.49	(72)

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

(73)m=	707.56	701.23	673.24	630.53	586.98	548.73	527.13	537.94	563.26	606.21	653.4	688.92	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	176.65	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	288.11	(78)

South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	351.81	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	392.38	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	405.2	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	406.5	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	399.93	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	387.78	(78)
South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	373.25	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	318.38	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	209.3	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	152.64	(78)

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

(83)m=	176.65	288.11	351.81	392.38	405.2	406.5	399.93	387.78	373.25	318.38	209.3	152.64	(83)

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

(84)m=	884.21	989.34	1025.05	1022.91	992.18	955.22	927.06	925.72	936.51	924.59	862.69	841.56	(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	1	0.99	0.97	0.87	0.63	0.63	0.9	0.99	1	1	(86)

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

(87)m=	20.23	20.32	20.47	20.61	20.81	20.95	21	21	20.93	20.71	20.41	20.24	(87)

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

(88)m=	19.84	19.85	19.85	19.86	19.86	19.86	19.87	19.87	19.86	19.86	19.85	19.85	(88)

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

(89)m=	1	1	1	0.99	0.94	0.76	0.46	0.46	0.81	0.98	1	1	(89)

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

(90)m=	18.83	18.97	19.19	19.41	19.68	19.84	19.87	19.87	19.82	19.55	19.11	18.86	(90)

fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	19.39	19.51	19.7	19.89	20.13	20.28	20.31	20.31	20.26	20.01	19.62	19.4	(92)

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

(93)m=	19.39	19.51	19.7	19.89	20.13	20.28	20.31	20.31	20.26	20.01	19.62	19.4	(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	1	1	0.99	0.95	0.81	0.53	0.53	0.84	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	883.58	987.57	1020.12	1010.97	945	769.84	489.9	489.88	790.79	906.08	861.11	841.05	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)

SAP WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(97)m=	2197.45	2131.17	1894.7	1628.13	1220.2	820.36	491.83	491.83	864.55	1341.15	1845.54	2130.69		(97)

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=	977.52	768.5	650.69	444.35	204.75	0	0	0	0	323.69	708.79	959.5		

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5037.79 (98)

Space heating requirement in kWh/m²/year 44.45 (99)

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	977.52	768.5	650.69	444.35	204.75	0	0	0	0	323.69	708.79	959.5		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	1053.36	828.13	701.18	478.83	220.64	0	0	0	0	348.8	763.78	1033.94		(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 5428.66 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10....12}$= 0 (215)

Water heating

Output from water heater (calculated above)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16

Efficiency of water heater 79.1 (216)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(217)m=	87.74	87.54	87.15	86.59	84.72	79.1	79.1	79.1	79.1	85.75	87.35	87.75	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(219)m=	234.42	206.49	216.46	193.36	192.24	181.78	172.49	192.16	192.73	202.57	212.69	228.1

Total = Sum(219a)$_{1...12}$ = 2425.48 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			5428.66	
Water heating fuel used			2425.48	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			514.01	(232)

10a. Fuel costs - individual heating systems:

SAP WorkSheet: New dwelling design stage

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	168.2884	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	75.19	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	58.91	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)...(254) =	428.4383	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.2717	(257)
SAP rating (Section 12)		82.2593	(258)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	1074.87	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	480.24	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1555.12	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	265.74	(268)
Total CO2, kg/year		sum of (265)…(271) =		1911.34	(272)
CO2 emissions per m²		(272) ÷ (4) =		16.86	(273)
EI rating (section 14)				84	(274)

13a. Primary Energy

	Energy kWh/year	Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x	1.02	=	5537.23	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2473.99	(264)
Space and water heating	(261) + (262) + (263) + (264) =			8011.22	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511	(267)

SAP WorkSheet: New dwelling design stage

Electricity for lighting	(232) x	0	=	1500.9	(268)
‘Total Primary Energy		sum of (265)…(271) =		10023.12	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		88.43	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	48.77	(1a) x	2.5	(2a) =	121.925	(3a)
First floor	48.77	(1b) x	2.5	(2b) =	121.925	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	97.54	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		243.85	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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 *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		6.1	(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 on which 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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.38	0.36	0.36	0.32	0.29	0.28	0.26	0.26	0.3	0.32	0.34	0.36

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	0.54	0.54	0.53	0.53	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	0.56	0.56	0.55	0.54	0.54	0.53	0.53	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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(1.5)+ 0.04]		=	14.33			(27)
Floor Type 1			48.77	x	0.24	=	11.7048			(28)
Floor Type 2			48.77	x	0.24	=	11.7048			(28)
Walls	97.72	22.25	75.47	x	0.25	=	18.87			(29)
Roof	48.77	0	48.77	x	0.2	=	9.75			(30)
Total area of elements, m²			244.03							(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) = 83.49 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 17942.8802 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 24.4 (36)

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

Total fabric heat loss (33) + (36) = 107.89 (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=	46.07	45.44	45.44	44.29	43.6	43.28	42.98	42.98	43.77	44.29	44.85	45.44	(38)

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

(39)m=	153.96	153.33	153.33	152.18	151.49	151.17	150.87	150.87	151.66	152.18	152.74	153.33

Average = Sum(39)$_{1…12}$ /12= 152.26 (39)

SAP WorkSheet: New dwelling design stage

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=	1.58	1.57	1.57	1.56	1.55	1.55	1.55	1.55	1.55	1.56	1.57	1.57	

Average = Sum(40)1…12 /12= 1.56 (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 — 2.7156 (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 — 103.8889 (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=	114.28	110.12	105.97	101.81	97.66	93.5	93.5	97.66	101.81	105.97	110.12	114.28	
										Total = Sum(44)1…12 =		1246.6668	(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=	169.88	148.57	153.32	133.66	128.25	110.67	102.56	117.68	119.09	138.79	151.5	164.52	
										Total = Sum(45)1…12 =		1638.4874	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.48	22.29	23	20.05	19.24	16.6	15.38	17.65	17.86	20.82	22.72	24.68	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0.024 (47)

Temperature factor from Table 2b — 0.54 (48)

Energy lost from water storage, kWh/year — (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same — 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0 (51)

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) — 0.013 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 — 360 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	

Output from water heater (annual)$_{1...12}$ 2003.2178 (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=	80.94	71.49	75.44	68.11	67.1	60.47	58.56	63.59	63.27	70.61	74.04	79.16	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	56.43	50.12	40.76	30.86	23.07	19.47	21.04	27.35	36.71	46.62	54.41	58	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	376.55	380.46	370.61	349.65	323.19	298.32	281.7	277.8	287.64	308.6	335.07	359.94	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	(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=	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	(71)
Water heating gains (Table 5)													
(72)m=	108.8	106.39	101.39	94.6	90.19	83.99	78.71	85.47	87.87	94.9	102.84	106.4	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	650.1	645.29	621.09	583.43	544.77	510.1	489.78	498.94	520.55	558.44	600.63	632.66	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	353.3	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	576.23	(78)
South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	703.61	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	784.75	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	810.4	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	813	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	799.85	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	775.56	(78)

South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	746.5	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	636.76	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	418.6	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	305.28	(78)

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

(83)m=	353.3	576.23	703.61	784.75	810.4	813	799.85	775.56	746.5	636.76	418.6	305.28	(83)

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

(84)m=	1003.4	1221.52	1324.7	1368.18	1355.17	1323.1	1289.63	1274.5	1267.05	1195.2	1019.23	937.93	(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	0.96	0.88	0.7	0.48	0.48	0.75	0.95	1	1	(86)

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

(87)m=	20.13	20.3	20.51	20.68	20.88	20.98	21	21	20.97	20.76	20.37	20.14	(87)

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

(88)m=	19.63	19.64	19.64	19.65	19.65	19.65	19.66	19.66	19.65	19.65	19.64	19.64	(88)

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

(89)m=	1	0.99	0.97	0.93	0.81	0.57	0.32	0.33	0.63	0.91	0.99	1	(89)

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

(90)m=	18.54	18.78	19.08	19.32	19.56	19.65	19.66	19.66	19.64	19.43	18.88	18.55	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	19.14	19.36	19.62	19.84	20.06	20.15	20.17	20.17	20.14	19.94	19.45	19.15	(92)

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

(93)m=	19.14	19.36	19.62	19.84	20.06	20.15	20.17	20.17	20.14	19.94	19.45	19.15	(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	0.97	0.94	0.83	0.62	0.38	0.39	0.68	0.92	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	999.94	1208.05	1286.62	1282.67	1129.33	821.75	492	491.94	856.25	1099.37	1009.94	935.33	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2254.44	2201.8	1965.48	1695.36	1266.63	839.19	492.65	492.64	885.7	1390.54	1900.89	2184.87	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	933.35	667.8	505.07	297.14	102.15	0	0	0	0	216.63	641.49	929.66	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 4293.28 (98)

Space heating requirement in kWh/m²/year 44.02 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	933.35	667.8	505.07	297.14	102.15	0	0	0	0	216.63	641.49	929.66		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	1005.77	719.61	544.26	320.19	110.07	0	0	0	0	233.44	691.26	1001.78		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4626.37	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49		
Efficiency of water heater													79.1	(216)
(217)m=	87.7	87.33	86.67	85.68	82.96	79.1	79.1	79.1	79.1	84.76	87.2	87.74		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	229.03	202.17	212.65	190.98	191.93	177.81	168.81	187.94	188.45	200.28	208.12	222.81		
Total = Sum(219a)$_{1...12}$ =													2380.99	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4626.37	
Water heating fuel used			2380.99	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			398.64	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year		**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211)	x	3.1	x 0.01 =	143.4176	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		3.1	x 0.01 =	73.81	(247)

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	45.68	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			388.9675	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.2826	(257)
SAP rating (Section 12)		82.1084	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	916.02	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	471.44	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1387.46	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	206.1	(268)
Total CO2, kg/year		sum of (265)…(271) =		1684.03	(272)
CO2 emissions per m²		(272) ÷ (4) =		17.27	(273)
EI rating (section 14)				84	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	4718.9	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2428.61	(264)
Space and water heating	(261) + (262) + (263) + (264) =			7147.52	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511	(267)
Electricity for lighting	(232) x	0	=	1164.03	(268)
‘Total Primary Energy		sum of (265)…(271) =		8822.54	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		90.45	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	41.5	(1a)	x	2.5	(2a)	=	103.75	(3a)
First floor	41.5	(1b)	x	2.5	(2b)	=	103.75	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	83	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	207.5	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		6.1	(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 on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.35	0.33	0.33	0.29	0.27	0.25	0.24	0.24	0.27	0.29	0.31	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=	0.56	0.55	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	0.55	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	x	1.4	=	2.8			(26)
Windows			6.125	x1/[1/(1.5)+ 0.04]		=	8.67			(27)
Floor Type 1			41.5	x	0.24	=	9.96			(28)
Floor Type 2			41.5	x	0.24	=	9.96			(28)
Walls	83.18	14.25	68.93	x	0.25	=	17.23			(29)
Roof	41.5	0	41.5	x	0.2	=	8.3			(30)
Total area of elements, m²			207.68							(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) = 65.59 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15904.05 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 16.61 (36)

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

Total fabric heat loss (33) + (36) = 82.2 (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=	38.43	37.98	37.98	37.15	36.66	36.42	36.21	36.21	36.77	37.15	37.55	37.98	(38)

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

(39)m=	120.63	120.18	120.18	119.35	118.86	118.63	118.41	118.41	118.98	119.35	119.75	120.18

Average = Sum(39)$_{1…12}$ /12= 119.41 (39)

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

(40)m=	1.45	1.45	1.45	1.44	1.43	1.43	1.43	1.43	1.43	1.44	1.44	1.45

Average = Sum(40)$_{1...12}$ /12= 1.44 (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 2.5173 (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 98.9331 (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=	108.83	104.87	100.91	96.95	93	89.04	89.04	93	96.95	100.91	104.87	108.83	
										Total = Sum(44)$_{1...12}$ =		1187.197	(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=	161.77	141.49	146	127.29	122.14	105.39	97.66	112.07	113.41	132.17	144.27	156.67	
										Total = Sum(45)$_{1...12}$ =		1560.3265	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	24.27	21.22	21.9	19.09	18.32	15.81	14.65	16.81	17.01	19.82	21.64	23.5	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	

Output from water heater (annual)$_{1…12}$ 1925.0569 (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=	78.25	69.14	73.01	65.99	65.07	58.71	56.93	61.72	61.38	68.41	71.64	76.55	(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=	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	(66)

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

(67)m=	53.33	47.37	38.52	29.16	21.8	18.41	19.89	25.85	34.7	44.06	51.42	54.81	(67)

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

(68)m=	336.71	340.2	331.4	312.66	288.99	266.76	251.9	248.41	257.21	275.95	299.62	321.85	(68)

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

(69)m=	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	(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=	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	(71)

Water heating gains (Table 5)

(72)m=	105.17	102.88	98.13	91.66	87.46	81.55	76.52	82.96	85.25	91.94	99.5	102.89	(72)

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

(73)m=	598.19	593.43	571.02	536.45	501.22	469.68	451.28	460.19	480.12	514.92	553.5	582.53	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	811.91	942.01	996.66	1011.17	991.47	961.49	935.14	929.35	931.71	900.12	806.73	767.2	(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=	1	1	0.99	0.97	0.91	0.75	0.52	0.52	0.8	0.96	1	1	(86)

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

(87)m=	20.21	20.34	20.52	20.68	20.87	20.97	21	21	20.96	20.76	20.41	20.22	(87)

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

(88)m=	19.73	19.73	19.73	19.74	19.74	19.74	19.75	19.75	19.74	19.74	19.73	19.73	(88)

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

(89)m=	1	0.99	0.98	0.96	0.86	0.62	0.36	0.36	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=	18.72	18.91	19.16	19.39	19.64	19.73	19.75	19.75	19.72	19.51	19.02	18.73	(90)

fLA = Living area ÷ (4) = | 0.36 | (91)

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

(92)m=	19.26	19.43	19.65	19.86	20.08	20.18	20.2	20.2	20.17	19.97	19.53	19.27	(92)

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

(93)m=	19.26	19.43	19.65	19.86	20.08	20.18	20.2	20.2	20.17	19.97	19.53	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	0.96	0.87	0.67	0.42	0.42	0.72	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	809.67	934.96	977.7	968.71	866.69	645.18	390.02	389.99	671.1	845.89	801.11	765.42	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1780.17	1733.82	1544.7	1331.53	996.14	662.24	390.6	390.59	698.56	1094.01	1500.01	1726.75	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	722.05	536.83	421.84	261.23	96.31	0	0	0	0	184.6	503.21	715.23	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = | 3441.3 | (98)

Space heating requirement in kWh/m²/year | 41.46 | (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	722.05	536.83	421.84	261.23	96.31	0	0	0	0	184.6	503.21	715.23		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	778.07	578.48	454.57	281.49	103.78	0	0	0	0	198.93	542.25	770.72		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3708.3	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65		
Efficiency of water heater													79.1	(216)
(217)m=	87.31	86.98	86.35	85.46	82.91	79.1	79.1	79.1	79.1	84.44	86.78	87.34		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	220.76	194.84	204.96	184.03	184.66	171.14	162.63	180.84	181.27	193.2	200.79	214.83		
Total = Sum(219a)$_{1...12}$ =													2293.97	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3708.3	
Water heating fuel used			2293.97	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			376.75	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	114.9572	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	71.11	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	43.18	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			355.3007	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.3046	(257)
SAP rating (Section 12)		81.8006	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	734.24	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	454.21	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1188.45	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	194.78	(268)
Total CO2, kg/year		sum of (265)…(271) =		1473.7	(272)
CO2 emissions per m²		(272) ÷ (4) =		17.76	(273)
EI rating (section 14)				85	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	3782.46	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2339.85	(264)
Space and water heating	(261) + (262) + (263) + (264) =			6122.31	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511	(267)
Electricity for lighting	(232) x	0	=	1100.11	(268)
'Total Primary Energy		sum of (265)…(271) =		7733.42	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		93.17	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	62.66	(1a) x	2.39	(2a) =	149.7574	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.66	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	149.7574	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		6.1	(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 on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

SAP WorkSheet: New dwelling design stage

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

0.35	0.33	0.33	0.29	0.27	0.25	0.24	0.24	0.27	0.29	0.31	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=	0.56	0.55	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	0.55	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	x	1.4	=	2.8			(26)
Windows			6.125	x1/[1/(1.5)+ 0.04]		=	8.67			(27)
Floor			62.66	x	0.24	=	15.0384			(28)
Walls	62.84	14.25	48.59	x	0.25	=	12.15			(29)
Roof	62.66	0	62.66	x	0.2	=	12.53			(30)
Total area of elements, m²			188.16							(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) = 59.85 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 11823.09 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 18.82 (36)

