NORTHSTOWE
PHASE 2 PLANNING APPLICATION

Energy Strategy

August 2014

Homes & Communities Agency

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Northstowe Phase 2

Energy Strategy

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1 Introduction

This Energy Statement has been prepared by Hyder Consulting Ltd, on behalf of the HCA (hereafter referred to as the 'Applicant'), in support of the planning application for the Northstowe Phase 2 development.

The proposed energy strategy for the 'main Phase 2 development area' has been guided by the following key principles:

- To meet all relevant local and national planning policy
- To be an exemplar in sustainability (whilst maintaining technical and financial viability)
- To adopt a fabric first approach to ensure that carbon emission reductions are secured for the lifetime of the development
- To mitigate adverse impacts on the surrounding environment.
- To be flexible so as to provide longevity to any proposed strategy within an evolving climate. d
- To ensure the successful integration with the rest of the Northstowe development.

The statement provides a detailed account of the relevant planning policy and Building Regulations requirements to which the development will be constructed. The statement then establishes a baseline assessment of the predicted energy demans and associated carbon emissions (based upon current Building Regulations 2013) before investigating the potential means of achieving the developments energy reduction and carbon emission targets.

2 Development Overview

The proposed Northstowe Phase 2 development is located 10km northwest of Cambridge, east of Longstanton and North Oakington within the South Cambridgeshire District.

The main Phase 2 development area is approximately 165 hectares. The area is bordered to the east by the route of the Cambridgeshire Guided Busway, and to the west by Longstanton. The area includes the former Oakington Barracks, which currently comprises of three buildings, with no current use; slabs remaining from demolished buildings; remaining facilities associated with the barracks including sports amenities and green space; and a water tower which is the tallest structure on the site and visible feature in the wider landscape. The area surrounds the existing settlement of Rampton Drift, comprised of 92 properties, originally built as part of the barracks complex, although this area is not included in the application. The wider main Phase 2 Development area includes areas of hardstanding and open space associated with the former airfield (much of this currently occupied by agricultural tenants), farmland including Brookfield Farm and Larksfield Farm. The area also includes a section of Rampton Road.

Intervening vegetation results in the site being largely screened from surrounding villages and farmsteads. There are groups of trees throughout the former Oakington Barracks including avenues of mature trees around the barracks complex and leading to the station headquarter building. There are also groups of mature trees in the western corner of the site and around Rampton Drift. These all contribute to the setting of the site and adjacent Longstanton.

To the south of the main Phase 2 development area, and through which its proposed access routes run, is land that is identified for future phases of development of Northstowe. To the north of the site is the site of Northstowe Phase 1, for which an outline planning application was submitted by Gallagher Estates to South Cambridgeshire District Council in February 2012, and was granted in April 2014. The current uses of this site include agricultural fields and Cambridge Golf Club, which closed in August 2013.

The South Cambridgeshire Core Strategy has allocated Northstowe as a site for a sustainable new town with a target of up to 10,000 dwellings and associated facilities and non-residential areas. Phase 2 of the of the Northstowe development is comprised of 3,500 dwellings, two primary schools, the secondary school, the town centre, employment adjacent to the town centre, formal and informal recreational space and landscaped areas, the eastern sports hub, the remainder of the western sports hub (to complete the provision delivered at Phase 1), two primary roads to link to the southern access and the busway, engineering and infrastructure works.

Affordable housing will be provided as part of the development. The affordable housing will be ‘pepper-potted’ throughout the housing areas. The proportion of affordable housing to be provided will be determined as a part of a process of negotiation with the local planning authority on planning obligations.

Phase 2 includes the delivery of the town centre (~6.96 hectares) for Northstowe. Non-residential floorspace within the town centre comprises of approximately 57,500 sq.m. GIA. The precise use and layout of this area will be determined by subsequent reserved matters applications should outline planning permission be granted.

Provision has been made for the following types of uses to be located within the town centre: retail, F&B, health centre, civic hub, community meeting space, place of worship, youth facilities, crèche and library. Within the town centre area provision has been made for a town square. The extent of the town square is shown on the Landscape Parameter Plan. It extends to 0.28 hectares and is likely to be 51.55m x 54.31m.

2.1 Development Schedule

This is an outline application and therefore the assessment of energy demand and carbon emissions calculations can only be based on notional buildings. The following tables provide a summary of how the development of the site could come forward in line with the parameters and provides the notional residential unit mix and floor space areas that have been used as the basis for the basis of the energy demand and carbon emission calculations throughout.

Table 2.1 Potential mix of Residential Units

Dwelling Type	Total Units	Unit Area (m^2)	Total Unit Area (m^2)	No. of Occupants "N" SAP box 42
Town Centre 1 Bed Apartment (Ground Floor)	275	56.10	15,428	1.87
Town Centre 2 Beds Apartment (Mid Floor)	417	72.60	30,274	2.64
2 Beds House (Mid Terrace)	441	90.84	40,091	2.64
3 Beds House (Semi Detached)	1447	101.89	147,391	2.76
4 Beds House (End Terrace)	832	116.37	96,844	2.85
5 Beds House (Detached)	88	128.00	11,241	2.89
Total	**3500**		**341,269**	

Table 2.2: Potential floorspace for Non-Residential Units

Dwelling Type	Total Area	GIA (m^2)
Secondary School	141,200	47,067
Primary School	48,500	16,167
Convenience Retail	-	10,000
Comparison/ Service Retail	-	25,000
Food and Drink	-	3,500
Office	-	16,200
Light Industrial	-	5,000
Leisure	-	10,000
Health, Community and Fitness Centre	-	6,000
Youth Facility	-	2,000
Place of Worship	-	1,000
Total		**141,933**

3 Planning Policy Requirements and Targets

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.

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 progresses; and therefore maintaining flexibility in any strategy is crucial to facilitating continued sustainable development.

3.2 National Planning and Policy Requirements

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% CO_2 reduction by 2020 and the Government has now proposed that the fourth carbon budget will be a 50% CO_2 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.

UK Low Carbon Transition Plan (2009)

The Labour 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

National Planning Policy Framework

The National Planning Policy Framework was published on 27 March 2012 and sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

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 Building Regulations (Part L)

As part of the British Governments commitment to cutting carbon emissions by 80%, compared to 1990 levels (by 2050) the government is escalating Building Regulations requirements to reduce carbon emissions within the built environment. The government's proposed trajectory for Building Regulations Part L1A (Conservation of fuel and power in new dwellings) was outlined within Building a Greener Future: A Policy Statement (2007). This outlines the reductions in 'regulated' carbon emissions compared to a Building Regulations (2006) baseline outline in table 3.1 below:

Table 3.1 Carbon reduction improvement compared to Building Regulations 2006

Building type	Part L 2010	Part L 2013	Part L 2016	Part L 2018	Part L 2019
Domestic	25%	30%	Zero Carbon	Zero Carbon	Zero Carbon
Non – domestic	25%	32%	Further improvement	Zero Carbon	Zero Carbon

The latest Building Regulations (2013) came into effect on the 6th April 2014. As outlined above the principle aim for Part L 2013 is to:

- Provide a meaningful step towards the UK Government commitment to zero carbon standards for homes by 2016
- Drive innovation in the right direction

- Aid learning to deliver zero carbon homes.

The methodology for demonstrating compliance combines the carbon emission measure (kgCO_2/ m^2/year) calculated for the dwelling, with a 'new' requirement to consider the fabric energy efficiency (FEE) (kWh/m^2/year) of the building envelope. The process of demonstrating compliance uses the calculated carbon emission rate for the building in question and compares this to a target carbon emission rate, also calculated specifically for that building. In Part L terminology, the Dwelling Emission Rate (DER) must be less than the Target Emission Rate (TER). This approach is familiar from Part L 2010.

However, all residential dwellings in Phase 2 at Northstowe will come forward beyond 2016. Likewise, most non-residential (commercial and community etc.) buildings are expected to come forward post 2019. Therefore, the vast majority of buildings will need to achieve Zero Carbon, as defined by the Zero Carbon Homes policy, which represents the exemplar standard for the energy performance of dwellings.

Given the relatively minor reduction between 2010 and 2013 (6% for domestic and 9% non-domestic) the anticipated jump to zero carbon represents a major step change and will almost certainly require additional updates to Part L and how it 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 it would rely on, extremely expensive, small scale renewable electricity generation. Inevitably this would mean that around half would not be able to meet the target and many of those that could meet the target would be economically unviable.

3.4 Achieving Zero Carbon

Residential Buildings

It was announced in the 2011 Budget 'The Plan for Growth' document, that a 'Zero Carbon Home' requires a 100% reduction in regulated energy (heating, hot water and fixed electrical items – pumps, fans, lights) over Building Regulations 2006. Therefore, emissions from cooking or from appliances such as computers and televisions are excluded from the definition.

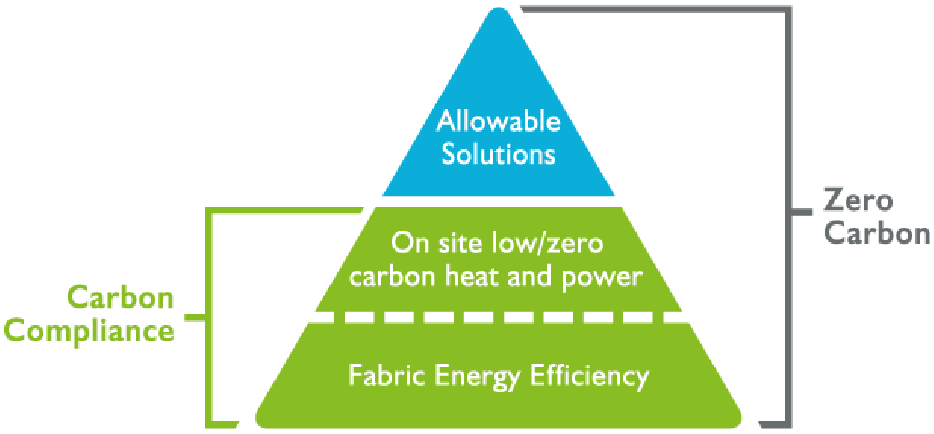
The Government's commitment to achieving Zero Carbon Homes is based on the following hierarchical approach to achieving zero carbon targets:

1. Mandatory Fabric Energy Efficiency (FEE) Level – To ensure energy efficiency by energy efficient building design.

2. Mandatory onsite Carbon Compliance Level – To ensure energy efficiency by energy efficient building design and to reduce carbon emissions through on-site low carbon and renewable energy technologies and near-site heat networks.

3. Mitigate the remaining carbon emissions through use of 'Allowable Solutions'.

Figure 3.1: Showing approach to achieving Zero Carbon homes.



In February 2011 recommendations for national minimum standards of Carbon Compliance – the onsite reductions of emissions – were developed by a Zero Carbon Hub led Task Group. The Task Group found that the proposal from July 2009, to tighten the Carbon Compliance standard by 70% (equivalent to 6 kg CO_2(eq)/m^2/year), may not be achievable in all cases. In addition, it was felt that the previous method of calculating carbon compliance level was confusing and now suggest that an absolute limit in terms of CO_2 emissions per m^2 floor area per annum be the measure used. These are provided in Table 3.2 below.

Table 3.2: Proposed approach to achieving Zero Carbon homes

Built Form	Fabric Standard ($kWh/m^2/yr$)	Carbon Compliance ($kgCO_2/m^2/yr$)
Detached houses	46	10
Semi-detached houses	46	11
End of terrace	46	11
Mid terrace	39	11
Apartment block	39	14

In addition, the task group are set to review and establish the Carbon Compliance limit for higher apartment blocks but the work is still ongoing.

It is proposed that the remainder of the regulated carbon emissions associated with the dwellings may be dealt with through the use of renewable technologies and/or the use of Allowable Solutions whereby each kg CO_2 emitted per annum must be matched by a saving in CO_2 off-site. In some instances this may not be possible, and therefore a financial contribution to either the CIL fund, Community Energy Fund (CEF) or some other energy related fund may be made. The pricing range is expected to between £36 and £90 per tonne with the financial impact modelled on the mid-range value of £60 per CO_2 tonne for 30 years.

It is envisaged that when the Northstowe site is developed, most of the buildings (if not all) will have to comply with the zero carbon requirements and so construction will have to take this into consideration.

As well as complying with the future zero carbon Building Regulations, there are further Code for Sustainable Homes and BREEAM requirements arising from the South Cambridgeshire Council's policy. These requirements are discussed Sections 3.6 and 3.7.

Non-residential Buildings

The equivalent definition of 'Zero Carbon' for non-domestic buildings has not progressed to the same level as that of dwellings. However it is expected that a similar framework (energy efficiency, on-site carbon compliance and allowable solutions) will be developed to ensure 'Zero Carbon' is achieved by 2019 (2018 for public sector buildings) for non-domestic buildings.

3.4.1 Allowable Solutions

Allowable solutions have been introduced to offer flexibility and options to offset remaining emissions (beyond carbon compliance), when other on-site options are not considered technically and commercially feasible. Therefore, allowable solutions are likely to become central to the overall policy of ensuring that achieving zero carbon is affordable and can be achieved.

However, 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. The Zero Carbon Hub (Allowable Solutions for Tomorrows New Homes, June 2011)) announced its proposals for a framework for allowable solutions. This was further refined within the Zero Carbon Strategies for Tomorrow's New Homes report released in February 2013.

According to these proposals, the initial choice for developers will be either:

1. To pay into a carbon fund (Type 1 Allowable Solution). Here the payments from developers would be accumulated and the fund manager will take responsibility for investing in suitable Allowable Solutions projects - a wide range of carbon-saving projects could qualify as Allowable Solutions. It is expected that Local Planning Authorities will have the option to set up carbon funds and may establish local priorities for particular Allowable Solutions.

2. To invest in carbon-saving projects associated directly with their own developments (Type 2 Allowable Solution).

In July 2014 the Government released a summary of responses to the '*Next steps to zero carbon homes – allowable solutions*' consultation which ran from 6th of August to the 15th of October 2013. Within the report the Government announced its intention to adopt the following 4 routes, proposed in the consultation document, as part of the delivery model for allowable solutions:

- the house builder could do more or all carbon abatement on site or through connected measures (e.g. a heat network)

- the house builder could meet the remaining carbon abatement requirements themselves through their own off-site carbon abatement action (e.g. retrofitting existing buildings)

- the house builder could contract with a third party to deliver the carbon abatement measures sufficient to meet the house builder's zero carbon obligation.

- the house builder could make a payment into a fund which then invests in carbon abatement projects sufficient to meet the house builder's zero carbon obligation.

These routes are not mutually exclusive. Energy strategies will therefore be able to make use of a variety of measures such as:

1. On-site allowable options – 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 options - 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 options - 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/tCO2 to £90/tCO2; which can make considerable difference to the total cost of achieving 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.

3.5 Local Policy

The current Local Development Framework (LDF) comprises a number of Development Plan Documents (DPDs) that set out policies and proposals for the development and use of land in the district. The LDF includes a vision for the future of South Cambridgeshire and objectives and targets, which developments must meet to secure that vision. The LDF consists of the following documents (considered relevant to Northstowe):

- Core Strategy DPD - adopted January 2007
- Development Control Policies DPD - adopted July 2007
- Northstowe AAP - adopted July 2007
- Site Specific Policies DPD - adopted January 2010

The Proposed Submission Local Plan for South Cambridgeshire is intended to update and replace the South Cambridgeshire Local Development Framework which was adopted between January 2007 and January 2010 and covered the period up to 2016. The draft Local Plan’s policies and proposals cover the period 2011 to 2031. Underpinning the whole of the Plan is the Government’s commitment to sustainable development.

3.5.1 South Cambridgeshire District Council – Core Strategy 2006

The Core Strategy allocates Northstowe to be developed as a new town of up to 10,000 new homes, with a town centre providing additional commercial areas. This proposal is the subject of a separate Area Action Plan (outlined below).

Objective ST/g of the Core Strategy reads as follows:

> '*To ensure development addresses sustainability issues, including climate change mitigation and adaptation issues*'

3.5.2 South Cambridgeshire District Council - Development Control Policies DPD 2007

The following policies were deemed relevant to this statement:

POLICY DP/1 Sustainable Development

1. *Development will only be permitted where it is demonstrated that it is consistent with the principles of sustainable development, as appropriate to its location, scale and form. It should:*

   f. Where practicable, minimise use of energy and resources;

   g. Where practicable, maximise the use of renewable energy sources;

2. *In criteria e, f, g, j and n it will be for any applicant or developer proposing to compromise sustainability to demonstrate the impracticability of use of sustainable methods, systems, materials and energy sources and provision of sustainable infrastructure. Additional cost will not, on its own, amount to impracticability.*

POLICY NE/1 Energy Efficiency

1. *Development will be required to demonstrate that it would achieve a high degree of measures to increase the energy efficiency of new and converted buildings, for example through location, layout, orientation, aspect, and external design.*

2. *Developers are encouraged to reduce the amount of CO_2 m^3 / year emitted by 10% compared to the minimum Building Regulation requirement when calculated by the Elemental Method in the current building regulations for a notional building of the same size and shape as that proposed, particularly for new or substantially demolished buildings.*

<u>Due to the age of this policy, the following should be noted:</u>

- The standard metric for CO_2 in terms of Building Regulations compliance is $kg/m^2/yr$ rather than $kg/m^3/yr$. The former has therefore been used throughout this statement to demonstrate compliance. 'Current' refers to building regulation in place at the time of publication of this policy. This policy therefore requires a 10% improvement over Building Regulation 2006 using the CO_2 emissions rate ($kg/m^2/yr$).

POLICY NE/2 Renewable Energy

The District Council will grant planning permission for proposals to generate energy from renewable sources, subject to proposals according with the development principles set out in Policies DP/1 to DP/3 and complying with the following criteria:

1. *The proposal can be connected efficiently to existing national grid infrastructure unless it can be demonstrated that energy generation would be used on-site to meet the needs of a specific end user;*

2. *The proposal makes provision for the removal of the facilities and reinstatement of the site, should the facilities cease to be operational.*

POLICY NE/3 Renewable Energy Technologies in New Development

All development proposals greater than 1,000 m^2 or 10 dwellings will include technology for renewable energy to provide at least 10% of their predicted energy requirements, in accordance with Policy NE/2.

Please note:

- This policy is understood to refer to total energy (regulated AND unregulated)

- This is superseded by item D13.4 of the Northstowe Area Action Plan (see below).

POLICY NE/16: Emissions Address Air Quality Issues

1. *Development proposals will need to have regard to any emissions arising from the proposed use and seek to minimise those emissions to control any risks arising and prevent any detriment to the local amenity by locating such development appropriately.*

2. *Where significant increases in emissions covered by nationally prescribed air quality objectives are proposed, the applicant will need to assess the impact on local air quality by undertaking an appropriate modelling exercise to show that the national objectives will still be achieved. Development will not be permitted where it would adversely affect air quality in an Air Quality Management Area.*

3.5.3 Northstowe Area Action Plan (AAP)

This document provides site specific policy for Northstowe – which has been identified as a site for a sustainable new town with a target size of 10,000 dwellings and associated development.

The following section and policies of the AAP were deemed relevant to this statement:

SECTION B (Vision and Development Principles)

Item B.13 states that the buildings will:

'*need to be sustainable – planned to take advantage of natural sunlight and manage internal temperatures, incorporating a high degree of energy efficiency. Opportunities for generating some of the town's own energy needs will need to be investigated to meet the requirement that 10% of energy should be from renewable sources.*

POLICY NS/1: The Vision for Northstowe

Northstowe will be a sustainable and vibrant new community that is inclusive and diverse with its own distinctive local identity which is founded on best practice urban design principles, drawing on the traditions of fen-edge market towns, which encourages the high quality traditions and innovation that are characteristic of the Cambridge Sub-Region.

POLICY NS/2: Development Principles

3. *The town of Northstowe will be developed:*

   g. *To a flexible design which will be energy efficient, and built to be an exemplar of sustainable living with low carbon and greenhouse gas emissions and able to accommodate the impacts of climate change;*

SECTION D13 (An Exemplar in Sustainability)

This section outlines the following sustainability objectives for Northstowe:

- *D13/a To include within Northstowe, projects which are an exemplar in terms of the use of the earth's resources, including energy, water and materials.*
- *D13/b To contribute to the achievement of medium and long term emissions targets that move towards the Government's ambition of zero carbon development country-wide, with proposals seeking to achieve significant improvements sought by the Code of Sustainable Homes and significantly exceeding national standards set by Building Regulations subject to wider economic, viability and social testing.*
- *D13/c To use energy efficiently.*
- *D13/d To make greater use of renewable energy sources*

Item D.13.4 states that:

'*A major development of the scale of Northstowe, and the fact that it will be a freestanding new settlement, enhances the potential for a comprehensive approach towards the provision of energy. It offers the opportunity for innovative measures, including the use of renewable energy. Policy NE/3 of the Development Control Policies DPD requires the provision of technology for renewable energy to provide at least 10% of predicted energy requirements, but the Northstowe proposals should seek to do better where possible, aiming towards a target of 20% of predicted energy needs from renewable energy subject to wider economic, viability and social testing'*.

POLICY NS/23: An Exemplar in Sustainability

1. *Northstowe will include within the development exemplar projects in sustainable development, including energy efficient measures. This could be achieved by:*

   a. *Providing an increased level of sustainability across the development as a whole above current requirements to a material extent;*

   b. *Building a proportion of the development to advanced practice which fully addresses sustainability issues and minimises any environmental impact by pushing at the boundaries of the proven technology available at the time of the development.*

3.5.4 Proposed Submission Local Plan

The Proposed Submission Local Plan (prepared in accordance with the NPPF) contains policies and land allocations to 2031. The draft Local Plan and its supporting documents were submitted to the Planning Inspectorate for independent examination which is scheduled to open in Autumn 2014. As such the emerging Local Plan is an important consideration in determining the proposals for Northstowe. The proposed energy strategy is therefore considerate to the following relevant policy within the draft Local Plan:

POLICY CC/2: Renewable and Low Carbon Energy Generation

1. *Planning permission for proposals to generate energy from renewable and low carbon sources will be permitted provided that:*

    a. *The development, either individually or cumulatively with other developments, does not have unacceptable adverse impacts on heritage assets (including their settings), natural assets, the landscape, or the amenity of nearby residents (visual impact, noise, shadow flicker, odour, fumes, traffic);*

    b. *The development can be connected efficiently to existing national energy infrastructure or it can be demonstrated that the energy generated would be used for onsite needs only;*

    c. *Provision is made for decommissioning once the operation has ceased, including the removal of the facilities and the restoration of the site; and*

    d. *Developers have engaged effectively with the local community and local authority.*

2. *For proposals of 2 or more wind turbines, a minimum distance of 2 km between a dwelling and a wind turbine is set to protect residents from disturbance and visual impact. If the applicant can prove that this is not the case, a shorter distance would be considered.*

POLICY CC/3: Renewable and Low Carbon Energy in New Developments

1. *Proposals for new dwellings and new non-residential buildings of 1,000m2 or more will be required to reduce carbon emissions (over the requirements set by Building Regulations) by a minimum of 10% through the use of on-site renewable energy technologies.*

2. *This could be provided through the installation of an integrated system or site wide solutions involving the installation of a system that is not integrated within the new building. For a site wide solution, evidence must be submitted demonstrating that the installation is technically feasible and is capable of being installed.*

3. *For growth areas and new settlements, site wide renewable and low carbon energy solutions that maximise on-site generation from these sources will be sought, such as renewable and low carbon district heating systems.*

3.6 Development Framework Document

In 2012 The Development Framework Document (DFD), along with a suite of documents, refreshed the master plan for Northstowe by making it relevant to today's circumstances.

The DFD confirms that the vision for Northstowe has progressed and responded to national and local policy, independent challenge and stakeholder involvement. It confirms that the vision is based on the core characteristics (the four C's) of the Cambridgeshire Quality Charter for Growth:

"*planned growth of sustainable and vibrant new communities in accordance with four themes: Community, Climate, Connectivity and Character*"

And that the development should move "*towards low carbon with a combination of energy efficient solutions, local food production, green travel, innovative technology and communications systems and waste recycling centre to demonstrate Northstowe as an exemplar in sustainable living*".

An addendum to the DFD (An Exemplar of Sustainable living) confirms the following 'relevant' environmental qualities are identified as part of the supporting framework for the Northstowe Development:

- Building adaptation to the impacts of climate change
- Efficient use of water resources
- The provision of exemplar buildings in relation to renewable resources, energy efficiency and sustainable construction products and methods
- On and / or offsite renewable energy or very low carbon technologies (solar, biomass and wind) that exceeds the standard 10% on-site creation aiming for the target of 20%
- A reduction of carbon emissions aiming to exceed the planning policy requirement of a minimum of 10% below building regulation standards (NAAP 2007)

3.7 Code for Sustainable Homes

To strengthen the sustainability requirements of new dwellings, the Government launched the Code for Sustainable Homes (CSH or 'the Code') in 2006 to operate in parallel to the Building Regulations for energy use for new residential development (Approved Document Part L1A).

CSH sets out the national standard for sustainable design and construction of new homes. The Code includes sections under a number of different sustainability issues which includes; energy use in a home, materials used in the construction and the effect on biodiversity. The Code also addresses issues such as water use within each dwelling, surface water and flooding, health and wellbeing and pollution issues. This document only considers the energy/carbon aspect of the Code.

As discussed above, Part L of the Building Regulations (Conservation of fuel and power) will progressively become more stringent and will eventually require all new dwellings built from 2016 onwards to achieve "zero carbon" status.

The Code for Sustainable Homes (CSH) was introduced as a voluntary measure to provide a comprehensive assessment of the sustainability of a new home and replaced the Eco-Homes methodology. In terms of carbon emissions CSH Level 4 equals a 25% improvement over 2010 Building Regulations (this would equate to circa 20% improvement from 2013 Building Regulations) approximately. The original programme was for all new homes to meet 'Zero carbon' from 2016. The Code Level relates to; compliance with mandatory minimum standards for waste, material, and surface water run-off as well as energy and potable water consumption.

It should be noted however that the Government recently announced in the Housing Standards Review (March 2014) their intention to wind down the Code for Sustainable Homes in a further bid to cut regulatory red tape for house builders.

Under the proposals set out in the consultation document the government indicated that it could “wind down” the Code for Sustainable Homes (CSH) in favour of using the Building Regulations as the key vehicle to provide energy requirements for buildings.

3.8 BREEAM

BREEAM (Building Research Establishment’s Environmental Assessment Method) is a standard assessment method established by the Building Research Establishment (BRE), used to assess the environmental impact of non-domestic buildings. Overall BREEAM is similar to the Code and covers a range of issues and credits which are awarded where a building achieves a benchmark performance. Like the Code, BREEAM is a voluntary standard although central government and some planning authorities require compliance.

The BRE periodically updates BREEAM and the latest version of BREEAM New Construction came into force in May 2014. The latest version imposes more demanding standards and energy/carbon requirements than the previous standard. Because BRE have applied previous best practice carbon standards before the government has fully decided how to address the future carbon performance of nondomestic buildings, it is likely that the requirements will need to be changed again in the future to align with Part L (2013 and 2016) requirements.

BREEAM (2014) has the following mandatory energy requirements:

- Excellent: Energy Performance Ratio for New Construction of 0.375
- Outstanding: Energy Performance Ratio for New Construction of 0.60

3.9 Summary of Policy Requirements

The various policy and regulations requirements are summarised in table 3.3 below:

Table 3.3: Summary of Northstowe Energy Requirements

Policy	Document	Requirement
NE/1 Energy Efficiency	LDF Development Control Policies DPD, Adopted 2007	10% CO_2 reduction from 2006 Building Regulations
NE/3 Renewable	LDF Development Control Policies DPD, Adopted 2007	10% energy provided by on-site renewable technology
NS/23 An Exemplar in Sustainability	LDF Northstowe Area Action Plan DPD, Adopted July 2007	Aspiration to achieve 20% of predicted energy needs from renewable technology
CSH Level 4 – Ene 1 Dwelling Emission Rate	CSH 2010 Technical Note	25% improvement on 2010 Building Regulations
BREEAM Very Good rating	BREEAM New Construction 2011	No minimum requirement for Very Good
Building Regulations	Building Regulations 2016 (anticipated)	Zero Carbon from regulated energy

4 Methodology

The carbon dioxide emissions have been calculated by utilising the Building Regulations standards for domestic units; for non-domestic units an estimation has been made using the available benchmarks:

- Residential units: The Government's Standard Assessment Procedure (SAP) for Energy Rating of Dwellings.
- Non-domestic units: Chartered Institute of Building Services Engineers (CIBSE) Energy Benchmark TM 46 - 2008

4.1 Residential Emissions Calculation Methodology

The Target Emissions Rates (TER) for residential units of the proposed development were taken from the SAP (The Government's Standard Assessment Procedure for Energy Rating of Dwellings) assessment performed by using the Stroma FSAP software version 2009.

A sample set of dwellings were selected with the intention of demonstrating the potential energy demands of the proposed residential units. The following dwelling types have been modelled, with the range of dwelling geometries for each type to cater for the worst case:

- Town Centre 1 Bed Apartment (Ground Floor)
- Town Centre 2 Beds Apartment (Top Floor)
- 2 Beds House (Mid Terrace)
- 3 Beds House (Semi Detached)
- 4 Beds House (End Terrace)
- 5 Beds House (Detached)

The above dwellings have been modelled by using SAP software to estimate the TER emissions and energy demands which are covered by Part L of the Building Regulations, known as regulated emissions including space heating, hot water, ventilation, lighting, pumps and fans.

The unregulated emissions i.e. appliances and cooking have been estimated by utilising the SAP methodology formula A(iii) 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.