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

Total fabric heat loss (33) + (36) = 78.67 (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=	27.74	27.41	27.41	26.81	26.45	26.29	26.13	26.13	26.54	26.81	27.1	27.41	(38)

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

(39)m=	106.41	106.08	106.08	105.48	105.12	104.96	104.8	104.8	105.21	105.48	105.77	106.08	

Average = Sum(39)$_{1\ldots12}$ /12= 105.52 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.7	1.69	1.69	1.68	1.68	1.68	1.67	1.67	1.68	1.68	1.69	1.69

Average = Sum(40)$_{1…12}$ /12= 1.68 (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 2.0558 (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 87.3939 (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=	96.13	92.64	89.14	85.65	82.15	78.65	78.65	82.15	85.65	89.14	92.64	96.13

Total = Sum(44)$_{1…12}$ = 1048.7273 (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=	142.9	124.98	128.97	112.44	107.89	93.1	86.27	99	100.18	116.75	127.44	138.39

Total = Sum(45)$_{1…12}$ = 1378.3365 (45)

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

(46)m=	21.44	18.75	19.35	16.87	16.18	13.97	12.94	14.85	15.03	17.51	19.12	20.76	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	

Output from water heater (annual)$_{1…12}$ 1743.0669 (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=	71.98	63.65	67.34	61.06	60.33	54.63	53.15	57.38	56.98	63.28	66.05	70.48	(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=	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	(66)

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

(67)m=	40.03	35.55	28.91	21.89	16.36	13.81	14.93	19.4	26.04	33.06	38.59	41.14	(67)

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

(68)m=	268.06	270.84	263.83	248.91	230.07	212.37	200.54	197.76	204.77	219.69	238.53	256.24	(68)

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

(69)m=	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	(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=	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	(71)

Water heating gains (Table 5)

(72)m=	96.74	94.72	90.52	84.8	81.09	75.87	71.43	77.12	79.14	85.05	91.73	94.73	(72)

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

(73)m=	495.34	491.62	473.77	446.11	418.04	392.56	377.41	384.79	400.46	428.32	459.36	482.61	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.8	=	244.26	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.8	=	398.38	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.8	=	486.45	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.8	=	542.54	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.8	=	560.28	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.8	=	562.07	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.8	=	552.99	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.8	=	536.19	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.8	=	516.1	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.8	=	440.23	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.8	=	289.4	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.8	=	211.05	(78)

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

(83)m=	244.26	398.38	486.45	542.54	560.28	562.07	552.99	536.19	516.1	440.23	289.4	211.05	(83)

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

(84)m=	739.6	890	960.22	988.65	978.31	954.63	930.39	920.97	916.56	868.55	748.76	693.66	(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	0.97	0.94	0.86	0.68	0.46	0.46	0.72	0.93	0.99	1	(86)

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

(87)m=	20.12	20.29	20.51	20.68	20.88	20.98	21	21	20.96	20.77	20.36	20.12	(87)

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

(88)m=	19.55	19.55	19.55	19.56	19.56	19.56	19.57	19.57	19.56	19.56	19.55	19.55	(88)

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

(89)m=	0.99	0.98	0.96	0.91	0.78	0.54	0.3	0.3	0.59	0.88	0.99	1	(89)

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

(90)m=	18.45	18.7	19	19.25	19.48	19.56	19.57	19.57	19.55	19.36	18.81	18.46	(90)

fLA = Living area ÷ (4) = | 0.64 | (91)

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

(92)m=	19.52	19.72	19.96	20.16	20.37	20.46	20.48	20.48	20.45	20.26	19.8	19.52	(92)

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

(93)m=	19.52	19.72	19.96	20.16	20.37	20.46	20.48	20.48	20.45	20.26	19.8	19.52	(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	0.96	0.93	0.82	0.63	0.4	0.41	0.68	0.91	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	735.38	876	924.91	916.45	806.63	598.7	374.18	374.12	621.03	788.84	738.64	690.38	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1597.7	1561.28	1396.17	1209.32	911.54	615.34	375.16	375.16	647.24	997.58	1353.65	1550.68	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	641.57	460.51	350.62	210.86	78.06	0	0	0	0	155.3	442.81	640.07	

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 2979.79 | (98)

Space heating requirement in kWh/m²/year | 47.55 | (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	641.57	460.51	350.62	210.86	78.06	0	0	0	0	155.3	442.81	640.07		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	691.34	496.24	377.82	227.22	84.11	0	0	0	0	167.35	477.16	689.73		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3210.98	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37		
Efficiency of water heater													79.1	(216)
(217)m=	87.28	86.87	86.15	85.16	82.64	79.1	79.1	79.1	79.1	84.24	86.72	87.33		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	199.22	176.08	185.67	167.25	168.03	155.6	148.23	164.32	164.55	175.36	181.52	193.95		
Total = Sum(219a)$_{1...12}$ =													2079.77	(219)

Annual totals		kWh/year	kWh/year	
Space heating fuel used, main system 1			3210.98	
Water heating fuel used			2079.77	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			282.76	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	99.5403	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	64.47	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	32.4	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	322.4723	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.4078	(257)
SAP rating (Section 12)		80.3614	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	635.77	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	411.79	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1047.57	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	146.19	(268)
Total CO2, kg/year			sum of (265)…(271) =		1284.23	(272)
CO2 emissions per m²			(272) ÷ (4) =		20.5	(273)
EI rating (section 14)					84	(274)

DRAFT

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	3275.2	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2121.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =				5396.56	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	825.66	(268)
'Total Primary Energy			sum of (265)…(271) =		6733.22	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		107.46	(273)

CSH Level 4 SAP 2009 Worksheets for 1 to 5 Bedroom

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2009
Software Version: Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	75	(1a)	x	2.5	(2a)	=	187.5	(3a)
First floor	75	(1b)	x	2.5	(2b)	=	187.5	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	150	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	375	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.32	0.31	0.31	0.27	0.25	0.23	0.22	0.22	0.25	0.27	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	0.53	0.53	0.52	0.52	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	0.53	0.53	0.52	0.52	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	x	1.2	=	2.4			(26)
Windows			6.25	x1/[1/(1.2)+ 0.04]		=	7.16			(27)
Floor Type 1			75	x	0.2	=	15			(28)
Floor Type 2			75	x	0.2	=	15			(28)
Walls	150.18	14.5	135.68	x	0.18	=	24.42			(29)
Roof	75	0	75	x	0.18	=	13.5			(30)
Total area of elements, m²			375.18							(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) = 84.64 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 40329.1986 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 13.88 (36)

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

Total fabric heat loss (33) + (36) = 98.52 (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=	68.37	67.67	67.67	66.39	65.62	65.26	64.92	64.92	65.8	66.39	67.01	67.67	(38)

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

(39)m=	166.89	166.19	166.19	164.9	164.14	163.78	163.44	163.44	164.32	164.9	165.52	166.19

Average = Sum(39)$_{1…12}$ /12= 164.99 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.11	1.11	1.11	1.1	1.09	1.09	1.09	1.09	1.1	1.1	1.1	1.11

Average = Sum(40)$_{1…12}$ /12= 1.1 (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 2.9342 (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) + 36 109.3547 (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=	120.29	115.92	111.54	107.17	102.79	98.42	98.42	102.79	107.17	111.54	115.92	120.29	
									Total = Sum(44)$_{1…12}$ =			1312.2566	(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=	178.81	156.39	161.38	140.7	135	116.5	107.95	123.88	125.35	146.09	159.47	173.17	
									Total = Sum(45)$_{1…12}$ =			1724.6917	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	26.82	23.46	24.21	21.1	20.25	17.47	16.19	18.58	18.8	21.91	23.92	25.98	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	

Output from water heater (annual)$_{1...12}$ 2089.4221 (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=	84.24	74.38	78.44	70.76	69.67	62.72	60.68	65.97	65.66	73.36	77.01	82.36	(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=	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	(66)

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

(67)m=	85.57	76	61.81	46.79	34.98	29.53	31.91	41.48	55.67	70.69	82.5	87.95	(67)

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

(68)m=	478.39	483.36	470.85	444.22	410.6	379	357.89	352.93	365.44	392.07	425.69	457.28	(68)

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

(69)m=	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	(71)

Water heating gains (Table 5)

(72)m=	113.22	110.69	105.43	98.28	93.64	87.11	81.55	88.67	91.2	98.6	106.95	110.7	(72)

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

(73)m=	801.41	794.27	762.31	713.52	663.44	619.86	595.58	607.3	636.53	685.58	739.36	780.16	(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	0.77	x	6.25	x	47.32	x	0.76	x	0.7	=	218.09	(78)
South	0.9x	0.77	x	6.25	x	77.18	x	0.76	x	0.7	=	355.69	(78)
South	0.9x	0.77	x	6.25	x	94.25	x	0.76	x	0.7	=	434.33	(78)
South	0.9x	0.77	x	6.25	x	105.11	x	0.76	x	0.7	=	484.41	(78)
South	0.9x	0.77	x	6.25	x	108.55	x	0.76	x	0.7	=	500.25	(78)
South	0.9x	0.77	x	6.25	x	108.9	x	0.76	x	0.7	=	501.85	(78)
South	0.9x	0.77	x	6.25	x	107.14	x	0.76	x	0.7	=	493.74	(78)
South	0.9x	0.77	x	6.25	x	103.88	x	0.76	x	0.7	=	478.74	(78)

South	0.9x	0.77	x	6.25	x	99.99	x	0.76	x	0.7	=	460.8	(78)
South	0.9x	0.77	x	6.25	x	85.29	x	0.76	x	0.7	=	393.06	(78)
South	0.9x	0.77	x	6.25	x	56.07	x	0.76	x	0.7	=	258.39	(78)
South	0.9x	0.77	x	6.25	x	40.89	x	0.76	x	0.7	=	188.44	(78)

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

(83)m=	218.09	355.69	434.33	484.41	500.25	501.85	493.74	478.74	460.8	393.06	258.39	188.44	(83)

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

(84)m=	1019.49	1149.97	1196.64	1197.93	1163.69	1121.71	1089.32	1086.04	1097.33	1078.64	997.76	968.6	(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	1	1	0.98	0.86	0.61	0.61	0.9	0.99	1	1	(86)

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

(87)m=	20.33	20.42	20.55	20.68	20.85	20.97	21	21	20.96	20.76	20.49	20.34	(87)

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

(88)m=	19.99	20	20	20	20.01	20.01	20.01	20.01	20.01	20	20	20	(88)

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

(89)m=	1	1	1	0.99	0.95	0.77	0.47	0.47	0.81	0.98	1	1	(89)

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

(90)m=	19.11	19.24	19.43	19.62	19.86	19.99	20.01	20.01	19.98	19.75	19.35	19.13	(90)

fLA = Living area ÷ (4) = | 0.42 | (91)

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

(92)m=	19.62	19.73	19.9	20.07	20.28	20.4	20.43	20.43	20.39	20.17	19.83	19.64	(92)

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

(93)m=	19.47	19.58	19.75	19.92	20.13	20.25	20.28	20.28	20.24	20.02	19.68	19.49	(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	1	1	0.99	0.96	0.79	0.51	0.51	0.84	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1019.2	1148.91	1193.06	1187.6	1112.25	889.32	550.99	550.97	917.79	1061.56	996.85	968.36	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2498.76	2423.65	2152.47	1849.4	1383.2	925.96	551.75	551.74	976.09	1520.94	2098.52	2424.22	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1100.8	856.62	713.8	476.5	201.58	0	0	0	0	341.78	793.21	1083.15	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = | 5567.43 | (98)

Space heating requirement in kWh/m²/year | 37.12 | (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	1100.8	856.62	713.8	476.5	201.58	0	0	0	0	341.78	793.21	1083.15		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	1184.93	922.09	768.35	512.91	216.99	0	0	0	0	367.9	853.83	1165.94		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													5992.93	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15		
Efficiency of water heater													82.8	(216)
(217)m=	91.12	90.94	90.56	90	88.05	82.8	82.8	82.8	82.8	89.19	90.77	91.14		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	230.23	202.75	212.42	189.63	188.51	176.9	167.79	187.02	187.6	198.53	208.72	224		
Total = Sum(219a)$_{1...12}$ =													2374.1	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			5992.93	
Water heating fuel used			2374.1	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			604.48	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	185.7809	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	73.6	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	69.27	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			454.7062	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.096	(257)
SAP rating (Section 12)		84.7114	(258)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	1186.6	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	470.07	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1656.67	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	312.52	(268)
Total CO2, kg/year			sum of (265)…(271) =		2059.66	(272)
CO2 emissions per m²			(272) ÷ (4) =		13.73	(273)
EI rating (section 14)					86	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	6112.79	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2421.58	(264)
Space and water heating	(261) + (262) + (263) + (264) =				8534.37	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	1765.08	(268)
'Total Primary Energy			sum of (265)…(271) =		10810.45	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		72.07	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**

Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	56.67	(1a)	x	2.5	(2a)	=	141.675	(3a)
First floor	56.67	(1b)	x	2.5	(2b)	=	141.675	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.34	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	283.35	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.22	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.3	0.28	0.28	0.25	0.23	0.22	0.21	0.21	0.23	0.25	0.27	0.28

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=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(24d)

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(1.4)+ 0.04]		=	13.42			(27)
Floor Type 1			56.67	x	0.2	=	11.334			(28)
Floor Type 2			56.67	x	0.2	=	11.334			(28)
Walls	113.52	12.12	101.39	x	0.18	=	18.25			(29)
Roof	56.67	0	56.67	x	0.18	=	10.2			(30)
Total area of elements, m²			283.53							(31)
Party wall			10	x	0	=	0			(32)

* *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) =	67.34	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	27842.1791	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: High	450	(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		12.48	(36)

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

Total fabric heat loss	(33) + (36) =	79.82	(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=	50.95	50.5	50.5	49.67	49.17	48.94	48.72	48.72	49.29	49.67	50.07	50.5	(38)

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

(39)m=	130.77	130.32	130.32	129.49	128.99	128.76	128.54	128.54	129.11	129.49	129.89	130.32	

Average = Sum(39)$_{1...12}$ /12= 129.54 (39)

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

(40)m=	1.15	1.15	1.15	1.14	1.14	1.14	1.13	1.13	1.14	1.14	1.15	1.15	

Average = Sum(40)$_{1...12}$ /12= 1.14 (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 2.8335 (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) + 36 106.8364 (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=	117.52	113.25	108.97	104.7	100.43	96.15	96.15	100.43	104.7	108.97	113.25	117.52	

Total = Sum(44)$_{1...12}$ = 1282.037 (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=	174.7	152.79	157.67	137.46	131.89	113.81	105.47	121.02	122.47	142.72	155.8	169.18	

Total = Sum(45)$_{1...12}$ = 1684.9743 (45)

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

(46)m=	26.2	22.92	23.65	20.62	19.78	17.07	15.82	18.15	18.37	21.41	23.37	25.38	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

SAP WorkSheet: New dwelling design stage

Primary circuit loss (annual) from Table 3 | 360 | (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16

Output from water heater (annual)$_{1...12}$ | 2049.7047 | (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=	82.55	72.9	76.88	69.38	68.31	61.51	59.53	64.7	64.39	71.92	75.47	80.71	(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=	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	(66)

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

(67)m=	72.76	64.63	52.56	39.79	29.74	25.11	27.13	35.27	47.34	60.11	70.15	74.79	(67)

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

(68)m=	412.34	416.62	405.84	382.88	353.91	326.68	308.48	304.2	314.99	337.94	366.92	394.15	(68)

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

(69)m=	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	(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=	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	(71)

Water heating gains (Table 5)

(72)m=	110.95	108.48	103.34	96.36	91.82	85.44	80.01	86.96	89.43	96.66	104.82	108.49	(72)

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

(73)m=	707.56	701.23	673.24	630.53	586.98	548.73	527.13	537.94	563.26	606.21	653.4	688.92	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	176.65	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	288.11	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	351.81	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	392.38	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	405.2	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	406.5	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	399.93	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	387.78	(78)
South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	373.25	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	318.38	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	209.3	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	152.64	(78)

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

(83)m=	176.65	288.11	351.81	392.38	405.2	406.5	399.93	387.78	373.25	318.38	209.3	152.64	(83)

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

(84)m=	884.21	989.34	1025.05	1022.91	992.18	955.22	927.06	925.72	936.51	924.59	862.69	841.56	(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	1	0.99	0.96	0.82	0.57	0.57	0.85	0.98	1	1	(86)

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

(87)m=	20.35	20.44	20.58	20.71	20.87	20.98	21	21	20.97	20.79	20.51	20.36	(87)

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

(88)m=	19.96	19.96	19.96	19.97	19.97	19.97	19.98	19.98	19.97	19.97	19.97	19.96	(88)