4.2 Non-Residential Emissions Calculation Methodology

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 develops 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 following non-domestic units have been used to estimate the energy demands on the basis of their gross internal area,

- A1/A2 - Shops - Retail shops and services etc.
- A3 - Food & Drink - Restaurants/ Café
- B1 - Business Office/ Light Industrial
- D2 - Assembly & Leisure
- Schools & education establishments
- Public Buildings

The above building classification has been use to estimate the target emissions under Building Regulations 2013. At this outline stage this is the best practice approach which can be adopted to demonstrate the carbon emissions and proposed improvements. These predicted energy demands and emissions have used for estimation purposes, however, it is recognised that more detailed energy modelling will be undertaken at later design stage when building detailed designs have been formalised.

5 Baseline Energy Demand and Carbon Emission

In order to establish the approximate baseline energy demand (both thermal and electrical) for the development, an energy model has been produced. This is an outline application and therefore the assessment of the proposed design solution is based on the energy consumption of ‘notional’ domestic and non-domestic buildings on site which are compliant with Part L 2013 Building Regulations.

The residential energy demand was calculated using information regarding regulated energy consumption abstracted from a series of sample Standard Assessment Procedure (SAP) reports developed to provide typical residential dwelling types to develop preliminary energy benchmarks for domestic buildings. The assumptions on which the SAP calculations have been undertaken are as follows:

- Roof sizes are estimated as the exact roof dimensions are not available;
- Quantities and dimensions of openings (windows and doors) for each dwelling type are estimated;
- The differing types of openings and their dimensions are assumed to be the same for all dwelling types;
- Cooling is assumed not to be provided to any of the dwellings;
- Natural ventilation
- All internal and external lighting used throughout the dwellings is energy efficient.

A conservative approach has been adopted in the assumptions made for the purposes of the SAP calculations. This approach gives a degree of comfort since neither the worst case or best-case scenario is used and therefore incorporates an element of flexibility.

The energy consumption for space heating, hot water and electricity for lighting, pumps and fans per m^2 have been determined and derived from sample SAP’s for each typical dwelling. The average energy consumption for space heating, hot water and electricity for lighting per m^2 was calculated which is used as an energy benchmark for the energy demand assessment of each dwelling type.

Given that this is an outline planning application, there is still some uncertainty about the energy needs of the future occupants of non-domestic buildings. Without knowing the occupants or precise uses of the proposed units, it is difficult to accurately predict the energy demand. As such, standard benchmarks taken from CIBSE publication TM46 2008 and Guide F have been used to estimate as far as possible non-domestic energy use but there are a couple of issues with this approach. Firstly, there are multiple benchmarks for B1-B2 uses with wide differences between chilled and standard units and, secondly, the benchmarks are intended to be representative of the UK building stock as a whole and so tend to estimate higher heat demand than would typically be required for new buildings. This approach will tend to overestimate the overall energy demand.

Therefore, the non-domestic energy benchmarks, which reflect Part L 2013 Building Regulations and have been determined by assuming that the CIBSE TM46 and GUIDE F energy benchmarks, are reflective of energy consumption of 2006 Part L compliant buildings and so have been reduced by 10% to obtain the energy demand for non-domestic buildings.

These benchmarks were used in the energy model to determine the baseline energy demand.

The following tables provide a summary of the energy demand and carbon emission relative to anticipated accommodation schedule of the Phase 2 Northstowe development. The tables provide the baseline energy demand and carbon emission values based upon meeting Building Regulations 2013.

Table 5.1 Residential - Baseline Energy Demand and Carbon Emission (Building Regulations 2013)

Residential Buildings	BR2013 Building Demand	BR2013 Building Emissions
Total Regulated Electricity	1,685,749 kWh	874,904 kgCO2
Total Regulated Fossil Gas	20,673,178 kWh	4,465,407 kgCO2
Sub Total Regulated	**22,358,927 kWh**	**5,340,310 kgCO2**
Total Un-regulated Electricity	10,013,164 kWh	5,196,832 kgCO2
Total Un-regulated Gas	2,588,586 kWh	559,135 kgCO2
Sub Total Un-regulated	**12,601,750 kWh**	**5,755,967 kgCO2**
TOTAL	**34,960,677 kWh**	**11,096,277 kgCO2**

Table 5.2 Non - Residential - Baseline Energy Demand and Carbon Emission (Building Regulations 2013)

Non – Residential Buildings	BR2013 Building Demand	BR2013 Building Emissions
Total Regulated Electricity	8,434,942 kWh	4,377,735 kgCO2
Total Regulated Gas	14,074,026 kWh	3,039,990 kgCO2
Sub Total Regulated	**22,508,968 kWh**	**7,417,724 kgCO2**
Total Un-regulated Electricity	9,269,167 kWh	4,810,698 kgCO2
Total Un-regulated Gas	3,942,938 kWh	851,675 kgCO2
Sub Total Un-regulated	**13,212,104 kWh**	**5,662,372 kgCO2**
TOTAL	**35,721,072 kWh**	**13,080,096 kgCO2**

The below table provides a summary of the total energy demand and carbon emission for the proposed Phase 2 Northstowe development.

Table 5.3 All Buildings - Baseline Energy Demand and Carbon Emission (Building Regulations 2013)

All Buildings	BR2013 Building Demand	BR2013 Building Emissions
Total Regulated Electricity	10,120,690 kWh	5,252,638 kgCO2
Total Regulated Gas	34,747,204 kWh	7,505,396 kgCO2
Sub Total Regulated	**44,867,895 kWh**	**12,758,034 kgCO2**
Total Un-regulated Electricity	19,282,330 kWh	10,007,529 kgCO2
Total Un-regulated Gas	6,531,524 kWh	1,410,809 kgCO2
Sub Total Un-regulated	**25,813,854 kWh**	**11,418,339 kgCO2**
TOTAL	**70,681,748 kWh**	**24,176,373 kgCO2**

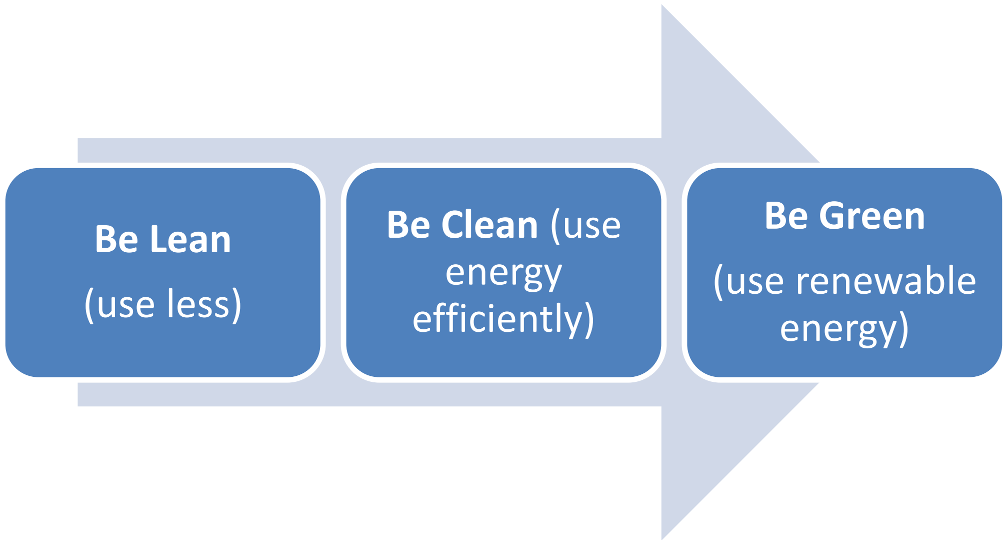
6 Strategic Approach and Carbon Reduction Targets

This report considers the strategic energy strategies that may be adopted at the site to meet policy and regulatory requirements as well as client aspirations. The following energy hierarchy has been utilised:

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

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

3. **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.

In order to achieve the expected 2016 Zero Carbon target the 'regulated' carbon will need to meet the following levels:

Table 6.1 Regulated Carbon Emission Targets

All Buildings	BR2013 Baseline Emissions	Carbon Compliance Target	Zero Carbon Homes Target
Total Regulated Electricity	5,252,638 kgCO2	4,054,175 kgCO2	0 kgCO2
Total Regulated Gas	7,505,396 kgCO2	5,537,403 kgCO2	0 kgCO2
Total Regulated	**12,758,034 kgCO2**	**9,591,578 kgCO2**	**0 kgCO2**

To achieve the Carbon Compliance Target, as defined by the Zero Carbon Hub, the regulated CO_2 emissions will need to be reduced by a minimum of 3**,166,457 kgCO_2** (based upon Carbon Compliance (kgCO_2/m^2/yr) limits provided in table 3.2)**.** Following the initial energy efficiency measures and the introduction of renewable technology any remaining reductions required to achieve 'Zero Carbon' will be achieved through application / integration of further Low Zero Carbon (LZC) technology and/or 'Allowable Solutions'.

The following sections identify the potential options and strategy proposed for the Northstowe Phase 2 development.

7 Energy Efficiency Measures (Be Lean)

7.1 Approach

The 'Be Lean' approach seeks to minimise energy use through demand reduction and passive measures, such as maximising insulation and use of natural ventilation, which minimise the use of energy and utilise energy more effectively (e.g. energy efficient lighting). The Northstowe development will adopt appropriate future proofed building standards to ensure energy efficiency is the first priority in achieving its carbon reduction and sustainability objectives.

A range of measures to reduce carbon emissions and increase resilience to climate change proposed for Northstowe are listed below.

Table 7.1 Building Energy Efficiency Measures

Passive Design	Technology
Air tightness	"A" rated appliances
Insulation	Automatic controls and monitoring
Reduced thermal bridging	Energy management systems
Solar shading	Energy efficient lighting
Use of natural daylight	Energy efficient systems
Natural ventilation	
High performance glazing	

Passive design is the process of best employing the conventional elements of construction to reduce energy consumption and to maximise the use of the natural elements such as daylight, sunlight and natural ventilation. The simplest and most effective method of achieving carbon reduction is often initially through the passive measures proposed above (and in section 7.2 below).

The development is proposed to be designed to utilise natural daylight in all the habitable spaces for the health and wellbeing of the building occupants. All the domestic units will incorporate suitable window sizes relative to living spaces and bedrooms. This will allow the development to achieve good daylighting standards as well as controlling solar gains. The careful choice of glazing and window U values will maintain the solar gain and also minimise the solar intensity to reduce potential overheating impact.

The development is also intended to incorporate high efficiency lighting throughout. The proposed target is to provide 100% of all light fittings as low energy lighting, and will accommodate the compact fluorescent or fluorescent luminaires only.

7.2 Fabric Energy Efficiency Standards (FEES):

The FEES of a building is a performance standard to measure the heating and cooling demands of the building and is measured in kWh/m^2/year. As mentioned previously the baseline has been considered to demonstrate compliance with current 2013 Building Regulations. However, due to the anticipated build out period for this development, it is reasonable to consider how the development may be future proofed relative to the 2016 Building Regulations and zero carbon building requirements. As such appropriate FEES criteria have been adopted in accordance with the FEES targets identified in Table 3.2.

The heat loss of building elements is dependent upon their U-value. The lower the U-value the better the level of insulation which will improve the thermal performance of the building and help to reduce the CO_2 emissions due to reduced space heating demands. The proposed residential units will incorporate high levels of insulation and high efficiency glazing.

Another cause of heat loss is air infiltration / permeability. In 'leaky' buildings the heat loss can occur through wind, internal / external pressure difference, stack effect etc. However, the careful design of appropriate air tightness can significantly reduce heat loss and save energy. The table below provides the breakdown of proposed U values and air tightness to attain the FEES targets.

Table 7.2 Proposed U Value and Air Tightness

Property Type	Floor (W/m2.K)	Wall (W/m2.K)	Roof (W/m2.K)	Window (W/m2.K)	Door (W/m2.K)	Air tightness (m3/h.m2)
1 Bed Apartment	0.14	0.18		1.2	1.0	4
2 Beds Apartment		0.18	0.10	1.2	1.0	4
2 Beds House	0.14	0.18	0.10	1.2	1.0	4
3 Beds House	0.14	0.20	0.10	1.2	1.0	4.5
4 Beds House	0.14	0.20	0.10	1.2	1.0	4.5
5 Beds House	0.14	0.20	0.10	1.2	1.0	4.5

Attaining these U Values and air tightness will be a significant improvement upon existing Building Regulations, and will enable the following FEES to be achieved for each dwelling type. This will future proof this build quality of this development to enable future zero carbon targets to be achieved.

Table 7.3 Fabric Energy Efficiency Standard (FEES) results for each building type

Property Type	FEE (kWh/m2/Year)
1 Bed Apartment	37.4
2 Beds Apartment	38.8
2 Beds House	39.0
3 Beds House	44.3
4 Beds House	42.9
5 Beds House	43.6

Climate Change Adaptation

The balance between ensuring good insulation and air tightness to minimise heat loss in the winter months and potential overheating in the summer months need to be carefully considered.

Adopting the ZCH recommended FEE standards ensures a highly efficient fabric capable of reducing the need for heating in the winter months through the minimisation of heat loss and protects the building against future temperature increases, and potential cooling requirements, through appropriate air tightness and ventilation standards.

7.3 Reduced Energy Demand and Carbon Emissions

The standards described in this section have been incorporated within the design and result in energy demand reduction of regulated energy and carbon emissions savings. The table below gives the breakdown of energy consumption and carbon emissions for space heating, hot water, lighting, pumps and fans (regulated energy) for domestic buildings and non-domestic units.

Table 7.4 All Buildings – Enhanced FEE Energy Demand and Carbon Emission

All Buildings	Enhanced FEE Demand	Enhanced FEE Emissions
Total Regulated Electricity	10,120,690 kWh	5,252,638 kgCO2
Total Regulated Gas	33,022,422 kWh	7,132,843 kgCO2
Sub Total Regulated	**43,143,112 kWh**	**12,385,481 kgCO2**
B'Regs 2013 Baseline	44,867,895 kWh	12,758,034 kgCO2
Carbon Compliance Target	33,447,636 kWh	9,591,578 kgCO2
Total Un-regulated Electricity	19,282,330 kWh	10,007,529 kgCO2
Total Un-regulated Gas	6,531,524 kWh	1,410,809 kgCO2
Sub Total Un-regulated	**25,813,854 kWh**	**11,418,339 kgCO2**
TOTAL	**68,956,966 kWh**	**23,803,820 kgCO2**
B'Regs 2013 Baseline	70,681,748 kWh	24,176,373 kgCO2
B'Regs 2010 (+6%)		25,719,545 kgCO2
B'Regs 2006 (+25%)		34,292,726 kgCO2

By adopting enhanced fabric efficiency standards in all residential dwellings, the total energy demand across the site is reduced by circa 2.5% (comprising a 4% improvement in residential dwelling thermal demand). This reduces the sites carbon emission by 1.5% (again from a 4% reduction in carbon emissions arising from residential thermal demand).

The 1.5% improvement in emissions over Building Regulations (2013) equates to an approximate reduction of 30% over Building Regulations (2006). The emissions reductions secured through improvements to the fabric energy efficiency are therefore substantially greater than the 10% required by Policy NE/1 of the LDF Development Control Policies DPD (2007).

8 Appraisal of Low and Zero Carbon Technology (Be Clean and Be Green)

8.1 Introduction

After the initial savings through energy efficiency measures, the next step in a Sustainable Energy Strategy is the consideration of 'onsite' low carbon (be clean) and renewable energy (be green); also referred to as low and zero carbon (LZC) technology. Section 8.6 below examines the applicability and appropriateness of each technology for Phase 2 of the Northstowe development.

Utilising energy generated locally (onsite) 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 microgeneration 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.

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.

The table below identifies the energy generation technologies and approaches considered.

Table 8.1 LZC Technologies

Macro Solutions (typically district scale or larger)	**Micro Solutions** (typically building related)
Anaerobic Digestion CHP	Air source heat pumps
Biomass heat, biomass power (CHP)	Ground source heat pumps
Gas CHP	Solar Thermal (building mounted)
Large scale PV array	Solar Photovoltaic (building mounted)
Large scale wind energy	Wind energy (building mounted)

8.2 Macro Technologies to be Appraised

8.2.1 Anaerobic Digestion

Anaerobic digestion (AD) involves the breakdown of biodegradable material in the absence of oxygen by micro-organisms called methanogens. It is already widely used to treat wastewater in the UK and can also be used to treat other organic wastes, including domestic and commercial food waste, manures and biofuel crops.

There are two main types of anaerobic digestion called thermophilic and mesophilic – the primary difference between them is the temperatures reached in the process. Thermophilic processes reach temperatures of up to 600C and mesophilic normally runs at about 35-400C.

The system chosen will largely depend on the feedstock to be processed. For example, 'high solid materials', such as a garden and food waste mixture, tend to be processed at a thermophilic temperature using the batch system, while 'low solid materials', such as animal slurry mixed with industrial and municipal food wastes, are more likely to be processed at a lower temperature using a continuous flow system.

The process of anaerobic digestion provides a source of renewable energy, since the food waste is broken down to produce biogas (a mixture of methane and carbon dioxide), which is suitable for energy production. The biogas can be used to generate electricity and heat to power on-site equipment and the excess electricity can be exported to the National Grid.

AD systems require large plant and storage space for successfully running the digestion process. Due to the odour, waste storage and fuel combustion emissions issues associated with this technology, the AD plants are normally located away from residential properties. Operationally there would be a requirement to capture additional organic waste from outside the development to provide sufficient ‘fuel’ to generate biogas to power a reasonably sized CHP.

8.2.2 Gas-fired CHP

Traditional coal and gas fired power stations lose vast amounts of the heat produced during the generation process. Combined Heat and Power (CHP) integrates the production of usable heat and power (electricity), in one single, highly efficient process. CHP generates electricity and produce usable heat at the same time. The specific technologies employed, and the efficiency they achieve will vary however the CHP system offers the capability to make more efficient and effective use of valuable primary fuel resources. The CHP system helps to avoid significant energy losses and reduces CO_2 emissions; hence CHP units can be up to 90% efficient.

Gas turbines generate power by means of the Brayton cycle and a working gas (typically ambient air) is compressed in the compressor, then fed with fuel and ignited. The high temperature high pressure combustion products are then expanded through turbines to generate shaft power for the compressor and the electrical generator. The action generates power and at the same time waste heat also leaves the gas turbine in the form of hot exhaust gases (≈ 500 °C).

Gas fired CHP systems could be sized to provide sufficient heat to meet the space heating and hot water demands of the development. This solution would also contribute to meeting the electrical needs of the development at the same time and therefore benefit the development in both ways.

Upfront investment and space is required for an energy centre to house the gas CHP, back up boiler(s) and thermal store to make the system effective; as well as the installation of a district heat network (at circa £500 to £1,100 per meter), which can add another layer of complexity in coordinating services but can remove the need to install natural gas mains throughout the development depending on the choice of cooking fuel.

8.2.3 Biomass Boiler / CHP

Biomass is any organic matter, typically plant-based, that is available on a renewable or recurring basis. Biomass resources include forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, fast growing trees and plants, and municipal and industrial waste. Biomass can be used in solid form or gasified for heating applications or electricity generation, or it can be converted into liquid or gaseous fuels. The use of biomass to produce heat and power can be environmentally beneficial because biomass is a renewable resource and its combustion does not contribute additional greenhouse gases to the atmosphere.

Biomass can be used to fuel boilers to deliver hot water to meet thermal demands and/or utilised as a fuel for CHP engines. There are two established processes for delivering biomass CHP in small to medium size applications (200KWe – 2.5MWe range): Organic Rankine Cycle (ORC) and Gasification technology. Due to the renewable nature of the fuel source it has an improved carbon factor over alternative gas fuelled boiler / CHP solutions.

Biomass CHP would be sized to meet the space heating and hot water demands of the development; and as (other CHP technologies) would also contribute to meeting the electrical needs of the development. It should be noted however, that biomass CHP has not been deployed at significant scale within the UK and so may be regarded as an unproven technology for primary application at this type of development.

Biomass boilers and CHP require significant quantities of solid biomass fuel, such as wood chips/ pellets, which should to be sourced as locally as possible to maintain its sustainability credentials and improve feasibility. As per other CHP solutions, this option would also require upfront investment and space for an energy centre to house the biomass CHP, back up boiler(s) and thermal store to make the system effective; as well as the installation of a district heat network (at circa £500 to £1,100 per meter), which can add another layer of complexity in coordinating services (however can remove the need to install natural gas mains throughout the development depending on the choice of cooking fuel).

8.2.4 Land Based Photovoltaic Array (Solar Farm)

Solar farms / land base PV arrays are large scale Solar Photovoltaic (PV) installations used to generate electricity. They often cover large areas of land, generally between 5 to 60 hectares and are usually developed in rural locations.

As with any type of large scale development, the potential impacts of solar parks must be assessed. Large scale arrays have the potential to impact the landscape setting, natural habitats, soils and geological and archaeological features. Damage may be caused during construction, when panels are being erected or decommissioned, and operation (relative to landscape setting and loss of agricultural land).

The key barriers of solar farms projects in the UK are grid generation capacity constraints, planning requirements, landscape issues and general public perception of the technology. The grid connection is an increasing constraint of this technology, the usual DNO's connection delivery quotation for medium to large scale projects connecting at 33kV is 12 to 24 months. The potential visual impact of fields of PV can sometimes be difficult to mitigate and are best suited to areas that are not significantly overlooked and/or can be adequately screened through landscape buffers.

Rapidly changing fiscal incentives can also influence the viability of large scale PV installations, such as the Renewables Obligations (ROCs) banding changes for Solar PV projects (annually) versus the typical development timeline of 12 to 24 months.

A solar farm could contribute to or meet the electricity demands of the development provided sufficient land space and appropriate grid capacity (to manage the intermittence) were available. This option would require significant investment but could developed in phases as the development build-out progressed.

8.2.5 Medium / Large Wind

Medium (circa 40 to 80m hub height averaging 500kW to 1MW) to large (circa 90 to 150m hub height averaging 1.5MW to 3MW) scale wind turbines are free standing structures that may be installed singly or in groups.

Wind turbines commonly require a buffer zone or separation zone where other land uses may be affected; for example in Wales there is a Technical Advice Note (TAN 8) that states: "500m is currently considered a typical separation distance between a wind turbine and residential property to avoid unacceptable noise impacts…" In addition, landscape visual issues are likely to require any turbine(s) to be located a suitable distance away from residential dwellings. These constraints would likely mean that any medium to large scale wind turbine would not be able to be sited within or in close proximity to the development and adjacent villages.

Wind speed is critical to wind turbines; and medium to large scale turbines require a minimum of 6 meters per second (m/s) to operate; and commonly require wind speeds over 9 to 10m/s to generate electricity efficiency. The DECC wind database only provides wind speed data up to 45m height, which in this location is estimated between 6 to 7m/s.

Medium to large scale wind turbines have the potential to generate significant quantities of electricity which could have a major contribution to the electricity demands and carbon emission reduction of this development; depending on actual wind speed.

8.3 Micro Scale Technologies to be Appraised

8.3.1 Building Integrated Photovoltaic

Solar- Photovoltaic (PV) systems convert energy from the photons within sunlight into electricity through the aid of photocells; made of semi-conductor material, usually Germanium or Silicon. PV systems are suitable for any type of building but they require significant unshaded south facing space as even a small shadow may significantly reduce output. PV systems can be incorporated on buildings in various ways: on sloped roofs and flat roofs, or in facades, atria and shading devices.

Currently, there are four types of solar cells available: mono-crystalline, poly-crystalline, thin film and hybrid. Mono-crystalline and hybrid cells are the most expensive to produce but are the most efficient (12-20%), poly-crystalline cells are cheaper but their efficiency is lower (9-15%) and thin film cells are only 5-8% efficient but can be produced as thin flexible sheets. As the electrical output is DC, they are used in conjunction with inverters to convert this to a useable AC output.

The maximum total annual solar radiation is usually at an orientation due south and at a tilt from the horizontal equal to the latitude of the site minus approximately 20 degrees. However, PV's can operate at significant efficiency within a range of deviation from this optimum; e.g. a south east roof, at optimum inclination can achieve 96% efficiency; or a south west roof at +10 degree inclination can provide between 95% and 92% efficiency.

Roof mounted solar PV would be beneficial for the development; helping to meet the electricity demands of individual dwellings and contributing to the carbon reduction target.

8.3.2 Solar Thermal

Solar thermal technology converts the solar energy into heat which can be used to mitigate hot water demands. Solar water heating systems use solar panels, called collectors, fitted to the roof. To gain better savings and most benefits from this technology, the system is integrated with a thermal store system which has the capability to store the heat for a longer period of time, i.e. during the day to be utilised at peak time, and also act as a heater (e.g. immersion heater) to further reach the hot water temperatures that may be required.

Solar thermal collectors need to be positioned to receive maximum sunlight; and therefore should face south at approximately 32 degrees to attain maximum proportion of sunlight hours. Easterly facing collectors capture more energy at the start of the day, and westerly facing collectors capture more energy in the later afternoon / early evening.

Whilst large solar thermal collector systems can also provide some contribution to space heating, this would be limited and require further heating via a boiler, and is often not considered worthwhile. Similarly, during winter months the system typically requires a heating boost from a boiler/immersion heater to achieve desired hot water temperatures

8.3.3 Heat Pumps

Heat pump technology is designed to provide heating and cooling demands. There are two principle type: Ground Source and Air Source.

Ground Source Heat Pump (GSHP) technology can meet heating /cooling demands all year round as the earth's temperature is virtually constant at depth. This technology offers energy savings on meeting heating/cooling demands relatively efficiently. A kW of energy intake will produce up to 4 kW of output which makes this technology more efficient in comparison with traditional Gas boilers. This technology can be used for heating and cooling applications.

Air Source Heat Pump (ASHP) extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C. This heat can then be used to heat radiators, underfloor heating systems, or warm air convectors and hot water.

ASHP are typically less effective than GSHP but do not have any land requirements as GSHP do. All heat pumps need electricity to run, but the heat they extract from the ground or air is constantly being renewed naturally.

The significant barriers of GSHP technology is the land requirement for ground loop or borehole construction; which also have ground trench or borehole installation costs. ASHP can have external noise constraints (although generally minimal) and the positioning of the external unit needs careful consideration.

8.4 LZC technology Appraisal

This section provides an appraisal of the differing energy options that may be applied to the scheme. This has been used to inform the selection of the preferred options to meet the policy requirements and client driven aspirational targets. It has also been used to inform the development of the site masterplan.

8.4.1 Appraisal Methodology

This document appraises the various technical, environmental, social and economic constraints associated with each LZC technology in order to explore the options available.

Environmental Appraisal

Carbon reduction potential: This considers the carbon reduction potential of each technology; based upon the amount of energy a particular technology can generate and the carbon savings that can be attained from it. The main purpose of this is to identify those technologies that have the potential to generate maximum energy to meet the predicted energy demand but at the same time capable of minimising the carbon emissions

Landscape: This considered the implications of a proposed technology to the landscape character / visual impact, i.e. whether this technology will impose a negative impact towards the overall landscape character or it will enhance the landscape features of the development.

Environmental Quality: This considers the impacts of a proposed technology on the local environmental quality; i.e. disruption to local wildlife/biodiversity, noise disturbance, air quality issues etc. Due to the sensitivity of each of these issues, environmental quality can play a vital role towards to adoption or refusal of any technology.

Social Appraisal

Governance: This considers the likely governance of any proposed technology; i.e. whether local / community governance is possible.

Equity: This considers how a proposed technology can be implemented to deliver a fair and equitable outcome to all; and whether a particular technology can generate enough energy, at low cost, to reduce energy bills.

Health / Wellbeing: This considers how a proposed technology can be implemented to enhance the health and wellbeing of the future residents and existing local community. Issues that may be considered range from shadow flicker from wind turbine to the air pollutions from waste plants. Hence, this section considers any health and wellbeing issues linked with a proposed solution.

Economic Appraisal

Costs and Payback: This considers, at a high level, the typical costs (Capital and Operational expenditure) of the proposed technology, typical payback periods and incentives / grant schemes.

Phasing: Considers how the technology can be phased and therefore how costs may be spread relative to expenditure.

Land Values: The land value impact is varying from technology to technology however the significance of this could be higher for some technologies. We have evaluated this issue within this appraisal as the visual impacts on the land values and also the local land restrictions due to the planning etc.

Technical Appraisal

Physical Factors: This considers factors which can cause constraints to the particular technology; such as wind speed; land use and area (in case of wind turbines), orientation and overshadowing (in case of solar technologies) and restrictions due to the existing infrastructure such as telecommunication masts or aviation radars etc.

Connecting Infrastructure: This relates to whether enabling or connecting infrastructure is present and /or capable of managing the proposed technology; such as the intermittent energy generation technology impacting grid supply and capacity.

Integration with other technologies: Considers whether and how the technology integrates with other potential energy solutions / different technologies.

8.4.2 Carbon Reduction Potential

The first part of the appraisal is to assess the potential reductions achieved by each individual technologies. This is summarised within the table below.