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

(89)m=	1	1	0.99	0.98	0.92	0.71	0.43	0.43	0.76	0.97	1	1	(89)

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

(90)m=	19.11	19.25	19.44	19.63	19.86	19.96	19.98	19.98	19.95	19.75	19.35	19.13	(90)

fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	19.61	19.72	19.9	20.06	20.26	20.37	20.38	20.38	20.36	20.16	19.81	19.62	(92)

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

(93)m=	19.61	19.72	19.9	20.06	20.26	20.37	20.38	20.38	20.36	20.16	19.81	19.62	(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	1	0.99	0.98	0.93	0.75	0.48	0.48	0.8	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	883.55	987.3	1018.88	1007.04	926.74	720.08	447	446.99	746.53	899.4	860.88	841.03	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)

SAP WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(97)m=	1975.42	1918.52	1706.54	1470.72	1104.36	742.45	447.53	447.53	781.92	1212.58	1664.44	1918.04	(97)

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

(98)m=	812.35	625.78	511.62	333.85	132.15	0	0	0	0	233.01	578.56	801.29	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = | 4028.61 | (98)

Space heating requirement in kWh/m²/year | 35.54 | (99)

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)	812.35	625.78	511.62	333.85	132.15	0	0	0	0	233.01	578.56	801.29	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	875.38	674.33	551.31	359.75	142.4	0	0	0	0	251.09	623.45	863.46	(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= | 4341.17 | (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10....12}$= | 0 | (215)

Water heating

Output from water heater (calculated above)

205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16

Efficiency of water heater | 79.1 | (216)

(217)m=	87.41	87.16	86.64	85.92	83.56	79.1	79.1	79.1	79.1	84.9	86.94	87.44	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	235.29	207.41	217.72	194.88	194.91	181.78	172.49	192.16	192.73	204.61	213.68	228.92

Total = Sum(219a)$_{1...12}$ = | 2436.59 | (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4341.17	
Water heating fuel used			2436.59	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			514.01	(232)

10a. Fuel costs - individual heating systems:

SAP WorkSheet: New dwelling design stage

	Fuel kWh/year		Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211)	x	3.1	x 0.01 =	134.5763	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		3.1	x 0.01 =	75.53	(247)
Pumps, fans and electric keep-hot	(231)		11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a						
Energy for lighting	(232)		11.46	x 0.01 =	58.91	(250)
Additional standing charges (Table 12)					106	(251)
Appendix Q items: repeat lines (253) and (254) as needed						
Total energy cost	(245)...(247) + (250)...(254) =				395.0706	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1727	(257)
SAP rating (Section 12)		83.641	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	859.55	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	482.44	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1342	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	265.74	(268)
Total CO2, kg/year			sum of (265)…(271) =		1698.21	(272)
CO2 emissions per m²			(272) ÷ (4) =		14.98	(273)
EI rating (section 14)					86	(274)

13a. Primary Energy

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	4428	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2485.32	(264)
Space and water heating	(261) + (262) + (263) + (264) =				6913.31	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)

SAP WorkSheet: New dwelling design stage

Electricity for lighting	(232) x	0 =	1500.9	(268)
‘Total Primary Energy		sum of (265)…(271) =	8925.21	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =	78.75	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	48.77	(1a)	x	2.5	(2a)	=	121.925	(3a)
First floor	48.77	(1b)	x	2.5	(2b)	=	121.925	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	97.54	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			243.85	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		5.1	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.26	(18)

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

Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.32	0.3	0.3	0.27	0.24	0.23	0.22	0.22	0.25	0.27	0.28	0.3

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	0.53	0.53	0.52	0.52	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	0.53	0.53	0.52	0.52	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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(1.4)+ 0.04]		=	13.42			(27)
Floor Type 1			48.77	x	0.2	=	9.754001			(28)
Floor Type 2			48.77	x	0.2	=	9.754001			(28)
Walls	97.72	22.25	75.47	x	0.2	=	15.09			(29)
Roof	48.77	0	48.77	x	0.18	=	8.78			(30)
Total area of elements, m²			244.03							(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) = 73.03 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 17942.8802 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 19.52 (36)

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

Total fabric heat loss (33) + (36) = 92.55 (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=	44.32	43.87	43.87	43.07	42.59	42.36	42.15	42.15	42.7	43.07	43.46	43.87	(38)

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

(39)m=	136.86	136.42	136.42	135.62	135.14	134.91	134.7	134.7	135.25	135.62	136.01	136.42

Average = Sum(39)$_{1…12}$ /12= 135.67 (39)

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

(40)m=	1.4	1.4	1.4	1.39	1.39	1.38	1.38	1.38	1.39	1.39	1.39	1.4

Average = Sum(40)$_{1…12}$ /12= 1.39 (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 — 2.7156 (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 — 103.8889 (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=	114.28	110.12	105.97	101.81	97.66	93.5	93.5	97.66	101.81	105.97	110.12	114.28	
											Total = Sum(44)$_{1…12}$ =	1246.6668	(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=	169.88	148.57	153.32	133.66	128.25	110.67	102.56	117.68	119.09	138.79	151.5	164.52	
											Total = Sum(45)$_{1…12}$ =	1638.4874	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.48	22.29	23	20.05	19.24	16.6	15.38	17.65	17.86	20.82	22.72	24.68	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b: 0.54 (48)

Energy lost from water storage, kWh/year — (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same: 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day): 0 (51)

Volume factor from Table 2a: 0 (52)

Temperature factor from Table 2b: 0 (53)

Energy lost from water storage, kWh/year — ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55): 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3: 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	

Output from water heater (annual)$_{1...12}$ 2003.2178 (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=	80.94	71.49	75.44	68.11	67.1	60.47	58.56	63.59	63.27	70.61	74.04	79.16	(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=	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	(66)

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

(67)m=	56.43	50.12	40.76	30.86	23.07	19.47	21.04	27.35	36.71	46.62	54.41	58	(67)

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

(68)m=	376.55	380.46	370.61	349.65	323.19	298.32	281.7	277.8	287.64	308.6	335.07	359.94	(68)

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

(69)m=	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	(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=	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	(71)

Water heating gains (Table 5)

(72)m=	108.8	106.39	101.39	94.6	90.19	83.99	78.71	85.47	87.87	94.9	102.84	106.4	(72)

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

(73)m=	650.1	645.29	621.09	583.43	544.77	510.1	489.78	498.94	520.55	558.44	600.63	632.66	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	353.3	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	576.23	(78)
South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	703.61	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	784.75	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	810.4	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	813	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	799.85	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	775.56	(78)

South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	746.5	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	636.76	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	418.6	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	305.28	(78)

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

(83)m=	353.3	576.23	703.61	784.75	810.4	813	799.85	775.56	746.5	636.76	418.6	305.28	(83)

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

(84)m=	1003.4	1221.52	1324.7	1368.18	1355.17	1323.1	1289.63	1274.5	1267.05	1195.2	1019.23	937.93	(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	0.94	0.84	0.64	0.43	0.43	0.69	0.93	0.99	1	(86)

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

(87)m=	20.28	20.44	20.63	20.78	20.93	20.99	21	21	20.98	20.84	20.49	20.28	(87)

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

(88)m=	19.76	19.77	19.77	19.77	19.78	19.78	19.78	19.78	19.78	19.77	19.77	19.77	(88)

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

(89)m=	1	0.99	0.96	0.91	0.76	0.53	0.3	0.3	0.58	0.88	0.99	1	(89)

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

(90)m=	18.85	19.09	19.35	19.56	19.73	19.78	19.78	19.78	19.77	19.64	19.16	18.85	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	19.39	19.6	19.84	20.02	20.19	20.24	20.24	20.24	20.23	20.09	19.66	19.39	(92)

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

(93)m=	19.39	19.6	19.84	20.02	20.19	20.24	20.24	20.24	20.23	20.09	19.66	19.39	(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	0.96	0.92	0.79	0.57	0.35	0.35	0.62	0.9	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	999.66	1205.47	1276.57	1257.8	1072.67	753.83	450.16	450.14	789.95	1072	1008.35	935.17	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2038.14	1992.08	1778.6	1535.73	1146.76	760.52	450.34	450.34	802.22	1260.56	1722.28	1976.88	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	772.63	528.6	373.51	200.11	55.13	0	0	0	0	140.29	514.03	775.03	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3359.33 (98)

Space heating requirement in kWh/m²/year 34.44 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	772.63	528.6	373.51	200.11	55.13	0	0	0	0	140.29	514.03	775.03		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	828.12	566.56	400.33	214.48	59.08	0	0	0	0	150.36	550.94	830.69		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3600.56	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49		
Efficiency of water heater													79.6	(216)
(217)m=	87.86	87.36	86.46	85.15	82.1	79.6	79.6	79.6	79.6	84.11	87.24	87.92		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	228.6	202.1	213.15	192.18	193.94	176.7	167.75	186.76	187.27	201.84	208.02	222.35		
Total = Sum(219a)$_{1...12}$ =													2380.67	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3600.56	
Water heating fuel used			2380.67	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			398.64	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	111.6175	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	73.8	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06 (249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a				
Energy for lighting	(232)	11.46	x 0.01 =	45.68 (250)
Additional standing charges (Table 12)				106 (251)
Appendix Q items: repeat lines (253) and (254) as needed				
Total energy cost	(245)...(247) + (250)…(254) =			357.1573 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47 (256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1777 (257)
SAP rating (Section 12)		83.5716 (258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year
Space heating (main system 1)	(211) x	0.198	=	712.91 (261)
Space heating (secondary)	(215) x	0	=	0 (263)
Water heating	(219) x	0.198	=	471.37 (264)
Space and water heating	(261) + (262) + (263) + (264) =			1184.28 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48 (267)
Electricity for lighting	(232) x	0.517	=	206.1 (268)
Total CO2, kg/year		sum of (265)…(271) =		1480.86 (272)
CO2 emissions per m²		(272) ÷ (4) =		15.18 (273)
EI rating (section 14)				86 (274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year
Space heating (main system 1)	(211) x	1.02	=	3672.58 (261)
Space heating (secondary)	(215) x	0	=	0 (263)
Energy for water heating	(219) x	1.02	=	2428.28 (264)
Space and water heating	(261) + (262) + (263) + (264) =			6100.86 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511 (267)
Electricity for lighting	(232) x	0	=	1164.03 (268)
'Total Primary Energy		sum of (265)…(271) =		7775.88 (272)
Primary energy kWh/m²/year		(272) ÷ (4) =		79.72 (273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	41.5	(1a)	x	2.5	(2a)	=	103.75	(3a)
First floor	41.5	(1b)	x	2.5	(2b)	=	103.75	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	83	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			207.5	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.2	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.28	0.26	0.26	0.23	0.21	0.2	0.19	0.19	0.21	0.23	0.24	0.26

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=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(24d)

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

(25)m=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(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	x	1.2	=	2.4			(26)
Windows			6.125	x1/[1/(1.4)+ 0.04]		=	8.12			(27)
Floor Type 1			41.5	x	0.15	=	6.225			(28)
Floor Type 2			41.5	x	0.15	=	6.225			(28)
Walls	83.18	14.25	68.93	x	0.18	=	12.41			(29)
Roof	41.5	0	41.5	x	0.13	=	5.39			(30)
Total area of elements, m²			207.68							(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) =	48.89	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	15904.05	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: High	450	(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 11.42 (36)

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

Total fabric heat loss (33) + (36) = 60.32 (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=	36.83	36.55	36.55	36.04	35.73	35.59	35.46	35.46	35.81	36.04	36.29	36.55	(38)

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

(39)m=	97.15	96.87	96.87	96.36	96.05	95.91	95.77	95.77	96.12	96.36	96.6	96.87

Average = Sum(39)$_{1…12}$ /12= 96.39 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.17	1.17	1.17	1.16	1.16	1.16	1.15	1.15	1.16	1.16	1.16	1.17

Average = Sum(40)$_{1…12}$ /12= 1.16 (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 2.5173 (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 98.9331 (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=	108.83	104.87	100.91	96.95	93	89.04	89.04	93	96.95	100.91	104.87	108.83	
										Total = Sum(44)$_{1…12}$ =		1187.197	(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=	161.77	141.49	146	127.29	122.14	105.39	97.66	112.07	113.41	132.17	144.27	156.67	
										Total = Sum(45)$_{1…12}$ =		1560.3265	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	24.27	21.22	21.9	19.09	18.32	15.81	14.65	16.81	17.01	19.82	21.64	23.5	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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)

SAP WorkSheet: New dwelling design stage

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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	

Output from water heater (annual)$_{1...12}$ 1925.0569 (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=	78.25	69.14	73.01	65.99	65.07	58.71	56.93	61.72	61.38	68.41	71.64	76.55	(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=	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	(66)

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

(67)m=	53.33	47.37	38.52	29.16	21.8	18.41	19.89	25.85	34.7	44.06	51.42	54.81	(67)

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

(68)m=	336.71	340.2	331.4	312.66	288.99	266.76	251.9	248.41	257.21	275.95	299.62	321.85	(68)

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

(69)m=	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	(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=	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	(71)

Water heating gains (Table 5)

(72)m=	105.17	102.88	98.13	91.66	87.46	81.55	76.52	82.96	85.25	91.94	99.5	102.89	(72)

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

(73)m=	598.19	593.43	571.02	536.45	501.22	469.68	451.28	460.19	480.12	514.92	553.5	582.53	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	811.91	942.01	996.66	1011.17	991.47	961.49	935.14	929.35	931.71	900.12	806.73	767.2	(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=	1	0.99	0.98	0.95	0.84	0.63	0.42	0.42	0.68	0.93	0.99	1	(86)

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

(87)m=	20.45	20.58	20.72	20.84	20.96	21	21	21	20.99	20.9	20.62	20.45	(87)

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

(88)m=	19.95	19.95	19.95	19.95	19.96	19.96	19.96	19.96	19.96	19.95	19.95	19.95	(88)

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

(89)m=	1	0.99	0.97	0.92	0.77	0.53	0.31	0.32	0.58	0.88	0.99	1	(89)

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

(90)m=	19.25	19.43	19.63	19.8	19.93	19.96	19.96	19.96	19.95	19.86	19.49	19.25	(90)

fLA = Living area ÷ (4) = 0.36 (91)

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

(92)m=	19.68	19.84	20.03	20.18	20.3	20.33	20.34	20.34	20.33	20.24	19.9	19.68	(92)

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

(93)m=	19.68	19.84	20.03	20.18	20.3	20.33	20.34	20.34	20.33	20.24	19.9	19.68	(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	0.97	0.93	0.79	0.57	0.35	0.35	0.62	0.9	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	809.03	931.38	964.82	936.8	788.09	547.37	328.98	328.97	575	806.09	798.39	764.98	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1474.9	1437.64	1281.39	1105.69	825.99	549.77	329.01	329.01	579.53	909.34	1246.17	1431.93	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	495.4	340.2	235.53	121.6	28.2	0	0	0	0	76.82	322.4	496.21	

Total per year (kWh/year) = Sum(98)1…5,9…12 = 2116.37 (98)

Space heating requirement in kWh/m²/year 25.5 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	495.4	340.2	235.53	121.6	28.2	0	0	0	0	76.82	322.4	496.21		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	530.98	364.63	252.44	130.33	30.22	0	0	0	0	82.34	345.55	531.85		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2268.35	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65		
Efficiency of water heater													79.6	(216)
(217)m=	87.02	86.44	85.38	83.94	81.09	79.6	79.6	79.6	79.6	82.74	86.23	87.09		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	221.49	196.06	207.29	187.36	188.81	170.07	161.61	179.71	180.13	197.18	202.07	215.47		
Total = Sum(219a)$_{1...12}$ =													2307.24	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			2268.35	
Water heating fuel used			2307.24	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			376.75	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	70.3188	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	71.52	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	43.18	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			311.0737	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1422	(257)
SAP rating (Section 12)		84.066	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	449.13	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	456.83	(264)
Space and water heating	(261) + (262) + (263) + (264) =				905.97	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	194.78	(268)
Total CO2, kg/year			sum of (265)…(271) =		1191.22	(272)
CO2 emissions per m²			(272) ÷ (4) =		14.35	(273)
EI rating (section 14)					88	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	2313.72	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2353.39	(264)
Space and water heating	(261) + (262) + (263) + (264) =				4667.1	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	1100.11	(268)
'Total Primary Energy			sum of (265)…(271) =		6278.21	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		75.64	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	62.66	(1a) x	2.39	(2a) =	149.7574	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.66	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	149.7574	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.2	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

SAP WorkSheet: New dwelling design stage

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

0.28	0.26	0.26	0.23	0.21	0.2	0.19	0.19	0.21	0.23	0.24	0.26

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=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(24d)