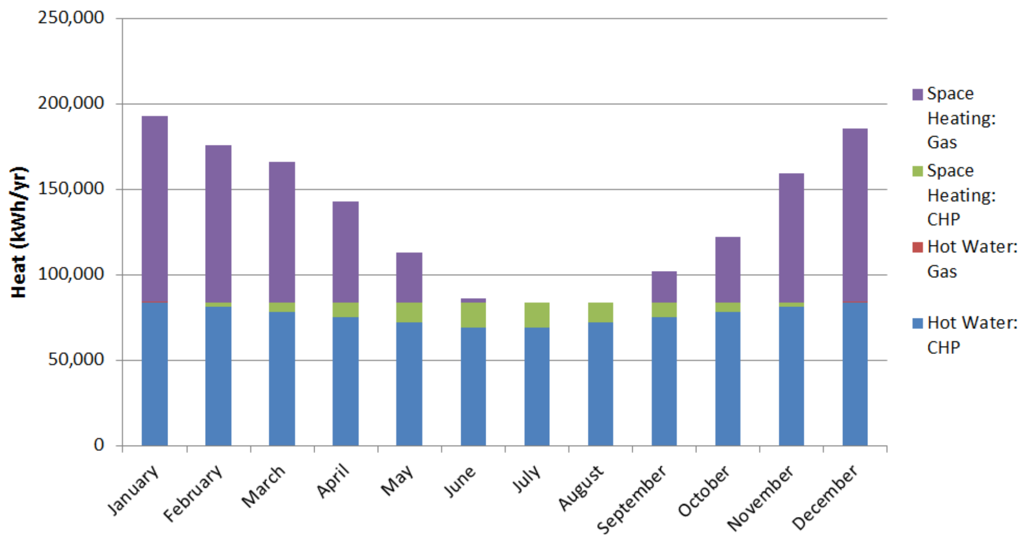
Table 8.2 Meeting Carbon Reduction Targets

Carbon Saving from Technology		Reductions required to achieve:	
MACRO - DISTRICT SCALE OPTIONS		Carbon Compliance Target	Zero Carbon Target
Energy Generation Technology	**Total Carbon Savings**	**2,794 tonnes CO2**	**12,385 tonnes CO2**
AD - (based upon amount of organic waste generated by the development)	704 tonnes	25%	6%
Biomass CHP (sized to meet hot water and 80 % of space heating demands)	12,791 tonnes	458%	103%
Gas CHP (sized to meet hot water and 80 % space heating demands)	12,753 tonnes	456%	103%
Large Scale PV (56.15ha - land space)	12,385 tonnes	443%	100%
MEDIUM TO LARGE SCALE WIND OPTIONS		Carbon Compliance Target	Zero Carbon Target
Energy Generation Technology	**Total Carbon Savings**	**2,794 tonnes CO2**	**12,385 tonnes CO2**
E33 Wind Turbine Unit (330KW Capacity)	406 tonnes	15%	3%
E44 Wind Turbine Unit (900KW Capacity)	688 tonnes	25%	6%
E48 Wind Turbine Unit (800KW Capacity)	794 tonnes	28%	6%
E53 Wind Turbine Unit (800KW Capacity)	1,005 tonnes	36%	8%
E70 Wind Turbine Unit (2300KW Capacity)	1,764 tonnes	63%	14%
E82 Wind Turbine Unit (2000KW Capacity)	2,346 tonnes	84%	19%
E82 Wind Turbine Unit (3000KW Capacity)	2,346 tonnes	84%	19%
E101 Wind Turbine Unit (3000KW Capacity)	3,484 tonnes	125%	28%
E126 Wind Turbine Unit (7500KW Capacity)	5,513 tonnes	197%	45%

MICRO - BUILDING SCALE OPTIONS		Carbon Compliance Target	Zero Carbon Target
Energy Generation Technology	**Total Carbon Savings**	**2,794 tonnes CO2**	**12,385 tonnes CO2**
Building Scale PV (26% of total roof space)	2,805 tonnes	100%	23%
Solar Thermal (sized to meet hot water and 80 % of space heating demands)	5,814 tonnes	208%	47%
Heat Pump (sized to meet hot water and 80 % of space heating demands)	1,224 tonnes	44%	10%

Note: CHP, solar thermal and heat pump technologies have been sized to meet 100% of the hot water demand and 80% of the heating demand. There is a working assumption that this represents an annual 'base load' that can be satisfied without the need for significant heat dumping during the summer months. This is illustrated within the indicative graph below:

Figure 8.1 Annual Thermal Base Load Demand



8.4.3 Technology Integration

The appraisal also discusses the limitations of each technology and how they may complement (C) or pair (P) well together; and conversely where they do not typically work well together (X). The following table provides a summary of technology integration and combination.

Table 8.3: Technology Integration

	AD CHP	Gas CHP	Biomass CHP	Land PV	Wind	Roof PV	Solar Thermal	Heat Pumps
AD CHP	-	X[1]	X[1]	C	C	C	X	X
Gas CHP	X[1]	-	X[1]	C	C	C	X	X
Biomass CHP	X[1]	X[1]	-	C	C	C	X	X
Land PV	C	C	C	-	P	P	C	C
Wind	C	C	C	P	-	P	C	C

Roof PV	C	C	C	P	P	-	C^2	C
Solar Thermal	X	X	X	C	C	C^2	-	X
Heat Pumps	X	X	X	C	C	C	X	-

As always, exceptions exist where technologies that do not typically complement each other; such as biomass CHP and gas CHP, can work together; e.g. when there is a significant heat demand and opportunity exists to have more than one technology combining to service that demand– and these opportunities are identified in the above table as X^1. Such a situation may exist at the Northstowe site due to the size of heat demand and may provide benefit relative to resilience and security of supply.

Where one technology generates heat and another power; then these technologies would typically complement each other. There can, however, be certain situations where physical limitations can create conflict; for example roof mounted solar PV and solar thermal complement each other relative to their respective electrical and thermal generation but compete on roof space to achieve this – such aspects are identified in the above table as C^2.

In other circumstances; technologies may be able to be paired together to meet a specific demand; such as roof mounted PV and wind turbines. Each generate electricity but do not necessarily compete against each other.

As part of this integration of technologies; a primary issue to consider is whether to link buildings to common energy infrastructure or to maintain independent operation of each building. The primary issues are that:

- Some energy technologies (e.g. CHP, biomass boiler) may not be viable or practical at a building level.
- Some low carbon systems (e.g. biomass boiler, CHP) require operational management that benefit from a shared system where centralised management can be more readily provided or is given over to a third party.
- Shared site-wide systems can introduce complexities for design, ownership, ongoing operation and allocation of costs and so are likely to require more involved management from a third party - one option would be to utilise a specialist Energy Service Company (ESCo), which could also take on some of the wider estate management..
- Shared systems can potentially provide more energy options and flexibility, as technology enhancement in the future can be swapped out in centralised locations to achieve higher carbon savings.
- Shared systems can be combined with some building level systems (e.g. CHP or biomass boiler with photovoltaics). Use of a combination of shared and building level systems can help to further improve flexibility and increase carbon savings.

8.5 Technology Appraisal

Table 8.4 LZC Technology Appraisal

	Environmental	Social	Economic	Technical
Macro Solutions				
Anaerobic Digester CHP	**Carbon reduction potential:** The relatively limited organic waste generated by the development would limit the heat and power generating ability of this technology. Carbon Reduction: 704 tonnes. Carbon Compliance Target: 25% Zero Carbon target: 6% **Landscape:** AD plants have a larger overall building footprint than some other boiler/CHP fed systems; as the AD digestion vessel needs to be accommodated. However, they are not particularly unsightly and are in keeping with the agricultural nature of the existing /surrounding land use. As this technology will not meet the sites total thermal demand; there would likely be a requirement to have additional complementary boilers located in energy centres within the masterplan site. The energy centre; with service yard would have a land space requirement; however, it is not considered that this	**Governance:** This type of technology could be linked to local governance structure, if deemed appropriate, and facilitate community buy-in. In addition, this technology would require a heat distribution network which again could be linked to local governance. **Equity:** This technology has the potential to help reduce the heating bills, depending on the pricing strategy adopted; as low cost heat could be used to support the sites thermal demand. However, due to the relatively small amount of thermal energy generated, this would not be a significant proportion of the heating bills and so limited impact. **Health / Wellbeing:** There is the potential that odour issues may be present which may negatively impact the immediately local environment.	**Cost:** Capital cost comparatively low but operation costs can be higher than other boiler/CHP options. Incentives available for this technology also mean that payback periods are low. However this technology would need to be combined with a District Heat Network which would add significant capital cost. Typical Payback: circa 10 years **Phasing:** This technology would need to be implemented at the start of build out; if it were to be a main contribution to the thermal demand; necessitating installation and connection to a site wide DHN. **Land Values:** Residential land value immediately adjacent to an AD plant may be reduced due to the potential odour issues as discussed above.	**Physical Factors:** The availability of suitable organic feedstock is one of the major issues and if sufficient organic waste is not available then this technology will not be work optimally. **Connecting Infrastructure:** Because this technology is not predicted to generate sufficient energy to meet the developments demand; it may be possible to integrate this technology alongside other energy generation plants that collectively contribute to a DHN. However, due to potential odour issue it is unlikely this option would be located within an urban setting and therefore connecting to a DHH would incur additional costs. This option requires a site wide heat network to distribute the hot water across the site to each building. In addition; it would require grid connection relative to electricity generated. Integration with other technologies:

	Environmental	Social	Economic	Technical
	would represent a negative spatial or landscape impact as it would be fully integrated into the masterplan layout and design. However, it would have exhaust flues extending some 15m from the roof of the CHP plant; which would have limited local landscape impact. **Environmental Quality:** Special precautions would need to be taken to reduce any potential odour related issue; such as negative air pressure unloading halls. Preventing odour issues would be possible but would add to building footprint and overall cost of construction and operation. More realistically, this option should not be located within an urban setting. Potential air quality impact can occur from the boiler/CHP combustion process; however this would be controlled as part of the plant and flue arrangements and is therefore unlikely to cause any significant impact. Noise will be generated by the CHP engines; however, this would be mitigated by acoustic enclosures to acceptable levels.			This technology can integrate with other boiler / CHP technologies as part of site wide network; if all units are designed to facilitate this. It will also integrate with other power generating technologies such as wind and solar PV. It would not integrate well with micro heat technologies such as solar thermal; unless specific areas of the site were not to be connected to the DHN.
Biomass boiler / CHP	**Carbon reduction potential:** CHP design would be optimised to meet the space heating and hot water	**Governance:** This is district scale technology that requires a site wide DHN to facilitate the	**Cost** Capital cost relatively high – reduces as the size of the engine increases	**Physical Factors:** The major technical constraint is the availability of biomass fuel and fuel

	Environmental	Social	Economic	Technical
	demands of entire development or a higher density part of it such as the town centre. Biomass boiler / CHP utilises renewable wood chips/pellets as a fuel source (or potentially biofuel) to generate heat and power; and therefore reduces carbon emissions further when compared to traditional gas boiler and gas CHP technologies. However, biomass CHP has not been utilised on a large scale within the UK and may be regarded as untested technology. Carbon Reduction: 12,791 tonnes Carbon Compliance Target: 458% Zero Carbon: 103% **Landscape:** No significant landscape issues associated with this option as the biomass plants are enclosed within a building structure; with the exception of the biomass fuel storage which may be a silo type structure; which is in keeping with the existing rural nature of the site and is not considered to represent a negative landscape impact. An energy centre would be required; with additional service yard. It is not considered that this would represent a negative spatial or landscape impact as it would be fully integrated into the	transfer of hot water to each building. This type of technology could be linked to local governance structure, if deemed appropriate, and facilitate the community buy-in. **Equity:** This technology has the potential to help reduce the heating bills, depending on the pricing strategy adopted and biomass fuel supply; as low cost heat could be used to meet the sites thermal demand. In addition; it is likely that the Biomass fuel would be purchased locally which would benefit local economy. **Health / Wellbeing:** No significant health and wellbeing issues.	however. High running and maintenance costs DHN increases cost significantly and therefore struggles to be cost effective on low density residential schemes. Typical Payback: circa10 – 15 Years **Phasing:** This technology would need to be implemented at the start of build out; if it were to be a main contribution to the thermal demand; necessitating installation and connection to a site wide DHN. **Land Values:** It is considered that this technology would not have any significant impact on land values.	security for long term generation. To generate the energy demand, in aaccordaance with" section 8.4.6, approximately 13,133 tonnes of biomass fuel would be required. **Connecting Infrastructure:** This option requires a site wide heat network to distribute the hot water across the site to each building. In addition; it would require grid connection relative to electricity generated. **Integration with other technologies:** This technology can integrate with other centralised boiler / CHP technologies as part of site wide network; if all units are designed to facilitate this. It will also integrate with other power generating technologies such as wind and solar PV. It would not integrate well with micro heat technologies such as solar thermal; unless specific areas of the site were not to be connected to the DHN.

	Environmental	Social	Economic	Technical
	masterplan layout and design. However, it would have exhaust flues extending some 15m from the roof of the CHP plant; which would have limited local landscape impact. **Environmental Quality:** Potential air quality impact can occur due to the burning of wood fuel, which has a higher nitrogen oxide content than traditional gas boilers; however this would be controlled as part of the plant and flue arrangements and is therefore unlikely to cause any significant impact. Noise will be generated by the CHP engines; however, this would be mitigated by acoustic enclosures to acceptable levels.			
Gas CHP	**Carbon reduction potential:** Gas CHP design would be optimised to meet the space heating and hot water demands of entire development or a higher density part of it such as the town centre. Carbon Reduction: 12,753 tonnes Carbon Compliance: 456% Zero Carbon: 103% **Landscape:** No significant landscape issues associated with this option as the gas	**Governance:** This is district scale technology that requires a site wide DHN to facilitate the transfer of hot water to each building. This type of technology could be linked to local governance structure, if deemed appropriate, and facilitate community buy-in. **Equity:** This technology has the potential to help reduce the heating bills, depending on the pricing strategy adopted; as low cost	**Cost:** Capital cost relatively high (although cheaper than Biomass alternative) –cost reduces as the size of the engine increases however. High running and maintenance costs (although cheaper than Biomass alternative) DHN increases cost significantly and therefore struggles to be cost effective on low density residential schemes. Typical Payback: circa 10-15 years **Phasing:**	**Physical Factors:** There are no specific physical limitations to this option. However, this technology will be dominated by the global supply of natural gas and fossil fuel prices. **Connecting Infrastructure:** This option requires a site wide heat network to distribute the hot water across the site to each building. In addition; it would require grid connection relative to electricity generated. Integration with other technologies:

	Environmental	Social	Economic	Technical
	CHP plants are enclosed within a building structure. An energy centre would be required; with additional service yard (although this would be smaller than for the biomass and AD options as gas is piped to the energy centre). It is not considered that these would represent a negative spatial or landscape impact as they would be fully integrated into the masterplan layout and design. The energy centre would need to incorporate exhaust flues extending some 15m from the roof of the CHP plant; which would have limited local landscape. **Environmental Quality**: Noise will be generated by the CHP engines; however, this would be mitigated by acoustic enclosures to acceptable levels.	heat could be used to meet the sites thermal demand. **Health / Wellbeing:** There are no negative health and wellbeing concerns.	This technology would need to be implemented at the start of build out; if it were to be a main contribution to the thermal demand; necessitating installation and connection to a site wide DHN. **Land Values:** It is considered that this technology would not have any significant impact on land values.	This technology can integrate with other centralised boiler / CHP technologies as part of site wide network; if all units are designed to facilitate this. It will also integrate with other power generating technologies such as wind and solar PV. It would not integrate well with micro heat technologies such as solar thermal; unless specific areas of the site were not to be connected to the DHN.
Large scale PV array	**Carbon reduction potential:** A large scale land based PV array has the potential to generate significant amounts of electricity resulting in substantial carbon savings. Carbon Reduction: 12,385 tonnes Carbon Compliance: 443% Zero Carbon: 100%	**Governance:** Local governance is possible provided a suitable arrangement is put in place that enables the upfront funding required to complete the array (in full or part). Some sort of 'share' arrangement may be possible as occupiers move into the development; linked to owning properties.	**Cost:** Solar PV is historically one of the more expensive renewable technologies, but one which has been subject to significant downward price shifting due to relatively rapid take up and technology improvements. As downward pricing continues the economics of this option continue to improve.	**Physical Factors:** The major physical constraint is availability of land; that is not overshadowed. **Connecting Infrastructure:** Due to the intermittency of electricity generation and balancing generation with demand; there is often a significant

	Environmental	Social	Economic	Technical
	Landscape: Land based PV array would occupy a significant area of land and depending where it is located may be overlooked. However, the site and immediate surrounding area is relatively flat, with numerous hedgerows that define the existing field patterns; which would likely afford significant screening. **Environmental Quality:** Installation of land based PV arrays can sit comfortably alongside biodiversity enhancements. The need to secure the area around the PV array would likely also benefit biodiversity. There are no negative issues with regards to air quality, noise and water quality.	There are potential issues around private wire but the opportunity to put in place bilateral agreements with iDNOs may overcome this. **Equity:** This technology has the potential to reduce energy bills, as electricity produced is utilised (through agreement). **Health / Wellbeing:** There are no negative health and wellbeing concerns of this technology	Typical Payback: payback continues to reduce and can generally be between 8 to 10 years. **Phasing:** Generally solar farms are brought forward in one go, although a larger array could be brought forward in several tranches. **Land Values:** Solar farms take up large areas of land; and therefore directly compete with other land uses. Dependent on screening and security issues; adjoining land values may also be affected by the presence of a PV array.	grid reinforcement issue associated with solar farms that requires additional infrastructure to be put in place or the incorporation of some balancing / storage technology. **Integration with other technologies:** Solar PV is a standalone technology and can be complementary / integrate with most other technologies. It can contribute to meeting the electricity demands without interfering with heat generating technologies and can sit comfortably with other electrical generating options.
Medium / Large scale Wind	**Carbon reduction potential:** Medium scale wind turbines, with a tower height of 45-65 meters and the average wind speed of 6.1 m/s to 6.4 m/s has the potential to generate electricity; albeit at the lower end of the power scale. Total electricity Generation from a single 800kW wind turbine system at a wind speed of 7m/s and hub height of 60m = 1,529,496 kWh; saving 794 tonnes of carbon per turbine. Larger scale turbines	**Governance:** Local governance is possible provided a suitable arrangement is put in place that enable the upfront funding required to install the turbine(s). Some sort of 'share' arrangement may be possible as occupiers move into the development; linked to owning properties. There are potential issues around private wire but the opportunity to put in place bilateral agreements with iDNOs may overcome this.	**Cost:** ~£1,000 per KW. Smaller models are more expensive per KW. Typical Payback: circa 10-20 years **Phasing:** Typical to install several turbine in one go to facilitate planning, grid connection issues and funding. However, individual turbines may be installed as required.	**Physical Factors:** Wind speed is the predominant factor in determining the suitability of this technology. Even at 60m hub height, the predicted wind speed is at the lower end of the power scale. **Connecting Infrastructure:** Due to the intermittency of electricity generation and balancing generation with demand; there is often a significant grid reinforcement issue associated with

	Environmental	Social	Economic	Technical
	could produce more electricity and save more carbon (see table 8.2) **Landscape:** Landscape visual impacts will occur as a result of the installation of wind turbines; which would necessitate detailed assessment. Residential development is typically sited at least 500m away from wind turbines. **Environmental Quality:** Bats and birds have the potential to be affected dependent on the scale and location of the wind turbines. Noise can be an issue associated with this technology; generally requiring turbines to be located at least 500m away from residential areas.	**Equity:** This technology has the potential to reduce energy bills as electricity produced is utilised (through agreement). **Health / Wellbeing:** There may be noise issues associated with this technology that may be regarded as a nuisance.	**Land Values:** Adjacent and nearby land values may be negatively affected due to perceived visual impact.	wind turbines that requires additional infrastructure to be put in place or the incorporation of some balancing / storage technology. **Integration with other technologies:** Wind turbines are a standalone technology and can integrate with most other technologies. It can contribute to meeting the electricity demands without interfering with heat generating technologies and can sit comfortably with other electrical generating options.
Micro Solutions				
Heat Pumps	**Carbon reduction potential:** This low carbon technology requires electricity to leverage the generation of high efficient heat, and therefore has a reduced carbon reduction potential relative to some other renewable options. Carbon Reduction: 1,224 tonnes Carbon Compliance: 44% Zero Carbon: 10%	**Governance:** This technology is typically installed on a building by building basis; and therefore it can largely be owned by the home owners / occupiers of the development. **Equity:** This option would create an immediate and direct benefit to the home owners	**Cost:** Comparable cost is low, however technology achieves lower levels of CO_2 reduction and would therefore need to incorporate other technologies to meet the target reductions which would add additional cost. Ground Source Heat pump incur additional infrastructure costs for ground works.	**Physical Factors:** Ground source heat pumps require access to land where the borehole system can be installed (underneath buildings if needed). Air source heat pumps require careful siting of the external heat exchanger to prevent nuisance. This technology generally works better with under floor heating system rather

	Environmental	Social	Economic	Technical
	Landscape: Heat pumps do not generally have any visual impact within the landscape. Air Source heat pumps have the potential to influence streetscape depending on their location. **Environmental Quality:** Noise issues can occur with air source heat pumps and therefore careful selection of low noise machines and siting external units in locations to avoid nuisance would be essential. Open loop ground source heat pumps have the potential to impact underlying groundwater characteristics; and would need approval from the Environment Agency. Close loop systems would be more typical and would not have the same potential risk.	and occupiers of buildings; reducing energy bills. **Health / Wellbeing:** There are no significant health and wellbeing issues associated with heat pump technology. However, there is the potential for air source heat pumps to cause noise issues; which requires careful selection of low noise machines and siting of external units in locations to avoid nuisance.	Typical Payback circa 8 years **Phasing:** This technology is applied at a building scale and so progresses in-line with build out. **Land Values:** There are not considered to be any land value issues associated with this technology.	than traditional wet radiator heating systems. **Connecting Infrastructure:** There are no additional infrastructure issues directly linked with this technology. **Integration with other technologies:** This is a standalone hot water/space heating generation technology that can combine with electricity generating technologies. It would not integrate with other heat generating technologies.
Solar Thermal	**Carbon reduction potential:** Solar Thermal technology generally only contributes towards the hot water demands and therefore has small footprint with regards to energy generated and carbon savings. However it has been sized here to meet 100% hot and 80% heating demands. This would require 91% of the total available roof space – forcing a monopitch roof design. Carbon Reduction: 6,153 tonnes	**Governance:** As this technology is installed on each building; it can largely be owned by the home owners / occupiers of the development **Equity:** Solar Thermal would create an immediate and direct benefit to the home owners and occupiers of buildings; reducing energy bills.	**Cost:** The solar thermal installation cost relatively low but additional plumbing is required in comparison with the traditional boiler which increases the overall cost. Typical Payback circa 10 years **Phasing:**	**Physical Factors:** Requirement for sufficient south roof facings, extra plumbing, and year round hot water demands require larger than normal hot water storage with immersion heater to boost heat. This technology may be difficult to install in small unit types and flats (such as those found in the Town Centre) due to limited roof space.

	Environmental	Social	Economic	Technical
	Carbon Compliance: 220% Zero Carbon: 50% **Landscape:** This technology is unlikely to have any impact to landscape character or view. It may however create a distinctive streetscape and design concept relative to the development. **Environmental Quality:** There are no negative issues with regards to biodiversity, air quality, land quality, noise and water quality regarding this option	**Health / Wellbeing:** There are no significant health and safety issues linked with this technology, except the risk of scalding which can if not designed appropriately. Design should be undertaken to maintain the balance between bacteria growth, scald risk, water flow rates and scale reduction.	This technology is applied at a building scale and so progresses in-line with build out. **Land Values:** There are not considered to be any land value issues associated with this technology.	**Connecting Infrastructure:** No grid connection is required and no additional infrastructure required. **Integration with other technologies:** This is a standalone hot water generation technology that can combine with electricity generating technologies; although may conflict with roof mounted solar PV (due to space requirements).
Solar PV (26% roof space)	**Carbon reduction potential:** Solar PV is renewable source of energy which displaces energy from the grid. It is therefore a very effective means of achieving carbon reductions if roof space is available. The below savings may be achieved if circa 26% of roof space is fitted with PV (i.e. half of the southern facing roof). Carbon Reduction: 2,805 tonnes Carbon Compliance: 100% Zero Carbon: 23% **Landscape:**	**Governance:** As this technology is installed on each building; it can largely be owned by the home owners / occupiers of the development. **Equity:** Solar PV creates an immediate and direct benefit to the home owners and occupiers of buildings; reducing electricity bills. **Health / Wellbeing:**	**Typical Cost:** Solar PV is historically one of the more expensive renewable technologies, but one which has been subject to significant downward price shifting due to relatively rapid take up and technology improvements. Typical Payback circa 10 years Additional costs are associated to grid import reinforcement costs. **Phasing:** This technology is applied at a building scale and so progresses in-line with build out.	**Physical Factors:** The primary physical constraint is the necessity to have roof orientations facing south to attain the maximum solar harvest for the benefit of the technology. Also the overshadowing needs to be considered for each dwelling/ buildings. **Connecting Infrastructure:** Due to the intermittency of electricity generation and balancing generation with demand; there is often a significant grid import reinforcement issue associated with solar PV that requires additional infrastructure to be put in

	Environmental	Social	Economic	Technical
	This technology is unlikely to have any impact to landscape character or view. It may however create a distinctive streetscape and design concept relative to the development. **Environmental Quality:** There are no negative issues with regards to biodiversity, air quality, land quality, noise and water quality as this option.	There are no negative health and wellbeing concerns regarding this technology	**Land Values:** There are not considered to be any land value issues associated with this technology.	place or the incorporation of some balancing / on-site storage technology. **Integration with other technologies:** Solar PV is a standalone technology that can integrate with other most other technologies; other than those that may compete for roof space (such as solar thermal). It can contribute to meeting the electricity demands without interfering with heat generating technologies and sit comfortably with other electrical generating options.

8.5.1 Appraisal Summary

The appraisal undertaken in the previous section is designed to identify suitable headline energy options and approaches. This has been fed into an initial screening in order to eliminate technologies from further evaluation:

Table 8.5: Technology Screening

Technology	Screening	Summary
Macro Solutions		
Anaerobic Digester	Reject	Anaerobic Digestion (AD) CHP is unlikely to be able to generate significant heat or power, relative to the sites predicted demands, due to likely limitations on organic waste feedstock; although additional feedstocks may be identified (but not necessarily guaranteed). There are potential odour issues associated with this technology which would point to it being located away from residential development. These issues, coupled with high maintenance, space and operational restrictions suggest that this technology is not appropriate for this development.
Biomass CHP	Reject	Biomass CHP could meet the overall heating demands and a considerable proportion of the electrical demand of the development; however, consistent and availability biomass fuel would be required to facilitate this. This option has the potential to create significant carbon savings, however the technology is still in its infancy and is therefore burdened by significant risk.
Gas CHP	Option	Gas CHP, if correctly sized, is capable of producing enough heat to meet the thermal demands of site; and enough electricity to meet the electrical demand. The CO_2 reductions would be significant, however as with the other centralised heating technology, this will incur extensive site wide District Heat Network (DHN) to ensure each building is connected. It would therefore be better suited to the high density, mixed use nature of the Town centre.
Large scale PV array	Option	A solar PV land based array would be able to generate significant electricity; provided that sufficient land is available. It is estimated that approximately 57ha of land would be required to meet 100% of the electricity demand of the Phase 2 site; and would require significant grid reinforcement (which will be necessary as part of the development). This option is able to sit comfortably alongside many other technologies and therefore could be considered as part of a suite of technologies utilised to achieve energy demand and carbon savings.
Wind Turbines	Option	Small scale wind turbines would not be viable at Northstowe due to the lack of sufficient wind speed. Medium scale turbines may be viable; with an estimated average speed of 6.3m/s at a hub height of 60meters. Each medium scale turbine would only contribute a small portion of the sites electricity demand; requiring approximately 16 turbines to meet the total electrical demand.

		Large scale wind turbines may be viable; the DECC wind database does not provide wind speed data at heights appropriate for large scale turbines (80+ meters). However we have assumed that a wind speed of 7m/s may be achievable. A 3MW turbine would meet less that 20% of sites electricity demand; requiring approximately 5 turbines to meet the total electrical demand. However any wind option, especially large scale, can present significant adverse visual and acoustic impacts on the surrounding area. It therefore represents a significant planning risk. (Note: If higher wind speeds were recorded at the site it would significantly improve electricity generation).
Micro Solutions		
Heat Pumps	Reject	Heat pump technology could meet the thermal demands of the site; however it requires electricity to operate and therefore does not create the same carbon savings as some other options. Ground source heat pumps require some ground space for borehole installation or trenches and air source heat pumps require careful siting of the external heat exchanger to avoid noise nuisance.
Solar Thermal	Reject	If this technology is used to replace traditional boiler solution then it would require circa 86% of available roof space – forcing a mono pitch roof design. Potential conflicting demands on roof space between Solar Thermal and Solar PV; and per m2 solar PV achieves a higher carbon saving.
Solar PV (building mounted)	Option	Roof mounted solar PV is able to generate electricity on site which enables significant carbon reductions. It is increasingly affordable and is able to sit comfortably alongside many other technologies – it could therefore be considered as part of a suite of technologies utilised to achieve energy demand and carbon savings.

In terms of land use the site is predominantly low/medium density residential with high density residential and non-residential aspects concentrated within the town centre. A district heat network for the entire site is therefore likely to be financially unviable due the extensive pipework costs. Site wide options will therefore need to incorporate some form of building scale technology. Solar PV represents the most practical and economically viable option in this regard.

However, the density of the town centre itself could result in installation costs of a DHN serving the town centre area being feasible. The town centre is also mixed use, containing a variety of residential and non-residential buildings which would enable any CHP system to work at full capacity for longer periods and therefore more efficiently. This would reduce CO_2 emissions significantly within the town centre and reduce the dependence on allowable solutions for the remainder of the site.

This supports the work undertaken by Renewables East (*Provision of Zero Carbon Energy for the Northstowe Eco-Town Development* (dated June 2010)) which suggests that the optimum technical solution for the whole development would likely involve the use of district heating for the central high density portion of the development, with micro-generation technologies recommended for the remainder.

Section 9 discusses the preferred energy strategy options for the development. It is recognised, however, that irrespective of whichever strategic approach and energy options are recommended, the implementation strategy must be flexible and adaptive to the development, shifting economic incentives and models, and evolving technologies.