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

(25)m=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(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	x	1.2	=	2.4			(26)
Windows			6.125	x1/[1/(1.4)+ 0.04]		=	8.12			(27)
Floor			62.66	x	0.15	=	9.399			(28)
Walls	62.84	14.25	48.59	x	0.15	=	7.29			(29)
Roof	62.66	0	62.66	x	0.13	=	8.15			(30)
Total area of elements, m²			188.16							(31)
Party wall			10	x	0	=	0			(32)
Internal wall **			0							(32c)

* *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) = 43.47 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 12523.09 (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 7.53 (36)

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

Total fabric heat loss (33) + (36) = 51 (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=	26.58	26.38	26.38	26.01	25.79	25.69	25.59	25.59	25.84	26.01	26.19	26.38	(38)

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

(39)m=	77.58	77.38	77.38	77.01	76.79	76.69	76.59	76.59	76.84	77.01	77.19	77.38	

Average = Sum(39)$_{1\ldots12}$ /12= 77.04 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.24	1.23	1.23	1.23	1.23	1.22	1.22	1.22	1.23	1.23	1.23	1.23

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 — 2.0558 (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 — 87.3939 (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=	96.13	92.64	89.14	85.65	82.15	78.65	78.65	82.15	85.65	89.14	92.64	96.13	
										Total = Sum(44)1…12 =		1048.7273	(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=	142.9	124.98	128.97	112.44	107.89	93.1	86.27	99	100.18	116.75	127.44	138.39	
										Total = Sum(45)1…12 =		1378.3365	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.44	18.75	19.35	16.87	16.18	13.97	12.94	14.85	15.03	17.51	19.12	20.76	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0.024 (47)

Temperature factor from Table 2b — 0.54 (48)

Energy lost from water storage, kWh/year — (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same — 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0 (51)

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) — 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 — 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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)

SAP WorkSheet: New dwelling design stage

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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	

Output from water heater (annual)$_{1...12}$ 1743.0669 (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=	72.3	63.94	67.67	61.37	60.66	54.94	53.47	57.7	57.29	63.6	66.36	70.8	(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=	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	(66)

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

(67)m=	40.41	35.89	29.19	22.1	16.52	13.95	15.07	19.59	26.29	33.38	38.96	41.54	(67)

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

(68)m=	268.06	270.84	263.83	248.91	230.07	212.37	200.54	197.76	204.77	219.69	238.53	256.24	(68)

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

(69)m=	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	(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=	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	(71)

Water heating gains (Table 5)

(72)m=	97.17	95.15	90.95	85.24	81.53	76.3	71.86	77.55	79.57	85.49	92.16	95.16	(72)

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

(73)m=	496.16	492.4	474.48	446.75	418.63	393.13	377.98	385.41	401.14	429.07	460.16	483.44	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	709.88	840.98	900.12	921.48	908.87	884.94	861.85	854.57	852.73	814.27	713.39	668.11	(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=	0.97	0.94	0.9	0.84	0.72	0.54	0.36	0.37	0.58	0.81	0.95	0.98	(86)

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

(87)m=	20.13	20.34	20.57	20.74	20.9	20.98	21	21	20.97	20.82	20.4	20.12	(87)

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

(88)m=	19.89	19.89	19.89	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.89	(88)

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

(89)m=	0.96	0.93	0.87	0.8	0.65	0.45	0.27	0.27	0.5	0.76	0.93	0.97	(89)

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

(90)m=	18.79	19.09	19.4	19.62	19.82	19.89	19.9	19.9	19.88	19.72	19.18	18.78	(90)

fLA = Living area ÷ (4) = 0.64 (91)

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

(92)m=	19.64	19.89	20.15	20.34	20.51	20.59	20.6	20.6	20.58	20.42	19.96	19.64	(92)

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

(93)m=	19.64	19.89	20.15	20.34	20.51	20.59	20.6	20.6	20.58	20.42	19.96	19.64	(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=	0.96	0.93	0.88	0.81	0.69	0.51	0.33	0.33	0.55	0.79	0.93	0.97	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	682.57	780.08	789.96	750.92	625.08	449.3	282.62	282.58	468.09	639.5	665.63	645.22	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1175.01	1152.18	1032.79	896.21	676.71	459.09	283.55	283.54	482.42	740.83	1000.5	1140.51	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	366.38	250.05	180.67	104.61	38.41	0	0	0	0	75.39	241.11	368.5	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1625.11 (98)

Space heating requirement in kWh/m²/year 25.94 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	366.38	250.05	180.67	104.61	38.41	0	0	0	0	75.39	241.11	368.5		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	392.69	268.01	193.64	112.12	41.17	0	0	0	0	80.8	258.42	394.96		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													1741.81	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37		
Efficiency of water heater													79.6	(216)
(217)m=	86.56	85.92	84.94	83.81	81.7	79.6	79.6	79.6	79.6	82.92	85.75	86.63		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	200.89	178.04	188.31	169.94	169.98	154.62	147.3	163.29	163.52	178.16	183.59	195.51		
Total = Sum(219a)$_{1...12}$ =													2093.13	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			1741.81	
Water heating fuel used			2093.13	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			285.49	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	53.9962	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	64.89	(247)

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	32.72	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	277.655	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.2121	(257)
SAP rating (Section 12)		83.0908	(258)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	344.88	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	414.44	(264)
Space and water heating	(261) + (262) + (263) + (264) =				759.32	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	147.6	(268)
Total CO2, kg/year			sum of (265)…(271) =		997.39	(272)
CO2 emissions per m²			(272) ÷ (4) =		15.92	(273)
EI rating (section 14)					88	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	1776.65	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2135	(264)
Space and water heating	(261) + (262) + (263) + (264) =				3911.65	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	833.62	(268)
‘Total Primary Energy			sum of (265)…(271) =		5256.26	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		83.89	(273)

CSH Level 5/6 SAP 2009 Worksheets for 1 to 5 Bedroom

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2009
Software Version: Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	75	(1a)	x	2.5	(2a)	=	187.5	(3a)
First floor	75	(1b)	x	2.5	(2b)	=	187.5	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	150	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	375	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.24	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.32	0.31	0.31	0.27	0.25	0.23	0.22	0.22	0.25	0.27	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	0.53	0.53	0.52	0.52	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	0.53	0.53	0.52	0.52	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	x	1.2	=	2.4			(26)
Windows			6.25	x1/[1/(1.2)+ 0.04]		=	7.16			(27)
Floor Type 1			75	x	0.15	=	11.25			(28)
Floor Type 2			75	x	0.15	=	11.25			(28)
Walls	150.18	14.5	135.68	x	0.13	=	17.64			(29)
Roof	75	0	75	x	0.15	=	11.25			(30)
Total area of elements, m²			375.18							(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) = 68.1 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 40329.1986 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 16.51 (36)

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

Total fabric heat loss (33) + (36) = 84.61 (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=	68.37	67.67	67.67	66.39	65.62	65.26	64.92	64.92	65.8	66.39	67.01	67.67	(38)

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

(39)m=	152.98	152.28	152.28	151	150.23	149.87	149.53	149.53	150.41	151	151.62	152.28

Average = Sum(39)$_{1…12}$ /12= 151.08 (39)

SAP WorkSheet: New dwelling design stage

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=	1.02	1.02	1.02	1.01	1	1	1	1	1	1.01	1.01	1.02		
												Average = Sum(40)$_{1…12}$ /12=	1.01	(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 — 2.9342 (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 — 109.3547 (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=	120.29	115.92	111.54	107.17	102.79	98.42	98.42	102.79	107.17	111.54	115.92	120.29		
												Total = Sum(44)$_{1…12}$ =	1312.2566	(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=	178.81	156.39	161.38	140.7	135	116.5	107.95	123.88	125.35	146.09	159.47	173.17		
												Total = Sum(45)$_{1…12}$ =	1724.6917	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	26.82	23.46	24.21	21.1	20.25	17.47	16.19	18.58	18.8	21.91	23.92	25.98		(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b: 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same: 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day): 0 (51)

Volume factor from Table 2a: 0 (52)

Temperature factor from Table 2b: 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55): 0.013 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3: 360 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

SAP WorkSheet: New dwelling design stage

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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	

Output from water heater (annual)$_{1...12}$ 2089.4221 (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=	84.24	74.38	78.44	70.76	69.67	62.72	60.68	65.97	65.66	73.36	77.01	82.36	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	85.57	76	61.81	46.79	34.98	29.53	31.91	41.48	55.67	70.69	82.5	87.95	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	478.39	483.36	470.85	444.22	410.6	379	357.89	352.93	365.44	392.07	425.69	457.28	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	(69)
Pumps and fans gains (Table 5a)													
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	(71)
Water heating gains (Table 5)													
(72)m=	113.22	110.69	105.43	98.28	93.64	87.11	81.55	88.67	91.2	98.6	106.95	110.7	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	801.41	794.27	762.31	713.52	663.44	619.86	595.58	607.3	636.53	685.58	739.36	780.16	(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	0.77	x	6.25	x	47.32	x	0.76	x	0.7	=	218.09	(78)
South	0.9x	0.77	x	6.25	x	77.18	x	0.76	x	0.7	=	355.69	(78)
South	0.9x	0.77	x	6.25	x	94.25	x	0.76	x	0.7	=	434.33	(78)
South	0.9x	0.77	x	6.25	x	105.11	x	0.76	x	0.7	=	484.41	(78)
South	0.9x	0.77	x	6.25	x	108.55	x	0.76	x	0.7	=	500.25	(78)
South	0.9x	0.77	x	6.25	x	108.9	x	0.76	x	0.7	=	501.85	(78)
South	0.9x	0.77	x	6.25	x	107.14	x	0.76	x	0.7	=	493.74	(78)
South	0.9x	0.77	x	6.25	x	103.88	x	0.76	x	0.7	=	478.74	(78)

South	0.9x	0.77	x	6.25	x	99.99	x	0.76	x	0.7	=	460.8	(78)
South	0.9x	0.77	x	6.25	x	85.29	x	0.76	x	0.7	=	393.06	(78)
South	0.9x	0.77	x	6.25	x	56.07	x	0.76	x	0.7	=	258.39	(78)
South	0.9x	0.77	x	6.25	x	40.89	x	0.76	x	0.7	=	188.44	(78)

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

(83)m=	218.09	355.69	434.33	484.41	500.25	501.85	493.74	478.74	460.8	393.06	258.39	188.44	(83)

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

(84)m=	1019.49	1149.97	1196.64	1197.93	1163.69	1121.71	1089.32	1086.04	1097.33	1078.64	997.76	968.6	(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	1	0.99	0.96	0.82	0.56	0.56	0.86	0.99	1	1	(86)

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

(87)m=	20.41	20.5	20.62	20.74	20.89	20.98	21	21	20.98	20.82	20.56	20.42	(87)

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

(88)m=	20.07	20.07	20.07	20.08	20.08	20.09	20.09	20.09	20.08	20.08	20.08	20.07	(88)

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

(89)m=	1	1	1	0.99	0.93	0.72	0.44	0.44	0.77	0.98	1	1	(89)

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

(90)m=	19.29	19.42	19.6	19.77	19.99	20.08	20.09	20.09	20.07	19.88	19.51	19.31	(90)

fLA = Living area ÷ (4) = 0.42 (91)

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

(92)m=	19.76	19.87	20.03	20.18	20.37	20.46	20.47	20.47	20.45	20.27	19.95	19.78	(92)

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

(93)m=	19.61	19.72	19.88	20.03	20.22	20.31	20.32	20.32	20.3	20.12	19.8	19.63	(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	1	1	0.99	0.94	0.75	0.47	0.47	0.8	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1019.18	1148.77	1192.23	1184.42	1094	838.39	511.26	511.25	872.53	1055.86	996.72	968.36	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2312.03	2241.89	1991.74	1710.83	1279.44	855.62	511.49	511.49	902.48	1407.88	1941.26	2242.37	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	961.88	734.58	594.84	379.01	137.97	0	0	0	0	261.9	680.07	947.87	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 4698.1 (98)

Space heating requirement in kWh/m²/year 31.32 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	961.88	734.58	594.84	379.01	137.97	0	0	0	0	261.9	680.07	947.87		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	1035.39	790.72	640.3	407.98	148.51	0	0	0	0	281.91	732.04	1020.31		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													5057.16	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15		
Efficiency of water heater													82.8	(216)
(217)m=	90.91	90.68	90.21	89.51	87.1	82.8	82.8	82.8	82.8	88.54	90.5	90.93		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	230.76	203.32	213.23	190.68	190.57	176.9	167.79	187.02	187.6	199.98	209.34	224.5		
Total = Sum(219a)$_{1...12}$ =													2381.68	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			5057.16	
Water heating fuel used			2381.68	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			604.48	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	156.772	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	73.83	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	69.27	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			425.9323	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.0266	(257)
SAP rating (Section 12)		85.6788	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	1001.32	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	471.57	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1472.89	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	312.52	(268)
Total CO2, kg/year			sum of (265)…(271) =		1875.88	(272)
CO2 emissions per m²			(272) ÷ (4) =		12.51	(273)
EI rating (section 14)					87	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	5158.3	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2429.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =				7587.62	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	1765.08	(268)
'Total Primary Energy			sum of (265)…(271) =		9863.69	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		65.76	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	56.67	(1a)	x	2.5	(2a)	=	141.675	(3a)
First floor	56.67	(1b)	x	2.5	(2b)	=	141.675	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.34	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	283.35	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)

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

Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.22	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.3	0.28	0.28	0.25	0.23	0.22	0.21	0.21	0.23	0.25	0.27	0.28

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=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(24d)

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(1.4)+ 0.04]		=	13.42			(27)
Floor Type 1			56.67	x	0.15	=	8.5005			(28)
Floor Type 2			56.67	x	0.15	=	8.5005			(28)
Walls	113.52	12.12	101.39	x	0.15	=	15.21			(29)
Roof	56.67	0	56.67	x	0.13	=	7.37			(30)
Total area of elements, m²			283.53							(31)
Party wall			10	x	0	=	0			(32)

** 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) = 55.8 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 27842.1791 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 14.18 (36)

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

Total fabric heat loss (33) + (36) = 69.98 (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

SAP WorkSheet: New dwelling design stage

(38)m=	50.95	50.5	50.5	49.67	49.17	48.94	48.72	48.72	49.29	49.67	50.07	50.5	(38)

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

(39)m=	120.93	120.48	120.48	119.65	119.15	118.92	118.7	118.7	119.27	119.65	120.05	120.48	

Average = $Sum(39)_{1...12}$ /12= 119.7 (39)

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

(40)m=	1.07	1.06	1.06	1.06	1.05	1.05	1.05	1.05	1.05	1.06	1.06	1.06	

Average = $Sum(40)_{1...12}$ /12= 1.06 (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 2.8335 (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) + 36 106.8364 (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=	117.52	113.25	108.97	104.7	100.43	96.15	96.15	100.43	104.7	108.97	113.25	117.52	

Total = $Sum(44)_{1...12}$ = 1282.037 (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=	174.7	152.79	157.67	137.46	131.89	113.81	105.47	121.02	122.47	142.72	155.8	169.18	

Total = $Sum(45)_{1...12}$ = 1684.9743 (45)

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

(46)m=	26.2	22.92	23.65	20.62	19.78	17.07	15.82	18.15	18.37	21.41	23.37	25.38	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

SAP WorkSheet: New dwelling design stage

Primary circuit loss (annual) from Table 3 | 360 | (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	

Output from water heater (annual)$_{1...12}$ | 2049.7047 | (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=	82.55	72.9	76.88	69.38	68.31	61.51	59.53	64.7	64.39	71.92	75.47	80.71	(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=	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	(66)

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

(67)m=	72.76	64.63	52.56	39.79	29.74	25.11	27.13	35.27	47.34	60.11	70.15	74.79	(67)

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

(68)m=	412.34	416.62	405.84	382.88	353.91	326.68	308.48	304.2	314.99	337.94	366.92	394.15	(68)

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

(69)m=	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	(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=	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	(71)

Water heating gains (Table 5)

(72)m=	110.95	108.48	103.34	96.36	91.82	85.44	80.01	86.96	89.43	96.66	104.82	108.49	(72)

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

(73)m=	707.56	701.23	673.24	630.53	586.98	548.73	527.13	537.94	563.26	606.21	653.4	688.92	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	176.65	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	288.11	(78)

South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	351.81	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	392.38	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	405.2	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	406.5	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	399.93	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	387.78	(78)
South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	373.25	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	318.38	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	209.3	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	152.64	(78)

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

(83)m=	176.65	288.11	351.81	392.38	405.2	406.5	399.93	387.78	373.25	318.38	209.3	152.64	(83)