9 Preferred Energy Strategy

Based upon the recommendations of the strategic LZC options appraisal this statement provides recommendations as to the preferred options, following the enhanced fabric enhancements outlined in section 7, to achieve the initial site wide carbon compliance reductions before providing an account of various further options to meet the future 2016 Zero Carbon Standard (as currently understood).

The sections below identify various combined technology solutions that seek to achieve the zero carbon target. As previously discussed, the applicant is focused on achieving this target through predominantly on-site and/or direct near site technology rather than any significant reliance on off-site/off-set allowable solutions. The energy strategy therefore needs to strike a balance between financial viability and the client aspiration to meet a significant proportion of the target through onsite solutions. 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 beyond the outline towards submission of reserved matter planning applications.

The options adopt a strategic approach appropriate for an outline application. Refinement and optimisation of the options will continue to progress during the detailed design stages and subsequent Reserved Matters Applications.

The preferred energy strategy is comprised of two key stages. Firstly, meeting the carbon compliance target and secondly, achieving zero carbon. The section below identifies the **preferred approach to achieve the carbon compliance** and sets a series of **options to achieve zero carbon**:

1. Carbon Compliance Target: Site wide building mounted Solar PV to meet 100% of the Carbon Compliance Target.

2. Zero Carbon Target: Options to be considered:

    - Town Centre: Gas CHP plus Allowable Solutions (Type 1) financial contribution for residual emissions

    - Allowable Solution (Type 2): Land based PV array

    - Allowable Solution (Type 2): Medium to Large Scale Wind

    - Allowable Solution (Type 1): Financial contribution

9.1 Carbon Compliance Target: Site wide Solar PV (Roof mounted)

The density of the development, outside of the town centre, makes a site wide DHN and associated LZC technologies (Biomass CHP, Gas CHP) financially unviable due to the extensive pipework costs. As a general rule a density of at least 50 dwellings per hectare is required before a DHN becomes viable. It is therefore recommended that the initial step towards Zero Carbon be achieved through roof mounted PV across the entire development.

The following general assumptions have been made:

- Annual PV output per kWp: 850.00 kWh/year

- PV peak output: 1.25 kWp at 850 kWh
- Typical PV Area per kWp: 10.00 m^2

The following assumptions have been made for the residential aspect:

- Total Available Roof Area: 137,393 m^2 (as per SAP calculations)
- % Roof with PV installed: 26% (space needed to achieve CC)
- Total PV area: 35,722 m^2

The following assumptions have been made for the commercial aspect:

- Total Available Roof Area: 58,239 m^2
- % Roof with PV installed: 26% (space needed to achieve CC)
- Total PV area: 15,142 m^2

Based on these assumptions the following calculations can be made:

Table 9.1: Option 1 Building Mounted Solar PV

All Buildings	Enhanced FEE Emissions
Total Regulated Electricity	5,252,638 kgCO2
Total Regulated Gas	7,132,843 kgCO2
Solar PV generation	- 2,804,841 kgCO2
Sub Total Regulated	**9,580,640 kgCO2**
B'Regs 2013 Baseline	**12,758,034 kgCO2**
Carbon Compliance Target	**9,591,578 kgCO2**

The above table demonstrates that the provision of solar PV to 26% of the available roof space (i.e. circa half of traditional south facing roof) would achieve an approximate reduction of 2,804,841 $KgCO_2$. This reduces the regulated emissions to **9,580,640 $kgCO_2$** which is beyond the Carbon Compliance target of 9,591,578 $kgCO_2$. This also represents a 25% reduction on the Building Regulations 2013 baseline emissions which exceeds the 10% reduction required by the emerging policy CC/3 of the Proposed Submission Local Plan.

9.2 Zero Carbon Target Options

Following the initial reductions achieved through fabric enhancements and roof mounted Solar PV a further reduction of 9,580,640 $kgCO_2$ is required in order to reach the Zero Carbon target.

Whilst preference has been given to on-site reductions in CO_2 emissions and low carbon/renewable energy generation, it is recognised by the government that it is often technically and economically unviable to achieve 100% of the Zero Carbon Target through onsite solutions. The Governments Zero Carbon framework therefore makes provision for 'Allowable Solutions', enabling the remaining CO_2 emissions to be achieved through alternative measures outside the scope of SAP and SBEM assessment procedures.

It should be noted however that technological solutions located outside of the application boundary would need to be taken forward as a standalone scheme.

Zero Carbon Hub recommendations on framework structure and how Allowable Solutions might be selected are currently under Government consideration (as discussed in Section 3.4). However it is expected that the initial choice for developers will be either:

1. To pay into a carbon fund (Type 1 Allowable Solution). Here the payments from developers would be accumulated and the fund manager will take responsibility for investing in suitable Allowable Solutions projects - a wide range of carbon-saving projects could qualify as Allowable Solutions. It is expected that Local Planning Authorities will have the option to set up carbon funds and may establish local priorities for particular Allowable Solutions.

2. To invest in carbon-saving projects associated directly with their own developments (Type 2 Allowable Solution). These would include on-site, near site and off-site solutions.

Evidence of Allowable Solutions will be required to be submitted as part of the Building Control Approval for Compliance with Building Regulations (2016). This Energy Statement provides a series of options, presented below, that will be further investigated in respect to meeting the future 2016 Building Regulation. It is envisaged that the selection of which, or combination of options, will either form separate planning applications or come forward as part of reserved matter applications. The options are not presented in order of preference.

Given the site constraints the options outlined below are considered to be the most practical, economical and low risk.

9.2.1 Option 1 – Town Centre Gas CHP District Heat Network + Allowable Solutions: financial contribution (Type 1)

It is the Applicant's intention that the economic and technical viability of utilising district heating, including the provision of CHP, for the town centre be explored. This will incorporate various relevant factors, with a particular focus on:

- The possible CO_2 reductions
- The capital costs
- The running costs.
- Acceptability and long term security

Below is an indicative assessment of the potential CO_2 reductions expected following provision of a Gas CHP DHN to the town centre, which assumes circa 692 dwellings (apartments) and mixed use commercial, educational and employment uses.

Within the town centre the initial carbon reductions are achieved through energy efficiency enhancements (as applied throughout the development); with the resultant carbon emissions as follows:

- BR 2013 Baseline: 7,960,792 $kgCO_2$
- Be Lean Enhancements: 7,875,448 $kgCO_2$

Installing a GAS CHP driven DHN to meet 100% hot water demands and 80% of the space heating demands will reduce the carbon emissions by approximately 5,919,435 $KgCO_2$ to 1,956,013 $KgCO_2$.

The provision of roof mounted PV to 26% of the available roof space, as outlined previously, reduces the town centre carbon emissions by a further 886,253 $KgCO_2$ to 1,069,760 $KgCO_2$.

This means that the remaining Phase 2 site wide emissions, following the implementation of this option to the town centre, would therefore be **3,661,205 $KgCO_2$ (3,661 tonnes)**.

The most likely means of achieving the remaining carbon reductions would be either:

1. Type 1 - Payment based on pounds (£) per tonne of CO_2 for 30 years:

   The table below demonstrates the potential residual Type 1 Allowable Solutions cost following application of Town Centre Gas CHP driven DHN:

   Table 9.2: Potential Residual Type 1 Allowable Solutions Cost

AS Rate	Cost (£)
@ **£60/tonne for 30 yrs**	**£6,590,169**
@ **£90/tonne for 30 yrs**	**£9,885,254**

2. 'Near-Site' option – such as land based Solar PV.

   If this were to be a large scale land based Solar PV array then a total space of circa 16.6ha would be required to achieve the remaining 3,661,205 KgCO2 emissions reduction. This is based upon a provision of 6.64ha of Solar PV and spacing at a ratio of 1: 2.5.

9.2.2 Option 2 – Allowable Solution (Type 2): Land based PV array

The following general assumptions have been made with regards to a Land Based PV Array:

- Annual PV output per kWp: 850.00 kWh/year
- PV peak output: 1.25 kWp at 850 kWh
- Typical PV Area per kWp: 10.00 m^2
- Total land required: spacing ratio of 1: 2.5 to enable suitable spacing and prevent overshadowing.

Following application of energy efficiency measures and installation of roof mounted PV to 26% of available roof space, the remaining regulated emissions to meet the Zero Carbon target will be 9,580,640 $kgCO_2$.

Based upon these assumptions the savings per hectare is estimated at **551,438 $kgCO_2$**. This means that approximately **43.43ha** of land would be required to achieve the Zero Carbon target ((9,580,640 $kgCO_2$ / 551,438 $kgCO_2$) x 2.5)).

9.2.3 Option 3 – Allowable Solution (Type 2): Medium to Large Scale Wind

Following application of energy efficiency measures and installation of roof mounted PV to 26% of available roof space, the remaining regulated emissions to meet the Zero Carbon target will be 9,580,640 kgCO2.

Medium Scale Wind

The following general assumptions have been made with regards to medium scale wind energy potential:

- Wind Turbine Total Capacity: 800 kWp (medium scale turbine)
- Available at wind speed of 7 m/s: 180 kWp
- Guarantee Availability 97%
- Operational hours 8760

Based upon these assumptions the total electricity generation potential per medium scale wind turbine is 1,529,496 kWh. This equates to a saving of **793,808 kgCO_2** which represents **8.3%** of the total reductions required to achieve the Zero Carbon Target. Over **12 medium turbines** would therefore be required.

Large Scale Wind

The following general assumptions have been made with regards to a large scale wind energy potential:

- Wind Turbine Total Capacity: 3000 kWp
- Available at wind speed of 7 m/s: 532 kWp
- Guarantee Availability 97%
- Operational hours 8760

Based upon these assumptions the total electricity generation potential per turbine is 4,520,510 kWh. This equates to a saving of **2,346,145 kgCO_2** which represents **24.49%** of the total reductions required to achieve the Zero Carbon Target. Over **4 large turbines** would therefore be required.

9.2.4 Option 4 – Allowable solutions: financial contribution (Type 1)

This option considers that the remainder of the regulated carbon emissions associated with the development may be dealt with through the use of Type 1 Allowable Solutions whereby each kg CO2 emitted per annum must be off-set by an appropriate financial contribution to either the CIL fund, Community Energy Fund (CEF) or some other energy related fund. This recognises that in some instances it may not be either technically or economically feasible to achieve the savings through application of technology alone and therefore a financial contribution may be made instead.

Following application of energy efficiency measures and installation of roof mounted PV to 26% of the available roof space, the remaining regulated emissions to meet the Zero Carbon target will be 9,580,640 kgCO2.

The payment required to off-set the above remaining emissions, based on two pricing scenarios, are provided in the table below:

Table 9.3: Allowable Solutions Cost

AS Rate	Cost (£)
@ £60/tonne for 30 yrs	£17,245,153
@ £90/tonne for 30 yrs	£25,867,729

10 Summary

This energy strategy has been prepared to ensure that Phase 2 of the Northstowe development meets the sustainability aspirations and key development priorities, Building Regulations requirements and planning targets. The following local and national energy requirements were deemed relevant:

Policy	Document	Requirement
NE/1 Energy Efficiency	LDF Development Control Policies DPD, Adopted 2007	10% CO_2 reduction from 2006 Building Regulations
NE/3 Renewable	LDF Development Control Policies DPD, Adopted 2007	10% energy provided by on-site renewable technology
NS/23 An Exemplar in Sustainability	LDF Northstowe Area Action Plan DPD, Adopted July 2007	Aspiration to achieve 20% of predicted energy needs from renewable technology
CC/3: Renewable and Low Carbon Energy in New Developments	Proposed Submission Local Plan, 2011-2031 (not yet adopted)	10% CO_2 reduction from 2013 Building Regulations through onsite renewable energy technologies
CSH Level 4 – Ene 1 Dwelling Emission Rate	CSH 2010 Technical Note	25% improvement on 2010 Building Regulations
BREEAM Very Good rating	BREEAM New Construction 2011	No minimum requirement for Very Good
Building regulations	Building regulations 2016	Zero Carbon from regulated energy

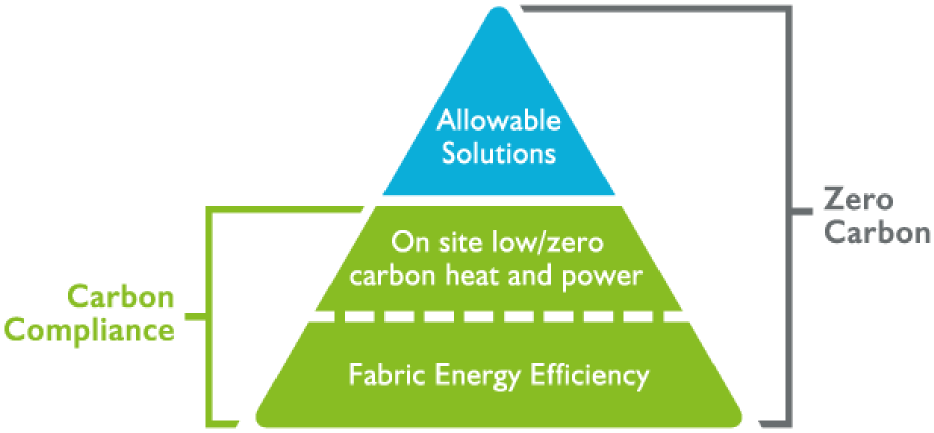
A fundamental premise of the energy strategy is that the development will be post implementation of the 2016 Building Regulations; which are set to implement zero carbon buildings standards as described in section 3.

As such, this strategy has adopted the approach advocated by the ZCH relative to future energy demand reduction targets and approaches relative to achieving zero carbon emissions:

1. Mandatory Fabric Energy Efficiency (FEE) Level – To ensure energy efficiency by energy efficient building design.

2. Mandatory onsite Carbon Compliance Level – To ensure energy efficiency by energy efficient building design and to reduce carbon emissions through on-site low carbon and renewable energy technologies and near-site heat networks.

3. Mitigate the remaining carbon emissions through use of ‘Allowable Solutions’.



To enable this the carbon compliance and allowable solution targets for the development have been calculated; as follows:

All Buildings	BR2013 Baseline Emissions	Carbon Compliance Target	Zero Carbon Homes Target
Total Regulated Electricity	5,252,638 kgCO2	4,054,175 kgCO2	0 kgCO2
Total Regulated Gas	7,505,396 kgCO2	5,537,403 kgCO2	0 kgCO2
Total Regulated	**12,758,034 kgCO2**	**9,591,578 kgCO2**	**0 kgCO2**

These targets, when combined, achieve zero carbon (regulated energy). To meet these targets the proposed strategy follows the energy hierarchy principles below:

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

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

3. **Be Green:** Use renewable energy systems.

10.1 Fabric Energy Efficiency Standard

The standards outlined within this statement surpass the FEES set by the ZCH and result in reduced energy demand and carbon emissions. The table below gives the breakdown of energy consumption and carbon emissions for space heating, hot water, lighting, pumps and fans (regulated energy) for domestic buildings and non-domestic units.