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

(84)m=	884.21	989.34	1025.05	1022.91	992.18	955.22	927.06	925.72	936.51	924.59	862.69	841.56	(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	1	0.99	0.94	0.77	0.52	0.52	0.81	0.98	1	1	(86)

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

(87)m=	20.43	20.52	20.65	20.76	20.91	20.99	21	21	20.98	20.84	20.58	20.44	(87)

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

(88)m=	20.03	20.03	20.03	20.04	20.04	20.04	20.05	20.05	20.04	20.04	20.04	20.03	(88)

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

(89)m=	1	1	0.99	0.98	0.9	0.67	0.4	0.4	0.72	0.96	1	1	(89)

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

(90)m=	19.28	19.41	19.6	19.77	19.97	20.04	20.05	20.05	20.03	19.88	19.51	19.3	(90)

fLA = Living area ÷ (4) = | 0.4 | (91)

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

(92)m=	19.74	19.85	20.02	20.17	20.34	20.42	20.42	20.42	20.41	20.26	19.93	19.75	(92)

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

(93)m=	19.74	19.85	20.02	20.17	20.34	20.42	20.42	20.42	20.41	20.26	19.93	19.75	(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	1	0.99	0.98	0.92	0.71	0.45	0.45	0.76	0.96	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	883.5	986.99	1017.5	1002.67	907.94	680.58	418.18	418.18	709.88	892.14	860.6	840.99	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(97)m=	1842.84	1789.4	1592.14	1371.81	1029.64	691.66	418.37	418.37	728.69	1131.54	1552.6	1788.93	(97)

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

(98)m=	713.75	539.22	427.53	265.78	90.55	0	0	0	0	178.11	498.24	705.26	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3418.45 (98)

Space heating requirement in kWh/m²/year 30.16 (99)

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)	713.75	539.22	427.53	265.78	90.55	0	0	0	0	178.11	498.24	705.26	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	769.13	581.06	460.7	286.4	97.57	0	0	0	0	191.93	536.9	759.98	(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3683.67 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] + (214) m } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10....12}$= 0 (215)

Water heating

Output from water heater (calculated above)

205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16

Efficiency of water heater 79.1 (216)

(217)m=	87.16	86.85	86.23	85.34	82.62	79.1	79.1	79.1	79.1	84.18	86.62	87.19	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	235.96	208.14	218.77	196.2	197.14	181.78	172.49	192.16	192.73	206.35	214.47	229.56

Total = Sum(219a)$_{1...12}$ = 2445.76 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3683.67	
Water heating fuel used			2445.76	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			514.01	(232)

10a. Fuel costs - individual heating systems:

SAP WorkSheet: New dwelling design stage

		Fuel kWh/year		Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211)	x		3.1	x 0.01 =	114.1938	(240)
Space heating - main system 2	(213)	x		0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x		0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)			3.1	x 0.01 =	75.82	(247)
Pumps, fans and electric keep-hot	(231)			11.46	x 0.01 =	20.06	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)		11.46	x 0.01 =	58.91	(250)
Additional standing charges (Table 12)					106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)...(254) =	374.9726	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.113	(257)
SAP rating (Section 12)		84.4732	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	729.37	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	484.26	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1213.63	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	265.74	(268)
Total CO2, kg/year			sum of (265)…(271) =		1569.84	(272)
CO2 emissions per m²			(272) ÷ (4) =		13.85	(273)
EI rating (section 14)					87	(274)

13a. Primary Energy

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	3757.34	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2494.68	(264)
Space and water heating	(261) + (262) + (263) + (264) =				6252.02	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)

SAP WorkSheet: New dwelling design stage

Electricity for lighting	(232) x	0	=	1500.9	(268)
'Total Primary Energy		sum of (265)…(271) =		8263.92	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		72.91	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	48.77	(1a)	x	2.5	(2a)	=	121.925	(3a)
First floor	48.77	(1b)	x	2.5	(2b)	=	121.925	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	97.54	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	243.85	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.22	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.3	0.28	0.28	0.25	0.23	0.22	0.21	0.21	0.23	0.25	0.27	0.28

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=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(24d)

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.54	0.54	(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	x	1	=	2			(26)
Windows			10.125	x1/[1/(1.4)+ 0.04]		=	13.42			(27)
Floor Type 1			48.77	x	0.18	=	8.778601			(28)
Floor Type 2			48.77	x	0.18	=	8.778601			(28)
Walls	97.72	22.25	75.47	x	0.15	=	11.32			(29)
Roof	48.77	0	48.77	x	0.13	=	6.34			(30)
Total area of elements, m²			244.03							(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) = 64.06 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 17942.8802 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 19.52 (36)

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

Total fabric heat loss (33) + (36) = 83.59 (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=	43.85	43.46	43.46	42.74	42.32	42.12	41.93	41.93	42.42	42.74	43.09	43.46	(38)

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

(39)m=	127.44	127.05	127.05	126.33	125.91	125.71	125.52	125.52	126.01	126.33	126.68	127.05

Average = Sum(39)1…12 /12= 126.38 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.31	1.3	1.3	1.3	1.29	1.29	1.29	1.29	1.29	1.3	1.3	1.3

Average = Sum(40)$_{1...12}$ /12= 1.3 (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 2.7156 (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) + 36 103.8889 (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=	114.28	110.12	105.97	101.81	97.66	93.5	93.5	97.66	101.81	105.97	110.12	114.28	
										Total = Sum(44)$_{1...12}$ =		1246.6668	(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=	169.88	148.57	153.32	133.66	128.25	110.67	102.56	117.68	119.09	138.79	151.5	164.52	
										Total = Sum(45)$_{1...12}$ =		1638.4874	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.48	22.29	23	20.05	19.24	16.6	15.38	17.65	17.86	20.82	22.72	24.68	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	

Output from water heater (annual)$_{1...12}$ 2003.2178 (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=	80.94	71.49	75.44	68.11	67.1	60.47	58.56	63.59	63.27	70.61	74.04	79.16	(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=	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	(66)

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

(67)m=	56.43	50.12	40.76	30.86	23.07	19.47	21.04	27.35	36.71	46.62	54.41	58	(67)

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

(68)m=	376.55	380.46	370.61	349.65	323.19	298.32	281.7	277.8	287.64	308.6	335.07	359.94	(68)

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

(69)m=	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	(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=	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	(71)

Water heating gains (Table 5)

(72)m=	108.8	106.39	101.39	94.6	90.19	83.99	78.71	85.47	87.87	94.9	102.84	106.4	(72)

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

(73)m=	650.1	645.29	621.09	583.43	544.77	510.1	489.78	498.94	520.55	558.44	600.63	632.66	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	353.3	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	576.23	(78)
South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	703.61	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	784.75	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	810.4	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	813	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	799.85	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	775.56	(78)

South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	746.5	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	636.76	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	418.6	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	305.28	(78)

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

(83)m=	353.3	576.23	703.61	784.75	810.4	813	799.85	775.56	746.5	636.76	418.6	305.28	(83)

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

(84)m=	1003.4	1221.52	1324.7	1368.18	1355.17	1323.1	1289.63	1274.5	1267.05	1195.2	1019.23	937.93	(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	0.97	0.93	0.81	0.6	0.4	0.4	0.66	0.91	0.99	1	(86)

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

(87)m=	20.36	20.52	20.7	20.84	20.96	21	21	21	20.99	20.88	20.56	20.36	(87)

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

(88)m=	19.84	19.84	19.84	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.84	19.84	(88)

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

(89)m=	1	0.99	0.95	0.89	0.73	0.5	0.29	0.29	0.55	0.86	0.99	1	(89)

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

(90)m=	19.03	19.26	19.51	19.69	19.82	19.85	19.85	19.85	19.85	19.75	19.32	19.02	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	19.53	19.74	19.96	20.12	20.25	20.28	20.29	20.29	20.28	20.18	19.79	19.53	(92)

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

(93)m=	19.53	19.74	19.96	20.12	20.25	20.28	20.29	20.29	20.28	20.18	19.79	19.53	(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	0.98	0.96	0.9	0.76	0.54	0.33	0.33	0.59	0.88	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	999.34	1203	1267.44	1236.29	1030.26	711.32	425.26	425.25	747.23	1048.97	1006.82	934.97	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1915.84	1872.73	1671.97	1443.3	1076.72	714.65	425.33	425.33	753.67	1185.07	1619.99	1858.6	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	681.88	450.06	300.97	149.04	34.57	0	0	0	0	101.26	441.49	687.18	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 2846.44 (98)

Space heating requirement in kWh/m²/year 29.18 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	681.88	450.06	300.97	149.04	34.57	0	0	0	0	101.26	441.49	687.18		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	730.84	482.38	322.58	159.74	37.05	0	0	0	0	108.53	473.19	736.53		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3050.85	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49		
Efficiency of water heater													79.6	(216)
(217)m=	87.62	87	85.91	84.36	81.32	79.6	79.6	79.6	79.6	83.29	86.9	87.69		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	229.23	202.92	214.51	193.97	195.81	176.7	167.75	186.76	187.27	203.83	208.84	222.94		
Total = Sum(219a)$_{1...12}$ =													2390.53	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3050.85	
Water heating fuel used			2390.53	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			398.64	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	94.5763	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	74.11	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	45.68	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			340.422	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1225	(257)
SAP rating (Section 12)		84.3414	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	604.07	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	473.33	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1077.39	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	206.1	(268)
Total CO2, kg/year		sum of (265)…(271) =		1373.97	(272)
CO2 emissions per m²		(272) ÷ (4) =		14.09	(273)
EI rating (section 14)				87	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	3111.86	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2438.35	(264)
Space and water heating	(261) + (262) + (263) + (264) =			5550.21	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511	(267)
Electricity for lighting	(232) x	0	=	1164.03	(268)
'Total Primary Energy		sum of (265)…(271) =		7225.24	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		74.07	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	41.5	(1a)	x	2.5	(2a)	=	103.75	(3a)
First floor	41.5	(1b)	x	2.5	(2b)	=	103.75	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	83	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	207.5	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		4.8	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.24	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.2	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.28	0.26	0.26	0.23	0.21	0.2	0.19	0.19	0.21	0.23	0.24	0.26

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=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(24d)

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

(25)m=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(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	x	1.2	=	2.4			(26)
Windows			6.125	x1/[1/(1.2)+ 0.04]		=	7.01			(27)
Floor Type 1			41.5	x	0.15	=	6.225			(28)
Floor Type 2			41.5	x	0.15	=	6.225			(28)
Walls	83.18	14.25	68.93	x	0.15	=	10.34			(29)
Roof	41.5	0	41.5	x	0.13	=	5.39			(30)
Total area of elements, m²			207.68							(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) = 44.61 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15904.05 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 10.38 (36)

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

Total fabric heat loss (33) + (36) = 55 (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=	36.83	36.55	36.55	36.04	35.73	35.59	35.46	35.46	35.81	36.04	36.29	36.55	(38)

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

(39)m=	91.83	91.55	91.55	91.04	90.73	90.59	90.45	90.45	90.8	91.04	91.28	91.55

Average = Sum(39)$_{1…12}$ /12= 91.07 (39)

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SAP WorkSheet: New dwelling design stage

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

(40)m=	1.11	1.1	1.1	1.1	1.09	1.09	1.09	1.09	1.09	1.1	1.1	1.1

Average = $Sum(40)_{1...12}$ /12= 1.1 (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 2.5173 (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 98.9331 (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=	108.83	104.87	100.91	96.95	93	89.04	89.04	93	96.95	100.91	104.87	108.83	

Total = $Sum(44)_{1...12}$ = 1187.197 (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=	161.77	141.49	146	127.29	122.14	105.39	97.66	112.07	113.41	132.17	144.27	156.67

Total = $Sum(45)_{1...12}$ = 1560.3265 (45)

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

(46)m=	24.27	21.22	21.9	19.09	18.32	15.81	14.65	16.81	17.01	19.82	21.64	23.5	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	

Output from water heater (annual) $_{1...12}$ 1925.0569 (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=	78.25	69.14	73.01	65.99	65.07	58.71	56.93	61.72	61.38	68.41	71.64	76.55	(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=	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	53.33	47.37	38.52	29.16	21.8	18.41	19.89	25.85	34.7	44.06	51.42	54.81	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	336.71	340.2	331.4	312.66	288.99	266.76	251.9	248.41	257.21	275.95	299.62	321.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	(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=	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	(71)
Water heating gains (Table 5)													
(72)m=	105.17	102.88	98.13	91.66	87.46	81.55	76.52	82.96	85.25	91.94	99.5	102.89	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	598.19	593.43	571.02	536.45	501.22	469.68	451.28	460.19	480.12	514.92	553.5	582.53	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	811.91	942.01	996.66	1011.17	991.47	961.49	935.14	929.35	931.71	900.12	806.73	767.2	(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=	1	0.99	0.97	0.94	0.81	0.6	0.4	0.4	0.65	0.91	0.99	1	(86)

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

(87)m=	20.51	20.63	20.77	20.88	20.97	21	21	21	21	20.92	20.67	20.51	(87)

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

(88)m=	20	20	20	20.01	20.01	20.01	20.01	20.01	20.01	20.01	20	20	(88)

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

(89)m=	1	0.99	0.96	0.9	0.74	0.51	0.3	0.3	0.55	0.86	0.99	1	(89)

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

(90)m=	19.37	19.55	19.74	19.89	19.99	20.01	20.01	20.01	20.01	19.94	19.6	19.37	(90)

fLA = Living area ÷ (4) = 0.36 (91)

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

(92)m=	19.78	19.94	20.11	20.25	20.34	20.37	20.37	20.37	20.36	20.3	19.99	19.78	(92)

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

(93)m=	19.78	19.94	20.11	20.25	20.34	20.37	20.37	20.37	20.36	20.3	19.99	19.78	(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	0.96	0.91	0.77	0.54	0.34	0.34	0.59	0.88	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	808.68	929.58	958.64	922.47	760.08	521.14	313.72	313.72	548.2	789.24	797	764.73	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1403.37	1367.66	1218.95	1051.08	784.35	522.37	313.74	313.74	550.64	864.48	1185.69	1362.34	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	442.45	294.39	193.67	92.6	18.05	0	0	0	0	55.98	279.86	444.62	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 1821.62 (98)

Space heating requirement in kWh/m²/year 21.95 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system			0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =		1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =		1	(204)
Efficiency of main space heating system 1			93.3	(206)
Efficiency of secondary/supplementary heating system, %			0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	442.45	294.39	193.67	92.6	18.05	0	0	0	0	55.98	279.86	444.62		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	474.22	315.53	207.58	99.24	19.35	0	0	0	0	60	299.95	476.55		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													1952.43	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

Output from water heater (calculated above)	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65		
Efficiency of water heater													79.6	(216)
(217)m=	86.76	86.07	84.85	83.26	80.61	79.6	79.6	79.6	79.6	82.08	85.87	86.84		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	222.16	196.89	208.57	188.89	189.95	170.07	161.61	179.71	180.13	198.75	202.92	216.09		
Total = Sum(219a)$_{1...12}$ =													2315.74	(219)

Annual totals

		kWh/year	kWh/year	
Space heating fuel used, main system 1			1952.43	
Water heating fuel used			2315.74	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		175	(231)
Electricity for lighting			376.75	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	60.5253	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	71.79	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	43.18	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			301.5435	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1072	(257)
SAP rating (Section 12)		84.5541	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	386.58	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	458.52	(264)
Space and water heating	(261) + (262) + (263) + (264) =				845.1	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	90.48	(267)
Electricity for lighting	(232)	x	0.517	=	194.78	(268)
Total CO2, kg/year			sum of (265)…(271) =		1130.35	(272)
CO2 emissions per m²			(272) ÷ (4) =		13.62	(273)
EI rating (section 14)					88	(274)

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13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	1991.48	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2362.05	(264)
Space and water heating	(261) + (262) + (263) + (264) =				4353.53	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	511	(267)
Electricity for lighting	(232)	x	0	=	1100.11	(268)
'Total Primary Energy			sum of (265)…(271) =		5964.64	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		71.86	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	62.66	(1a) x	2.39	(2a) =	149.7574	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.66	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	149.7574	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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			4.8	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.24	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides on which sheltered			2	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor		(21) = (18) x (20) =	0.2	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

SAP WorkSheet: New dwelling design stage

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

0.28	0.26	0.26	0.23	0.21	0.2	0.19	0.19	0.21	0.23	0.24	0.26

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=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(24d)

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

(25)m=	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53	(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	x	1.2	=	2.4			(26)
Windows			6.125	x	1/[1/(1)+ 0.04]	=	5.89			(27)
Floor			62.66	x	0.15	=	9.399			(28)
Walls	62.84	14.25	48.59	x	0.15	=	7.29			(29)
Roof	62.66	0	62.66	x	0.13	=	8.15			(30)
Total area of elements, m²			188.16							(31)
Party wall			10	x	0	=	0			(32)
Internal wall **			0							(32c)

** 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) = 39.01 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 12523.09 (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 7.53 (36)

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

Total fabric heat loss (33) + (36) = 46.54 (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=	26.58	26.38	26.38	26.01	25.79	25.69	25.59	25.59	25.84	26.01	26.19	26.38	(38)

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

(39)m=	73.12	72.92	72.92	72.55	72.33	72.23	72.13	72.13	72.38	72.55	72.73	72.92	

Average = Sum(39)$_{1…12}$ /12= 72.58 (39)

SAP WorkSheet: New dwelling design stage

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=	1.17	1.16	1.16	1.16	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16

Average = Sum(40)$_{1…12}$ /12= 1.16 (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 2.0558 (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 87.3939 (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=	96.13	92.64	89.14	85.65	82.15	78.65	78.65	82.15	85.65	89.14	92.64	96.13

Total = Sum(44)$_{1…12}$ = 1048.7273 (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=	142.9	124.98	128.97	112.44	107.89	93.1	86.27	99	100.18	116.75	127.44	138.39

Total = Sum(45)$_{1…12}$ = 1378.3365 (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=	21.44	18.75	19.35	16.87	16.18	13.97	12.94	14.85	15.03	17.51	19.12	20.76

(46)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

If manufacturer’s declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4

(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(57)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4

(57)

Primary circuit loss (annual) from Table 3 360 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(59)m=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58

(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	

Output from water heater (annual)$_{1...12}$ 1743.0669 (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=	72.3	63.94	67.67	61.37	60.66	54.94	53.47	57.7	57.29	63.6	66.36	70.8	(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=	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	41.24	36.63	29.79	22.55	16.86	14.23	15.38	19.99	26.83	34.07	39.76	42.38	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	268.06	270.84	263.83	248.91	230.07	212.37	200.54	197.76	204.77	219.69	238.53	256.24	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	(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=	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	(71)
Water heating gains (Table 5)													
(72)m=	97.17	95.15	90.95	85.24	81.53	76.3	71.86	77.55	79.57	85.49	92.16	95.16	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	496.98	493.13	475.08	447.2	418.96	393.41	378.29	385.81	401.68	429.75	460.96	484.28	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	710.71	841.71	900.72	921.93	909.21	885.22	862.15	854.97	853.27	814.95	714.18	668.96	(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=	0.97	0.94	0.88	0.82	0.69	0.51	0.34	0.34	0.55	0.79	0.94	0.97	(86)

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

(87)m=	20.23	20.43	20.64	20.8	20.93	20.99	21	21	20.98	20.86	20.48	20.22	(87)

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

(88)m=	19.95	19.95	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.96	19.95	19.95	(88)

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

(89)m=	0.96	0.92	0.86	0.78	0.63	0.43	0.26	0.26	0.47	0.74	0.92	0.96	(89)

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

(90)m=	18.97	19.26	19.54	19.74	19.9	19.95	19.96	19.96	19.95	19.82	19.34	18.96	(90)

fLA = Living area ÷ (4) = 0.64 (91)

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

(92)m=	19.77	20.01	20.25	20.41	20.56	20.61	20.62	20.62	20.61	20.48	20.07	19.76	(92)

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

(93)m=	19.77	20.01	20.25	20.41	20.56	20.61	20.62	20.62	20.61	20.48	20.07	19.76	(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=	0.96	0.92	0.87	0.8	0.66	0.48	0.31	0.31	0.52	0.77	0.93	0.96	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	681.35	775.3	779.99	735.35	603.38	427.99	268.04	268.01	447.01	624.17	662.12	644.41	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1116.73	1094.47	980.46	849.83	640.68	434.29	268.57	268.56	456.49	702.4	950.49	1083.85	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	323.93	214.49	149.15	82.42	27.75	0	0	0	0	58.2	207.63	326.94	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 1390.5 (98)

Space heating requirement in kWh/m²/year 22.19 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system			0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =		1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =		1	(204)
Efficiency of main space heating system 1			93.3	(206)
Efficiency of secondary/supplementary heating system, %			0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	323.93	214.49	149.15	82.42	27.75	0	0	0	0	58.2	207.63	326.94		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	347.19	229.89	159.86	88.34	29.74	0	0	0	0	62.37	222.54	350.42		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													1490.36	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37		
Efficiency of water heater													79.6	(216)
(217)m=	86.25	85.51	84.43	83.21	81.2	79.6	79.6	79.6	79.6	82.36	85.35	86.34		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	201.6	178.87	189.45	171.15	171.01	154.62	147.3	163.29	163.52	179.37	184.44	196.17		
Total = Sum(219a)$_{1...12}$ =													2100.79	(219)

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Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		1490.36	
Water heating fuel used		2100.79	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	130		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year (sum of (230a)…(230g) =)		175	(231)
Electricity for lighting		291.31	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	46.2011	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	65.12	(247)

SAP WorkSheet: New dwelling design stage

Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	20.06	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	33.38	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			270.7652	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1821	(257)
SAP rating (Section 12)		83.5104	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	295.09	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	415.96	(264)
Space and water heating	(261) + (262) + (263) + (264) =			711.05	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	150.61	(268)
Total CO2, kg/year		sum of (265)…(271) =		952.13	(272)
CO2 emissions per m²		(272) ÷ (4) =		15.2	(273)
EI rating (section 14)				88	(274)

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13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	1520.16	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2142.81	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3662.97	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	511	(267)
Electricity for lighting	(232) x	0	=	850.64	(268)
'Total Primary Energy		sum of (265)…(271) =		5024.61	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		80.19	(273)

Passivhaus SAP 2009 Worksheets for 1 to 5 Bedroom

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2009 | **Software Version:** Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	75	(1a) x	2.5	(2a) =	187.5	(3a)
First floor	75	(1b) x	2.5	(2b) =	187.5	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	150	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	375	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		0.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.03	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides on which sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.03	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 77.35 (23c)

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

(24a)m=	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	(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	x	1.2	=	2.4			(26)
Windows			6.25	x1/[1/(0.8)+ 0.04]		=	4.84			(27)
Floor Type 1			75	x	0.15	=	11.25			(28)
Floor Type 2			75	x	0.15	=	11.25			(28)
Walls	150.18	14.5	135.68	x	0.15	=	20.35			(29)
Roof	75	0	75	x	0.15	=	11.25			(30)
Total area of elements, m²			375.18							(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) = 66.19 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 40329.1986 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 16.51 (36)

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

Total fabric heat loss (33) + (36) = 82.7 (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=	19.03	18.75	18.75	18.19	17.82	17.63	17.45	17.45	17.91	18.19	18.47	18.75	(38)

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

(39)m=	101.73	101.45	101.45	100.89	100.52	100.33	100.15	100.15	100.61	100.89	101.17	101.45

Average = Sum(39)$_{1…12}$ /12= 100.9 (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=	0.68	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.68

Average = Sum(40)$_{1…12}$ /12= 0.67 (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 2.9342 (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) + 36 109.3547 (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=	120.29	115.92	111.54	107.17	102.79	98.42	98.42	102.79	107.17	111.54	115.92	120.29

Total = Sum(44)$_{1…12}$ = 1312.2566 (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=	178.81	156.39	161.38	140.7	135	116.5	107.95	123.88	125.35	146.09	159.47	173.17

Total = Sum(45)$_{1…12}$ = 1724.6917 (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=	26.82	23.46	24.21	21.1	20.25	17.47	16.19	18.58	18.8	21.91	23.92	25.98	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

SAP WorkSheet: New dwelling design stage

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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	(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=	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15	

Output from water heater (annual)1…12 2089.4221 (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=	84.24	74.38	78.44	70.76	69.67	62.72	60.68	65.97	65.66	73.36	77.01	82.36	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	176.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	87.69	77.88	63.34	47.95	35.84	30.26	32.7	42.5	57.05	72.43	84.54	90.12	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	478.39	483.36	470.85	444.22	410.6	379	357.89	352.93	365.44	392.07	425.69	457.28	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	55.54	(69)
Pumps and fans gains (Table 5a)													
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	-117.37	(71)
Water heating gains (Table 5)													
(72)m=	113.22	110.69	105.43	98.28	93.64	87.11	81.55	88.67	91.2	98.6	106.95	110.7	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	803.52	796.15	763.84	714.67	664.31	620.59	596.37	608.32	637.91	687.32	741.4	782.33	(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	0.77	x	6.25	x	47.32	x	0.76	x	0.7	=	218.09	(78)
South	0.9x	0.77	x	6.25	x	77.18	x	0.76	x	0.7	=	355.69	(78)
South	0.9x	0.77	x	6.25	x	94.25	x	0.76	x	0.7	=	434.33	(78)
South	0.9x	0.77	x	6.25	x	105.11	x	0.76	x	0.7	=	484.41	(78)
South	0.9x	0.77	x	6.25	x	108.55	x	0.76	x	0.7	=	500.25	(78)
South	0.9x	0.77	x	6.25	x	108.9	x	0.76	x	0.7	=	501.85	(78)
South	0.9x	0.77	x	6.25	x	107.14	x	0.76	x	0.7	=	493.74	(78)
South	0.9x	0.77	x	6.25	x	103.88	x	0.76	x	0.7	=	478.74	(78)

South	0.9x	0.77	x	6.25	x	99.99	x	0.76	x	0.7	=	460.8	(78)
South	0.9x	0.77	x	6.25	x	85.29	x	0.76	x	0.7	=	393.06	(78)
South	0.9x	0.77	x	6.25	x	56.07	x	0.76	x	0.7	=	258.39	(78)
South	0.9x	0.77	x	6.25	x	40.89	x	0.76	x	0.7	=	188.44	(78)

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

(83)m=	218.09	355.69	434.33	484.41	500.25	501.85	493.74	478.74	460.8	393.06	258.39	188.44	(83)

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

(84)m=	1021.61	1151.85	1198.17	1199.09	1164.55	1122.44	1090.11	1087.06	1098.71	1080.39	999.8	970.77	(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	0.98	0.95	0.79	0.57	0.38	0.38	0.61	0.91	1	1	(86)

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

(87)m=	20.73	20.81	20.89	20.96	21	21	21	21	21	20.98	20.83	20.73	(87)

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

(88)m=	20.36	20.36	20.36	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.36	20.36	(88)

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

(89)m=	1	1	0.98	0.92	0.74	0.52	0.32	0.32	0.56	0.87	1	1	(89)

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

(90)m=	20.01	20.12	20.24	20.32	20.37	20.37	20.37	20.37	20.37	20.35	20.15	20.01	(90)

fLA = Living area ÷ (4) = | 0.42 | (91)

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

(92)m=	20.31	20.41	20.52	20.59	20.63	20.63	20.63	20.63	20.63	20.61	20.44	20.31	(92)

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

(93)m=	20.16	20.26	20.36	20.44	20.48	20.48	20.48	20.48	20.48	20.46	20.29	20.16	(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	0.92	0.75	0.53	0.33	0.33	0.57	0.87	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1020.61	1146.01	1169.77	1108.7	877.33	590.32	359.01	359.01	621.96	943.81	994.81	970.05	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1593.41	1547.87	1376.14	1184.37	882.58	590.37	359.01	359.01	622.09	975	1344.25	1548.26	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	426.16	270.05	153.54	54.49	3.91	0	0	0	0	23.2	251.59	430.19	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = | 1613.13 | (98)

Space heating requirement in kWh/m²/year | 10.75 | (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.9	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	426.16	270.05	153.54	54.49	3.91	0	0	0	0	23.2	251.59	430.19		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	458.73	290.69	165.27	58.65	4.2	0	0	0	0	24.97	270.82	463.07		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													1736.41	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	209.79	184.37	192.36	170.67	165.98	146.47	138.93	154.85	155.33	177.07	189.45	204.15		
Efficiency of water heater													82.8	(216)
(217)m=	89.31	88.52	87	85.04	83.01	82.8	82.8	82.8	82.8	83.86	88.27	89.39		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	234.91	208.28	221.11	200.71	199.96	176.9	167.79	187.02	187.6	211.15	214.61	228.38		
Total = Sum(219a)$_{1...12}$ =													2438.41	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			1736.41	
Water heating fuel used			2438.41	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		343.12		(230a)
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		518.12	(231)
Electricity for lighting			619.43	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	53.8288	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)

SAP WorkSheet: New dwelling design stage

Water heating cost (other fuel)	(219)	3.1	x 0.01 =	75.59	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	59.38	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	70.99	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	365.7836	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.8816	(257)
SAP rating (Section 12)		87.7012	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	343.81	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	482.81	(264)
Space and water heating	(261) + (262) + (263) + (264) =			826.62	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	267.87	(267)
Electricity for lighting	(232) x	0.517	=	320.25	(268)
Total CO2, kg/year		sum of (265)…(271) =		1414.73	(272)
CO2 emissions per m²		(272) ÷ (4) =		9.43	(273)
EI rating (section 14)				90	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.02	=	1771.14	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2487.18	(264)
Space and water heating	(261) + (262) + (263) + (264) =			4258.32	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	1512.92	(267)
Electricity for lighting	(232) x	0	=	1808.74	(268)
‘Total Primary Energy		sum of (265)…(271) =		7579.99	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		50.53	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	56.67	(1a)	x	2.5	(2a)	=	141.675	(3a)
First floor	56.67	(1b)	x	2.5	(2b)	=	141.675	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.34	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	283.35	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		0.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.03	(18)

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

Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.03	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 79.05 (23c)

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

(24a)m=	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14	(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	x	1.4	=	2.8			(26)
Windows			10.125	x1/[1/(0.8)+ 0.04]		=	7.85			(27)
Floor Type 1			56.67	x	0.15	=	8.5005			(28)
Floor Type 2			56.67	x	0.15	=	8.5005			(28)
Walls	113.52	12.12	101.39	x	0.15	=	15.21			(29)
Roof	56.67	0	56.67	x	0.15	=	8.5			(30)
Total area of elements, m²			283.53							(31)
Party wall			10	x	0	=	0			(32)

** 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) = 51.36 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 27842.1791 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 11.34 (36)

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

Total fabric heat loss (33) + (36) = 62.7 (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

SAP WorkSheet: New dwelling design stage

(38)m=	13.3	13.1	13.1	12.71	12.45	12.32	12.19	12.19	12.52	12.71	12.91	13.1	(38)

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

(39)m=	76	75.8	75.8	75.41	75.16	75.03	74.9	74.9	75.22	75.41	75.61	75.8	

Average = Sum(39)1…12 /12= 75.42 (39)

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

(40)m=	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66	0.67	0.67	0.67

Average = Sum(40)1…12 /12= 0.67 (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 2.8335 (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) + 36 106.8364 (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=	117.52	113.25	108.97	104.7	100.43	96.15	96.15	100.43	104.7	108.97	113.25	117.52

Total = Sum(44)1…12 = 1282.037 (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=	174.7	152.79	157.67	137.46	131.89	113.81	105.47	121.02	122.47	142.72	155.8	169.18

Total = Sum(45)1…12 = 1684.9743 (45)

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

(46)m=	26.2	22.92	23.65	20.62	19.78	17.07	15.82	18.15	18.37	21.41	23.37	25.38	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

SAP WorkSheet: New dwelling design stage

Primary circuit loss (annual) from Table 3 | 360 | (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16	(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=	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16

Output from water heater (annual)$_{1…12}$ | 2049.7047 | (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=	82.55	72.9	76.88	69.38	68.31	61.51	59.53	64.7	64.39	71.92	75.47	80.71	(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=	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	170.01	(66)

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

(67)m=	74.65	66.3	53.92	40.82	30.51	25.76	27.84	36.18	48.56	61.66	71.97	76.72	(67)

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

(68)m=	412.34	416.62	405.84	382.88	353.91	326.68	308.48	304.2	314.99	337.94	366.92	394.15	(68)

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

(69)m=	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	54.83	(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=	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	-113.34	(71)

Water heating gains (Table 5)

(72)m=	110.95	108.48	103.34	96.36	91.82	85.44	80.01	86.96	89.43	96.66	104.82	108.49	(72)

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

(73)m=	709.44	702.9	674.6	631.56	587.75	549.38	527.83	538.85	564.48	607.77	655.21	690.86	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	176.65	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	288.11	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	351.81	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	392.38	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	405.2	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	406.5	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	399.93	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	387.78	(78)
South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	373.25	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	318.38	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	209.3	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	152.64	(78)

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

(83)m=	176.65	288.11	351.81	392.38	405.2	406.5	399.93	387.78	373.25	318.38	209.3	152.64	(83)

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

(84)m=	886.09	991.01	1026.41	1023.94	992.95	955.87	927.76	926.63	937.73	926.15	864.51	843.5	(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	0.88	0.7	0.5	0.33	0.33	0.54	0.82	0.99	1	(86)

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

(87)m=	20.8	20.87	20.95	20.98	21	21	21	21	21	20.99	20.89	20.8	(87)

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

(88)m=	20.37	20.37	20.37	20.37	20.37	20.38	20.38	20.38	20.37	20.37	20.37	20.37	(88)

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

(89)m=	1	0.98	0.93	0.84	0.66	0.45	0.28	0.28	0.49	0.77	0.98	1	(89)

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

(90)m=	20.11	20.22	20.31	20.36	20.37	20.38	20.38	20.38	20.37	20.37	20.24	20.11	(90)

fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	20.39	20.48	20.56	20.61	20.62	20.62	20.62	20.62	20.62	20.62	20.5	20.38	(92)

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

(93)m=	20.39	20.48	20.56	20.61	20.62	20.62	20.62	20.62	20.62	20.62	20.5	20.38	(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	0.98	0.94	0.86	0.67	0.47	0.3	0.3	0.51	0.79	0.98	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	882.35	973.64	962.98	875.96	669.47	451.89	278.91	278.91	475.55	732.83	849.04	840.69	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)

SAP WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(97)m=	1207.36	1173.33	1043.37	897.93	670.53	451.9	278.91	278.91	475.57	740.3	1020.69	1173.57	(97)

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

(98)m=	241.81	134.19	59.81	15.82	0.79	0	0	0	0	5.56	123.59	247.67	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 829.23 (98)

Space heating requirement in kWh/m²/year 7.32 (99)

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		92.8	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	241.81	134.19	59.81	15.82	0.79	0	0	0	0	5.56	123.59	247.67		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	260.57	144.6	64.45	17.05	0.85	0	0	0	0	5.99	133.17	266.88		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													893.56	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	205.67	180.77	188.64	167.43	162.87	143.79	136.44	152	152.45	173.7	185.77	200.16		
Efficiency of water heater													79.1	(216)
(217)m=	84.54	83.33	81.44	79.92	79.15	79.1	79.1	79.1	79.1	79.39	83.05	84.68		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	243.27	216.93	231.65	209.5	205.79	181.78	172.49	192.16	192.73	218.79	223.68	236.37		
Total = Sum(219a)$_{1...12}$ =													2525.14	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			893.56	
Water heating fuel used			2525.14	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		229.02		(230a)
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		404.02	(231)
Electricity for lighting			527.3	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	27.7004	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.1	x 0.01 =	78.28	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	46.3	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	60.43	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	318.709	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.946	(257)
SAP rating (Section 12)		86.803	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.198	=	176.93	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	499.98	(264)
Space and water heating	(261) + (262) + (263) + (264) =			676.9	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	208.88	(267)
Electricity for lighting	(232) x	0.517	=	272.62	(268)
Total CO2, kg/year		sum of (265)…(271) =		1158.4	(272)
CO2 emissions per m²		(272) ÷ (4) =		10.22	(273)
EI rating (section 14)				90	(274)

13a. Primary Energy

	Energy kWh/year	Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x	1.02	=	911.43	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	1.02	=	2575.64	(264)
Space and water heating	(261) + (262) + (263) + (264) =			3487.07	(265)

SAP WorkSheet: New dwelling design stage

Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	1179.73	(267)
Electricity for lighting	(232) x	0	=	1539.72	(268)
'Total Primary Energy		sum of (265)…(271) =		6206.53	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		54.76	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	48.77	(1a)	x	2.5	(2a)	=	121.925	(3a)
First floor	48.77	(1b)	x	2.5	(2b)	=	121.925	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	97.54	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			243.85	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		0.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.03	(18)

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

Number of sides on which sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.03	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5 (23c)

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

(24a)m=	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.15	0.15	0.15	0.15	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.16	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.15	0.15	0.15	0.15	(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	x	1	=	2			(26)
Windows			10.125	x1/[1/(0.8)+ 0.04]		=	7.85			(27)
Floor Type 1			48.77	x	0.15	=	7.3155			(28)
Floor Type 2			48.77	x	0.15	=	7.3155			(28)
Walls	97.72	22.25	75.47	x	0.15	=	11.32			(29)
Roof	48.77	0	48.77	x	0.15	=	7.32			(30)
Total area of elements, m²			244.03							(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) = 50.96 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 17942.8802 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 9.76 (36)

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

Total fabric heat loss (33) + (36) = 60.73 (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=	12.47	12.3	12.3	11.97	11.74	11.63	11.52	11.52	11.8	11.97	12.14	12.3	(38)

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

(39)m=	73.2	73.03	73.03	72.69	72.47	72.36	72.25	72.25	72.53	72.69	72.86	73.03	

Average = Sum(39)$_{1…12}$ /12= 72.7 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74	0.75	0.75	0.75

Average = Sum(40)$_{1…12}$ /12= 0.75 (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 2.7156 (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) + 36 103.8889 (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=	114.28	110.12	105.97	101.81	97.66	93.5	93.5	97.66	101.81	105.97	110.12	114.28

Total = Sum(44)$_{1…12}$ = 1246.6668 (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=	169.88	148.57	153.32	133.66	128.25	110.67	102.56	117.68	119.09	138.79	151.5	164.52

Total = Sum(45)$_{1…12}$ = 1638.4874 (45)

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

(46)m=	25.48	22.29	23	20.05	19.24	16.6	15.38	17.65	17.86	20.82	22.72	24.68	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

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

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	(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=	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49	

Output from water heater (annual)$_{1...12}$ 2003.2178 (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=	80.94	71.49	75.44	68.11	67.1	60.47	58.56	63.59	63.27	70.61	74.04	79.16	(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=	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	162.93	(66)

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

(67)m=	57.35	50.94	41.42	31.36	23.44	19.79	21.38	27.8	37.31	47.37	55.29	58.94	(67)

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

(68)m=	376.55	380.46	370.61	349.65	323.19	298.32	281.7	277.8	287.64	308.6	335.07	359.94	(68)

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

(69)m=	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	54.01	(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=	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	-108.62	(71)

Water heating gains (Table 5)

(72)m=	108.8	106.39	101.39	94.6	90.19	83.99	78.71	85.47	87.87	94.9	102.84	106.4	(72)

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

(73)m=	651.01	646.1	621.75	583.93	545.14	510.42	490.12	499.38	521.14	559.2	601.51	633.6	(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	0.77	x	10.12	x	47.32	x	0.76	x	0.7	=	353.3	(78)
South	0.9x	0.77	x	10.12	x	77.18	x	0.76	x	0.7	=	576.23	(78)
South	0.9x	0.77	x	10.12	x	94.25	x	0.76	x	0.7	=	703.61	(78)
South	0.9x	0.77	x	10.12	x	105.11	x	0.76	x	0.7	=	784.75	(78)
South	0.9x	0.77	x	10.12	x	108.55	x	0.76	x	0.7	=	810.4	(78)
South	0.9x	0.77	x	10.12	x	108.9	x	0.76	x	0.7	=	813	(78)
South	0.9x	0.77	x	10.12	x	107.14	x	0.76	x	0.7	=	799.85	(78)
South	0.9x	0.77	x	10.12	x	103.88	x	0.76	x	0.7	=	775.56	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	10.12	x	99.99	x	0.76	x	0.7	=	746.5	(78)
South	0.9x	0.77	x	10.12	x	85.29	x	0.76	x	0.7	=	636.76	(78)
South	0.9x	0.77	x	10.12	x	56.07	x	0.76	x	0.7	=	418.6	(78)
South	0.9x	0.77	x	10.12	x	40.89	x	0.76	x	0.7	=	305.28	(78)

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

(83)m=	353.3	576.23	703.61	784.75	810.4	813	799.85	775.56	746.5	636.76	418.6	305.28	(83)

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

(84)m=	1004.31	1222.33	1325.36	1368.68	1355.54	1323.41	1289.97	1274.94	1267.65	1195.96	1020.11	938.87	(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=	0.98	0.9	0.77	0.65	0.5	0.35	0.23	0.23	0.38	0.62	0.92	0.99	(86)

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

(87)m=	20.86	20.96	20.99	21	21	21	21	21	21	21	20.95	20.85	(87)

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

(88)m=	20.3	20.3	20.3	20.3	20.3	20.3	20.31	20.31	20.3	20.3	20.3	20.3	(88)

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

(89)m=	0.97	0.88	0.74	0.62	0.46	0.31	0.19	0.19	0.34	0.58	0.9	0.98	(89)

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

(90)m=	20.13	20.26	20.29	20.3	20.3	20.3	20.31	20.31	20.3	20.3	20.25	20.11	(90)

fLA = Living area ÷ (4) = | 0.38 | (91)

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

(92)m=	20.41	20.52	20.56	20.57	20.57	20.57	20.57	20.57	20.57	20.57	20.52	20.39	(92)

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

(93)m=	20.41	20.52	20.56	20.57	20.57	20.57	20.57	20.57	20.57	20.57	20.52	20.39	(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=	0.97	0.88	0.75	0.63	0.47	0.33	0.21	0.21	0.36	0.59	0.91	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	977.42	1081.11	996.06	861.41	642.62	431.88	265.09	265.09	454.57	709.44	924.98	920.66	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1164.57	1133.63	1004.73	862.57	642.66	431.88	265.09	265.09	454.57	709.95	984.93	1131.31	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	139.24	35.29	6.45	0.83	0.03	0	0	0	0	0.37	43.17	156.72	

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 382.1 | (98)

Space heating requirement in kWh/m²/year | 3.92 | (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	139.24	35.29	6.45	0.83	0.03	0	0	0	0	0.37	43.17	156.72		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	149.24	37.82	6.92	0.89	0.03	0	0	0	0	0.4	46.27	167.98		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													409.54	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	200.85	176.55	184.29	163.64	159.23	140.65	133.53	148.66	149.07	169.76	181.47	195.49		
Efficiency of water heater													79.6	(216)
(217)m=	83.66	81.2	79.92	79.65	79.6	79.6	79.6	79.6	79.6	79.62	81.45	84.03		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	240.09	217.42	230.6	205.46	200.04	176.7	167.75	186.76	187.27	213.22	222.79	232.65		
Total = Sum(219a)$_{1...12}$ =													2480.74	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			409.54	
Water heating fuel used			2480.74	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		171.06		(230a)
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		346.06	(231)
Electricity for lighting			405.11	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	12.6957	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)

SAP WorkSheet: New dwelling design stage

Water heating cost (other fuel)	(219)	3.1	x 0.01 =	76.9	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	39.66	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	46.43	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)...(254) =	281.6824	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.9288	(257)
SAP rating (Section 12)		87.0433	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	81.09	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	491.19	(264)
Space and water heating	(261) + (262) + (263) + (264) =				572.27	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	178.91	(267)
Electricity for lighting	(232)	x	0.517	=	209.44	(268)
Total CO2, kg/year			sum of (265)…(271) =		960.63	(272)
CO2 emissions per m²			(272) ÷ (4) =		9.85	(273)
EI rating (section 14)					91	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	417.73	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2530.35	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2948.08	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	1010.5	(267)
Electricity for lighting	(232)	x	0	=	1182.91	(268)
'Total Primary Energy			sum of (265)…(271) =		5141.49	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		52.71	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Ground floor	41.5	(1a)	x	2.5	(2a)	=	103.75	(3a)
First floor	41.5	(1b)	x	2.5	(2b)	=	103.75	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	83	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	207.5	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		0.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.03	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.03	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 78.2 (23c)

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

(24a)m=	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.14	0.14	0.14	0.14	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.14	0.14	0.14	0.14	(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	x	1.2	=	2.4			(26)
Windows			6.125	x1/[1/(0.8)+ 0.04]		=	4.75			(27)
Floor Type 1			41.5	x	0.15	=	6.225			(28)
Floor Type 2			41.5	x	0.15	=	6.225			(28)
Walls	83.18	14.25	68.93	x	0.15	=	10.34			(29)
Roof	41.5	0	41.5	x	0.15	=	6.23			(30)
Total area of elements, m²			207.68							(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) = 40.91 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15904.05 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: High 450 (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 7.89 (36)

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

Total fabric heat loss (33) + (36) = 48.8 (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=	9.82	9.69	9.69	9.43	9.25	9.17	9.08	9.08	9.3	9.43	9.56	9.69	(38)

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

(39)m=	58.62	58.49	58.49	58.23	58.06	57.97	57.88	57.88	58.1	58.23	58.36	58.49

Average = Sum(39)$_{1…12}$ /12= 58.23 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	0.71	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Average = Sum(40)$_{1…12}$ /12= 0.7 (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 2.5173 (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 98.9331 (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)

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)

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	
(44)m=	108.83	104.87	100.91	96.95	93	89.04	89.04	93	96.95	100.91	104.87	108.83	
											Total = Sum(44)$_{1…12}$ =	1187.197	(44)
(45)m=	161.77	141.49	146	127.29	122.14	105.39	97.66	112.07	113.41	132.17	144.27	156.67	
											Total = Sum(45)$_{1…12}$ =	1560.3265	(45)
(46)m=	24.27	21.22	21.9	19.09	18.32	15.81	14.65	16.81	17.01	19.82	21.64	23.5	(46)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

If manufacturer’s declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	(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=	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65	

Output from water heater (annual)$_{1...12}$ 1925.0569 (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=	78.25	69.14	73.01	65.99	65.07	58.71	56.93	61.72	61.38	68.41	71.64	76.55	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	151.04	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	54.91	48.77	39.66	30.03	22.44	18.95	20.48	26.61	35.72	45.36	52.94	56.43	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	336.71	340.2	331.4	312.66	288.99	266.76	251.9	248.41	257.21	275.95	299.62	321.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	52.62	(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=	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	-100.69	(71)
Water heating gains (Table 5)													
(72)m=	105.17	102.88	98.13	91.66	87.46	81.55	76.52	82.96	85.25	91.94	99.5	102.89	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	599.76	594.82	572.16	537.31	501.87	470.22	451.87	460.95	481.15	516.22	555.02	584.15	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	813.49	943.41	997.8	1012.03	992.11	962.03	935.73	930.11	932.74	901.42	808.25	768.82	(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=	0.98	0.92	0.82	0.71	0.54	0.39	0.25	0.26	0.42	0.66	0.93	0.99	(86)

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

(87)m=	20.88	20.95	20.99	21	21	21	21	21	21	21	20.95	20.87	(87)

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

(88)m=	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.34	(88)

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

(89)m=	0.97	0.9	0.78	0.67	0.51	0.35	0.21	0.21	0.38	0.62	0.91	0.98	(89)

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

(90)m=	20.19	20.29	20.33	20.34	20.34	20.34	20.34	20.34	20.34	20.34	20.29	20.18	(90)

fLA = Living area ÷ (4) = 0.36 (91)

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

(92)m=	20.44	20.53	20.57	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.53	20.43	(92)

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

(93)m=	20.44	20.53	20.57	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.53	20.43	(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=	0.97	0.91	0.8	0.68	0.52	0.36	0.23	0.23	0.39	0.63	0.92	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	792.51	857.37	794.79	689.98	515.48	346.68	213.07	213.07	364.84	568.82	740.8	753.34	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	934.34	908.31	805.28	691.62	515.53	346.68	213.07	213.07	364.84	569.39	789.71	908.14	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	105.52	34.23	7.8	1.18	0.04	0	0	0	0	0.42	35.21	115.17	

Total per year (kWh/year) = Sum(98)1…5,9…12 = 299.58 (98)

Space heating requirement in kWh/m²/year 3.61 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	105.52	34.23	7.8	1.18	0.04	0	0	0	0	0.42	35.21	115.17		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	113.1	36.69	8.36	1.26	0.04	0	0	0	0	0.45	37.74	123.45		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													321.09	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)
Water heating														
Output from water heater (calculated above)	192.75	169.47	176.98	157.27	153.11	135.37	128.64	143.05	143.39	163.14	174.25	187.65		
Efficiency of water heater													79.6	(216)
(217)m=	83.08	81.22	80	79.67	79.6	79.6	79.6	79.6	79.6	79.62	81.22	83.36		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	232	208.66	221.22	197.4	192.35	170.07	161.61	179.71	180.13	204.89	214.54	225.11		
Total = Sum(219a)$_{1...12}$ =													2387.68	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			321.09	
Water heating fuel used			2387.68	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		170.88		(230a)
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		345.88	(231)
Electricity for lighting			387.88	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year		**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211)	x	3.1	x 0.01 =	9.9538	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	0	x 0.01 =	0	(242)

Water heating cost (other fuel)	(219)	3.1	x 0.01 =	74.02	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	39.64	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a					
Energy for lighting	(232)	11.46	x 0.01 =	44.45	(250)
Additional standing charges (Table 12)				106	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			274.06	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.0063	(257)
SAP rating (Section 12)		85.9619	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	63.58	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	472.76	(264)
Space and water heating	(261) + (262) + (263) + (264) =				536.34	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	178.82	(267)
Electricity for lighting	(232)	x	0.517	=	200.53	(268)
Total CO2, kg/year			sum of (265)…(271) =		915.69	(272)
CO2 emissions per m²			(272) ÷ (4) =		11.03	(273)
EI rating (section 14)					90	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	327.51	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2435.44	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2762.95	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	1009.96	(267)
Electricity for lighting	(232)	x	0	=	1132.6	(268)
'Total Primary Energy			sum of (265)…(271) =		4905.51	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		59.1	(273)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2009
Software Version: Version: 1.5.0.49

Property Address: House 1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Ground floor	62.66	(1a) x	2.39	(2a) =	149.7574	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62.66	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		149.7574	(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							0	x 10 =	0	(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) =	0	÷ (5) =	0	(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		0.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.03	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.03	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

SAP WorkSheet: New dwelling design stage

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

0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	78.2	(23c)

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

(24a)m=	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.14	0.14	0.14	0.14	(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	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.14	0.14	0.14	0.14	(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	x	1.2	=	2.4			(26)
Windows			6.125	x1/[1/(0.8)+ 0.04]		=	4.75			(27)
Floor			62.66	x	0.15	=	9.399			(28)
Walls	62.84	14.25	48.59	x	0.15	=	7.29			(29)
Roof	62.66	0	62.66	x	0.15	=	9.4			(30)
Total area of elements, m²			188.16							(31)
Party wall			10	x	0	=	0			(32)
Internal wall **			0							(32c)

** 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) =	37.98	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	12523.09	(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		1.88	(36)

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

Total fabric heat loss	(33) + (36) =	39.86	(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=	7.09	6.99	6.99	6.8	6.68	6.62	6.55	6.55	6.71	6.8	6.9	6.99	(38)

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

(39)m=	46.95	46.86	46.86	46.67	46.54	46.48	46.42	46.42	46.57	46.67	46.76	46.86	

Average = Sum(39)$_{1…12}$ /12= 46.67 (39)

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

(40)m=	0.75	0.75	0.75	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.75	0.75

Average = Sum(40)$_{1...12}$ /12= 0.74 (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 2.0558 (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 87.3939 (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=	96.13	92.64	89.14	85.65	82.15	78.65	78.65	82.15	85.65	89.14	92.64	96.13	
										Total = Sum(44)$_{1...12}$ =		1048.7273	(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=	142.9	124.98	128.97	112.44	107.89	93.1	86.27	99	100.18	116.75	127.44	138.39	
										Total = Sum(45)$_{1...12}$ =		1378.3365	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.44	18.75	19.35	16.87	16.18	13.97	12.94	14.85	15.03	17.51	19.12	20.76	(46)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0.024 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 0.013 (49)

If manufacturer’s declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year ((50) x (51) x (52) x (53) = 0 (54)

Enter (49) or (54) in (55) 0.013 (55)

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

(56)m=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(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=	0.4	0.36	0.4	0.39	0.4	0.39	0.4	0.4	0.39	0.4	0.39	0.4	(57)

Primary circuit loss (annual) from Table 3 360 (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=	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(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)

SAP WorkSheet: New dwelling design stage

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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	(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=	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37	

Output from water heater (annual)1…12 | 1743.0669 | (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=	72.3	63.94	67.67	61.37	60.66	54.94	53.47	57.7	57.29	63.6	66.36	70.8	(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=	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	123.35	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	41.24	36.63	29.79	22.55	16.86	14.23	15.38	19.99	26.83	34.07	39.76	42.38	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	268.06	270.84	263.83	248.91	230.07	212.37	200.54	197.76	204.77	219.69	238.53	256.24	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	49.39	(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=	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	-82.23	(71)
Water heating gains (Table 5)													
(72)m=	97.17	95.15	90.95	85.24	81.53	76.3	71.86	77.55	79.57	85.49	92.16	95.16	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	496.98	493.13	475.08	447.2	418.96	393.41	378.29	385.81	401.68	429.75	460.96	484.28	(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	0.77	x	6.12	x	47.32	x	0.76	x	0.7	=	213.73	(78)
South	0.9x	0.77	x	6.12	x	77.18	x	0.76	x	0.7	=	348.58	(78)
South	0.9x	0.77	x	6.12	x	94.25	x	0.76	x	0.7	=	425.64	(78)
South	0.9x	0.77	x	6.12	x	105.11	x	0.76	x	0.7	=	474.73	(78)
South	0.9x	0.77	x	6.12	x	108.55	x	0.76	x	0.7	=	490.24	(78)
South	0.9x	0.77	x	6.12	x	108.9	x	0.76	x	0.7	=	491.81	(78)
South	0.9x	0.77	x	6.12	x	107.14	x	0.76	x	0.7	=	483.86	(78)
South	0.9x	0.77	x	6.12	x	103.88	x	0.76	x	0.7	=	469.16	(78)

SAP WorkSheet: New dwelling design stage

South	0.9x	0.77	x	6.12	x	99.99	x	0.76	x	0.7	=	451.59	(78)
South	0.9x	0.77	x	6.12	x	85.29	x	0.76	x	0.7	=	385.2	(78)
South	0.9x	0.77	x	6.12	x	56.07	x	0.76	x	0.7	=	253.22	(78)
South	0.9x	0.77	x	6.12	x	40.89	x	0.76	x	0.7	=	184.67	(78)

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

(83)m=	213.73	348.58	425.64	474.73	490.24	491.81	483.86	469.16	451.59	385.2	253.22	184.67	(83)

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

(84)m=	710.71	841.71	900.72	921.93	909.21	885.22	862.15	854.97	853.27	814.95	714.18	668.96	(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=	0.91	0.82	0.71	0.61	0.47	0.34	0.22	0.22	0.37	0.58	0.84	0.92	(86)

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

(87)m=	20.8	20.91	20.97	20.99	21	21	21	21	21	20.99	20.91	20.78	(87)

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

(88)m=	20.3	20.3	20.3	20.3	20.3	20.3	20.31	20.31	20.3	20.3	20.3	20.3	(88)

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

(89)m=	0.9	0.8	0.68	0.58	0.44	0.3	0.18	0.18	0.33	0.54	0.81	0.91	(89)

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

(90)m=	20.05	20.19	20.26	20.29	20.3	20.3	20.31	20.31	20.3	20.3	20.2	20.03	(90)

fLA = Living area ÷ (4) = 0.64 (91)

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

(92)m=	20.53	20.65	20.71	20.74	20.75	20.75	20.75	20.75	20.75	20.74	20.65	20.51	(92)

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

(93)m=	20.53	20.65	20.71	20.74	20.75	20.75	20.75	20.75	20.75	20.74	20.65	20.51	(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=	0.9	0.81	0.7	0.6	0.46	0.32	0.21	0.21	0.35	0.56	0.82	0.91	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	640.53	681.46	632.9	555.46	420.19	285.73	178.66	178.66	300.21	460.48	588.18	610.97	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	752.44	733.2	651.84	561.71	421.06	285.78	178.66	178.66	300.31	463.95	638.35	731.37	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	83.26	34.77	14.09	4.5	0.64	0	0	0	0	2.58	36.13	89.58	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 265.55 (98)

Space heating requirement in kWh/m²/year 4.24 (99)

SAP WorkSheet: New dwelling design stage

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	83.26	34.77	14.09	4.5	0.64	0	0	0	0	2.58	36.13	89.58		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	89.24	37.27	15.11	4.83	0.69	0	0	0	0	2.76	38.72	96.01		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													284.62	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	173.88	152.96	159.95	142.42	138.87	123.08	117.25	129.98	130.16	147.73	157.42	169.37		
Efficiency of water heater													79.6	(216)
(217)m=	82.78	81.39	80.37	79.89	79.64	79.6	79.6	79.6	79.6	79.76	81.4	83		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	210.06	187.95	199.01	178.27	174.36	154.62	147.3	163.29	163.52	185.21	193.39	204.06		
Total = Sum(219a)$_{1...12}$ =													2161.04	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			284.62	
Water heating fuel used			2161.04	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		123.33		(230a)
central heating pump:		130		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		298.33	(231)
Electricity for lighting			291.31	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.1	x 0.01 =	8.8232	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	0	x 0.01 =	0	(242)

SAP WorkSheet: New dwelling design stage

Water heating cost (other fuel)	(219)	3.1	x 0.01 =	66.99	(247)
Pumps, fans and electric keep-hot	(231)	11.46	x 0.01 =	34.19	(249)

(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	11.46	x 0.01 =	33.38	(250)
Additional standing charges (Table 12)				106	(251)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	249.3881	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.0887	(257)
SAP rating (Section 12)		84.8123	(258)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.198	=	56.35	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.198	=	427.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =				484.24	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	154.23	(267)
Electricity for lighting	(232)	x	0.517	=	150.61	(268)
Total CO2, kg/year			sum of (265)…(271) =		789.08	(272)
CO2 emissions per m²			(272) ÷ (4) =		12.59	(273)
EI rating (section 14)					90	(274)

13a. Primary Energy

	Energy kWh/year		**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211)	x	1.02	=	290.31	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Energy for water heating	(219)	x	1.02	=	2204.26	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2494.57	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	2.92	=	871.11	(267)
Electricity for lighting	(232)	x	0	=	850.64	(268)
‘Total Primary Energy			sum of (265)…(271) =		4216.32	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		67.29	(273)

UnRegulated Energy Demand Calculations

Appliances Unregulated Emissions

House Type	TFA/Unit	No of Occupants	TFA XN	(TFA X N) ^ 0.4714	Total Electricity Appliances Demand (kWh)	Total Electricity Emissions (kgCO2)
1bed	63	2.06	129.49	9.90	2057.60	1063.78
2beds	83	2.52	208.00	12.38	2572.68	1330.07
3beds	98	2.72	264.88	13.87	2883.17	1490.60
4beds	113	2.83	321.15	15.19	3157.24	1632.29
5beds	150	2.93	440.13	17.63	3662.94	1893.74

Based upon the formula 207.8X(NXTFA)^0.4714 X 0.517

Cooking (All Electric)

House Type	No of Occupants (N)	55xN	275+(55XN) Cooking (All Electric) (kWh)	TFA/Unit	Total Cooking (All Electric) (kWh)
1bed	2.0558	113	388	63	6.16
2beds	2.5173	138	413	83	5.00
3beds	2.7156	149	424	98	4.35
4beds	2.8335	156	431	113	3.80
5beds	2.9342	161	436	150	2.91

Based upon the formula (275+(55X N))X0.517

Cooking (electric oven, gas hob)

House Type	No of Occupants (N)	27.5xN	137.5+(27.5XN)	48.15xN	280.5+(48.15XN)	Cooking (half electric, half gas) (kWh)	TFA/Unit	Total Cooking (half electric, half gas) (kWh/m2)
1bed	2.0558	57	194	99	379	573.52	63	9.10
2beds	2.5173	60	198	121	402	599.62	83	7.26
3beds	2.7156	65	203	131	411	613.93	98	6.29
4beds	2.8335	68	206	136	417	622.44	113	5.49
5beds	2.9342	70	208	141	422	629.70	150	4.20

Based upon the forumula (137.5+(27.5XN)X0.517)+(280.5+(48.15XN)X0.198)

Cooking (gas oven, gas hob)

House Type	No of Occupants (N)	96.3xN	481+(96.3XN) Cooking (All Gas) (kWh)	TFA/Unit	Total Cooking (All Gas) (kWh/m2)
1bed	2.0558	198	679	63	10.78
2beds	2.5173	242	723	83	8.75
3beds	2.7156	262	743	98	7.61
4beds	2.8335	273	754	113	6.65
5beds	2.9342	283	764	150	5.09

Based upon (481+(96.3XN)X0.198

CIBSE TM46 table1

Table 1 Benchmark categories and values; (*b*) benchmarks and building size metrics

[A]	[B]	[C]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]
Name and description			Energy benchmarks		Illustrative CO_2 benchmarks calculated from the energy benchmarks (see Table 3)			Building size metric for use by assessors		
Category	Name	Brief description	Electricity typical benchmark (kW·h/m^2)	Fossil-thermal typical benchmark (kW·h/m^2)	Illustrative electricity typical benchmark (kgCO_2/m^2)	Illustrative fossil-thermal typical benchmark (kgCO_2/m^2)	Illustrative total typical benchmark (kgCO_2/m^2)	Primary metric (as in energy benchmarks)	Approved alternate metric	Default multiplier (applied to alternate metric to obtain primary metric)
1	General office	General office and commercial working areas	95	120	52.3	22.8	75.1	Gross floor area measured as RICS gross internal area (GIA)	Net lettable area (NLA) measured as RICS	1.25
2	High street agency	High street agency	140	0	77.0	0.0	77.0	Gross floor area measured as RICS gross internal area (GIA)	(none)	
3	General retail	General street retail and services	165	0	90.8	0.0	90.8	Gross floor area measured as RICS gross internal area (GIA)	Sales floor area (SFA)	1.80
4	Large non-food shop	Retail warehouse or other large non-food store	70	170	38.5	32.3	70.8	Gross floor area measured as RICS gross internal area (GIA)	Sales floor area (SFA)	1.80
5	Small food store	Small food store	310	0	170.5	0.0	170.5	Gross floor area measured as RICS gross internal area (GIA)	Sales floor area (SFA)	1.35
6	Large food store	Supermarket or other large food store	400	105	220.0	20.0	240.0	Gross floor area measured as RICS gross internal area (GIA)	Sales floor area (SFA)	2.00
7	Restaurant	Restaurant	90	370	49.5	70.3	119.8	Gross floor area measured as RICS gross internal area (GIA)	(none)	
8	Bar, pub or licensed club	Bar, pub or club	130	350	71.5	66.5	138.0	Gross floor area measured as RICS gross internal area (GIA)	(none)	
9	Hotel	Hotel or boarding house	105	330	57.8	62.7	120.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
10	Cultural activities	Museum, art gallery or other public building with normal occupancy	70	200	38.5	38.0	76.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
11	Entertainment halls	Entertainment halls	150	420	82.5	79.8	162.3	Gross floor area measured as RICS gross internal area (GIA)	(none)	
12	Swimming pool centre	Swimming pool hall, changing and ancillaries	245	1130	134.8	214.7	349.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
13	Fitness and health centre	Fitness centre	160	440	88.0	83.6	171.6	Gross floor area measured as RICS gross internal area (GIA)	(none)	
14	Dry sports and leisure facility	Dry sports and leisure facility	95	330	52.3	62.7	115.0	Gross floor area measured as RICS gross internal area (GIA)	(none)	

[illegible]	[illegible] with light usage	[illegible] institutional buildings	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] measured as RICS gross internal area (GIA)	[illegible]	
17	Schools and seasonal public buildings	Public buildings nominally used for part of the year	40	150	22.0	28.5	50.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
18	University campus	University campus	80	240	44.0	45.6	89.6	Gross floor area measured as RICS gross internal area (GIA)	(none)	
19	Clinic	Health centres, clinics and surgeries	70	200	38.5	38.0	76.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
20	Hospital (clinical and research)	Clinical and research hospital	90	420	49.5	79.8	129.3	Gross floor area measured as RICS gross internal area (GIA)	(none)	
21	Long term residential	Long term residential accommodation	65	420	35.8	79.8	115.6	Gross floor area measured as RICS gross internal area (GIA)	(none)	
22	General accommodation	General accommodation	60	300	33.0	57.0	90.0	Gross floor area measured as RICS gross internal area (GIA)	(none)	
23	Emergency services	Emergency services	70	390	38.5	74.1	112.6	Gross floor area measured as RICS gross internal area (GIA)	(none)	
24	Laboratory or operating theatre	Laboratory or operating theatre	160	160	88.0	30.4	118.4	Gross floor area measured as RICS gross internal area (GIA)	(none)	
25	Public waiting or circulation	Bus or train station, shopping centre mall	30	120	16.5	22.8	39.3	Gross floor area measured as RICS gross internal area (GIA)	(none)	
26	Terminal	Regional transport terminal with concourse	75	200	41.3	38.0	79.3	Gross floor area measured as RICS gross internal area (GIA)	(none)	
27	Workshop	Workshop or open working area (not office)	35	180	19.3	34.2	53.5	Gross floor area measured as RICS gross internal area (GIA)	(none)	
28	Storage facility	Storage warehouse or depot	35	160	19.3	30.4	49.7	Gross floor area measured as RICS gross internal area (GIA)	(none)	
29	Cold storage	Refrigerated warehouse	145	80	79.8	15.2	95.0	Gross floor area measured as RICS gross internal area (GIA)	(none)	