All Buildings	Enhanced FEE Demand	Enhanced FEE Emissions
Total Regulated Electricity	10,120,690 kWh	5,252,638 kgCO2
Total Regulated Gas	33,022,422 kWh	7,132,843 kgCO2
Sub Total Regulated	**43,143,112 kWh**	**12,385,481 kgCO2**
B'Regs 2013 Baseline	**44,867,895 kWh**	**12,758,034 kgCO2**
Carbon Compliance Target	**33,447,636 kWh**	**9,591,578 kgCO2**

By adopting enhanced fabric efficiency standards in all residential dwellings, the total energy demand across the site is reduced by circa 2.5% (comprising a 4% improvement in residential dwelling thermal demand). This reduces the sites carbon emission by 1.5% (again from a 4% reduction in carbon emissions arising from residential thermal demand).

The 1.5% improvement in emissions over Building Regulations (2013) equates to an approximate reduction of 30% over Building Regulations (2006). The emissions reductions secured through improvements to the fabric energy efficiency are therefore substantially greater than the 10% required by Policy NE/1 of the LDF Development Control Policies DPD (2007).

10.2 Carbon Compliance Target

Having achieved the FEES Target the statement then outlines different means of achieving the Carbon Compliance Target. Whilst the options 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. It is recognised, however, that irrespective of whichever strategic approach and energy options are recommended, the implementation strategy must be flexible and adaptive to the development, shifting economic incentives and models, and evolving technologies.

The density of the development, outside of the town centre, makes a site wide DHN and associated LZC technologies (Biomass CHP, Gas CHP) financially unviable due to the extensive pipework costs. It is therefore recommended that the initial step towards Zero Carbon be achieved through roof mounted PV to the entire development.

The provision of Solar PV to 26% of the available roof space would generate 5,404,318 kWh of energy. This would meet 12.5% of the regulated energy demand of the development which surpasses the 10% requirement of Policy NE/3 (Renewable) of the LDF Development Control Policies DPD (Adopted 2007). It would also reduce the Northstowe regulated emissions by 2,804,841 KgCO_2 to **9,580,640 kgCO_2** which is beyond the Carbon Compliance Target of 9,591,578 kgCO_2. This represents a 20% reduction in CO_2 which is beyond the 10% requirement of the emerging policy CC/3 of the Proposed Submission Local Plan.

All Buildings	Enhanced FEE Emissions
Total Regulated Electricity	5,252,638 kgCO2
Total Regulated Gas	7,132,843 kgCO2
Solar PV generation	- 2,804,841 kgCO2
Sub Total Regulated	**9,580,640 kgCO2**
B'Regs 2013 Baseline	**12,758,034 kgCO2**
Carbon Compliance Target	**9,591,578 kgCO2**

10.3 Achieving Zero Carbon

Following the initial reductions achieved through roof mounted Solar PV a further reduction of 9,580,640 kgCO_2 is required in order to reach the Zero Carbon target. The client has the option to achieve this through further onsite technological additions, Allowable Solutions or a combination of the two; as identified below:

a) Town Centre: Gas CHP with remaining reductions to be achieved through allowable solutions

b) Type 2 Allowable Solution: Land based PV array

c) Type 2 Allowable Solution: Medium to Large Scale Wind

d) Type 1 Allowable solutions

The density of the Town Centre would reduce installation costs of a DHN significantly. The Town Centre is also mixed use, containing a variety of residential and non-residential buildings which would enable any CHP system to work at full capacity for longer periods and therefore more efficiently. This would reduce CO_2 emissions significantly within the Town Centre and reduce the dependence on allowable solutions for the remainder of the site.

Installing a GAS CHP driven DHN to meet 100% hot water demands and 80% of the space heating demands (option a) would reduce the carbon emissions by approximately 5,919,435 KgCO_2. The remaining site wide emissions to be met through allowable solutions, following the implementation of this option to the Town Centre, would be 3,661,205 KgCO_2 (3,661 tonnes).

Whilst the definition and methodology for the provision of Allowable Solutions is still in its infancy this statement provides an estimate of the land requirements for a potential Solar PV farm contribution for options a and b above. This would be 16.60ha (option a) and 43.43ha (option b) respectively. Utilising Solar PV for the Type 2 Allowable Solutions contribution would assist the development in meeting the aspirational target within policy NS/23 (An Exemplar in Sustainability) of the LDF Northstowe Area Action Plan DPD to achieve 20% of predicted energy needs from renewable technology.

Medium to large scale wind turbines (option c) would be a viable means of achieving the Zero Carbon Target however comes with significant planning risk due to the significant adverse visual and acoustic impacts on the surrounding area. Over 12 medium scale turbines or 4 large scale turbines would be the minimum requirement.

10.4 Northstowe Phase 2 Proposals

The table below provides a summary of the development requirements and the proposals to address them.

	Requirement	Northstowe Proposals
Policy Target	10% CO_2 reduction on 2006 B'regs through FEES	32% CO_2 reduction from 2006 Building Regulations
	10% energy provided by on-site renewable technology	Minimum of 12% regulated energy provided by on-site renewable technology (based upon PV to 26% of available roof space)
	10% CO_2 reduction through on-site renewable technology	25% CO_2 reduction provided by on-site renewable technology
	CSH Level 4: 25% improvement on 2010 Building Regulations	100% reduction (Zero Carbon)
	BREEAM Very Good: No minimum requirement	100% reduction (Zero Carbon)
Policy Aspiration	Aspiration to achieve 20% of predicted energy needs from renewable technology	Potential Near Site Land Based PV farm would increase renewables provision to exceed 20% aspirational target
Building regulations	Zero Carbon from regulated energy	FEES and Carbon Compliance targets met. Viability study to be undertaken for Town Centre DHN. Remaining reductions through Allowable Solutions.

The Energy Statement has adopted a strategic approach appropriate for an outline application. Refinement and optimisation of the options will continue to progress during the detailed design stages and subsequent Reserved Matters Applications.

Appendices

Appendix A: Roof Mounted Solar PV Calculations

Solar PV									
Annual PV output per kWp	850.00	kWh/year							
PV peak output	1.25	kWp at 850 kWh							
Typical PV Area per kWp	10.00	m2							
Residentail Solar PV Energy Potential				**Commercial Solar PV Energy Potential**					
Total Available Roof Area	137,393	m2		Total Available Roof Area	58,239	m2		137.3925317	
% of available Roof for PV	26%			% of available Roof for PV	26%				
Total available PV area	35,722	m2		Total available PV area	15,142	m2		50,864	m2
Total PV Installed capacity	4,465	kWp		Total PV Installed capacity	1,893	kWp			
Total annual output from PV	3,795,469	kWh/year		Total annual output from PV	1,608,849	kWh/year		5,404,318	kWh/year
Total Annual Solar PV Energy Generation				Total Annual Solar PV Energy Generation				**Total**	
Capacity For Residential Development	3,795,468.69	kWh/year		Capacity For Commercial Development	1,608,849	kWh/year		5,404,317.99	
Regulated Electricity Demand	1,685,748.75	kWh/year		Regulated Electricity Demand	8,434,942	kWh/year		10,120,690.42	
Un Regulated Electricity Demand	10,013,163.59	kWh/year		Un Regulated Electricity Demand	9,269,167	kWh/year		19,282,330.25	
Total Energy Demand	11,698,912.34	kWh/year		Total Energy Demand	17,704,108	kWh/year		29,403,020.67	
% of electricity demand met by Solar PV	**32%**			% of electricity demand met by Solar PV	**9%**			**18.38%**	
%Total Regulated Energy Demand	**225%**			%Total Regulated Energy Demand	**19%**			**53.40%**	
Carbon Savings									
Hence Carbon Savings would be	1,969,848.25	kgCO2		Hence Carbon Savings would be	834,993	kgCO2		2,804,841.04	
	1,970	tonnesCO2			835	tonnesCO2		2,805	tonnesCO2
total Regulated Emissions	4,968	tonnes		total Regulated Emissions	7417.72	tonnes		12,385	tonnesCO4
total Emissions	10,724	tonnes		total Emissions	13080.10	tonnes		23,804	tonnesCO5
% total Regulated Emissions	40%			% total Regulated Emissions	11%			23%	
% total Emissions	18%			% total Emissions	6%			12%	
Grid Supplied Electricity CO2 factor	*0.519*	*kgCO2/kWh*							

Appendix B: Town Centre CHP Calculations

CIBSE Method Calculations

Without CHP

Electricity Demand (P)	8,554,776	kWh
Electricity Emissions (P X Pf - electric emissions)	4,439,928.72	kgCO2
Thermal Demand (H)	15,905,180	kWh
Thermal Emissions (H X Hf - gas emissions)	3,435,518.95	kgCO2
Total Emissions without CHP	**7,875,448**	**kgCO2**
	7,875	**tonnes**

With CHP

Electricity Demand (P)	8,554,776	kWh
Thermal Demand (H)	15,905,180	kWh
Heat Generation from CHP (H_{CHP})	13,306,593	kWh
($H-H_{CHP}$) Heat (Demand - Generation)	2,598,587	kWh
[($H-H_{CHP}$)/η_{boiler} X $E_{f,boiler}$]	561,294.90	kgCO2
F_{CHP} - Gas Fuel to run CHP	11,420,387	kWh
(F_{CHP} X $E_{f,CHP}$) - Gas fuel X fuel factor	182,726.19	kgCO2
Electricity Generated from CHP (P_{CHP})	6,336,473	kWh
($P-P_{CHP}$) Elect. (Demand - Generation)	2,218,303	kWh
($P-P_{CHP}$)X electricity fuel factor	1,151,299.34	kgCO2
Total Emissions with CHP	**1,895,320**	**kgCO2**
	1,895	**tonnes**

Difference between the Emissions to estimate the savings

Total CO2 emissions Savings	5,980,127 kgCO2
Total CO2 emissions Savings	5,980 tonnes CO2

Appendix C: SAP Worksheets – Building Regulations Baseline

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 1 Bed - 2 Person - Flat

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	56.1	(1a) x	2.5	(2a) =	140.25	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	56.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	140.25	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.14	(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		5.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.42	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.36	(21)

Infiltration rate modified for monthly wind speed

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

SAP WorkSheet: New dwelling design stage

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

0.45	0.44	0.43	0.39	0.38	0.34	0.34	0.33	0.36	0.38	0.4	0.42

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=	0.6	0.6	0.59	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(24d)

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

(25)m=	0.6	0.6	0.59	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(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	1.1	=	2.2			(26)
Windows			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Floor			56.1	x	0.15	=	8.415			(28)
Walls	50	10.64	39.36	x	0.22	=	8.66			(29)
Total area of elements, m²			106.1							(31)
Party wall			15	x	0	=	0			(32)
Party ceiling			56.1							(32b)

** 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) = 29.95 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 13857.9 (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 5.3 (36)

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

Total fabric heat loss (33) + (36) = 35.26 (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=	27.88	27.7	27.52	26.67	26.51	25.77	25.77	25.64	26.06	26.51	26.83	27.17	(38)

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

(39)m=	63.14	62.96	62.78	61.92	61.77	61.03	61.03	60.89	61.31	61.77	62.09	62.42	

Average = Sum(39)$_{1…12}$ /12= 61.93 (39)

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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=	1.13	1.12	1.12	1.1	1.1	1.09	1.09	1.09	1.09	1.1	1.11	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 1.87 (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 82.74 (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=	91.01	87.7	84.39	81.08	77.77	74.46	74.46	77.77	81.08	84.39	87.7	91.01	

Total = Sum(44)$_{1…12}$ = 992.85 (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=	134.97	118.04	121.81	106.2	101.9	87.93	81.48	93.5	94.62	110.27	120.36	130.71	

Total = Sum(45)$_{1…12}$ = 1301.78 (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=	20.25	17.71	18.27	15.93	15.28	13.19	12.22	14.02	14.19	16.54	18.05	19.61	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (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	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	23.28	20.99	23.19	22.38	23.09	22.29	23.01	23.06	22.34	23.15	22.47	23.26	(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=	158.25	139.04	145	128.58	124.99	110.22	104.49	116.56	116.96	133.41	142.83	153.97	(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=	158.25	139.04	145	128.58	124.99	110.22	104.49	116.56	116.96	133.41	142.83	153.97	

Output from water heater (annual)$_{1…12}$ 1574.29 (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=	50.7	44.5	46.3	40.91	39.65	34.81	32.84	36.85	37.05	42.45	45.64	49.28	(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=	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	37.59	33.39	27.15	20.56	15.37	12.97	14.02	18.22	24.45	31.05	36.24	38.63	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	243.31	245.83	239.47	225.92	208.83	192.76	182.02	179.5	185.86	199.4	216.5	232.57	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	(71)
Water heating gains (Table 5)													
(72)m=	68.14	66.22	62.23	56.81	53.3	48.35	44.14	49.53	51.45	57.06	63.39	66.23	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	437.51	433.91	417.33	391.77	365.97	342.55	328.66	335.73	350.24	375.99	404.61	425.91	(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)

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

(83)m=	56.31	110.14	181.39	264.55	324.22	331.89	315.98	271.42	210.97	130.7	70.21	46.3	(83)

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

(84)m=	493.82	544.06	598.72	656.32	690.18	674.45	644.64	607.15	561.21	506.68	474.81	472.21	(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

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(86)m=	0.99	0.98	0.96	0.89	0.75	0.56	0.41	0.46	0.7	0.92	0.98	0.99	(86)

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

(87)m=	20.05	20.19	20.43	20.72	20.91	20.98	21	21	20.95	20.7	20.33	20.02	(87)

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

(88)m=	19.98	19.98	19.99	20	20	20.01	20.01	20.01	20.01	20	20	19.99	(88)

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

(89)m=	0.99	0.97	0.94	0.86	0.69	0.48	0.32	0.36	0.62	0.89	0.97	0.99	(89)

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

(90)m=	18.74	18.95	19.29	19.69	19.92	20	20.01	20.01	19.97	19.68	19.16	18.71	(90)

fLA = Living area ÷ (4) = | 0.5 | (91)

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

(92)m=	19.39	19.57	19.86	20.2	20.41	20.49	20.5	20.5	20.46	20.19	19.74	19.37	(92)

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

(93)m=	19.39	19.57	19.86	20.2	20.41	20.49	20.5	20.5	20.46	20.19	19.74	19.37	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.98	0.97	0.94	0.86	0.72	0.52	0.37	0.41	0.66	0.9	0.97	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	485.42	528.6	564.05	567.26	496.86	353.34	237.42	248.5	370.29	454.34	460.33	465.6	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	953	923.62	838.8	700.03	538.15	359.61	238.23	249.86	390.06	592.4	784.99	946.66	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	347.88	265.45	204.41	95.59	30.72	0	0	0	0	102.72	233.75	357.91	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = | 1638.43 | (98)

Space heating requirement in kWh/m²/year | 29.21 | (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		89.9	(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)													
	347.88	265.45	204.41	95.59	30.72	0	0	0	0	102.72	233.75	357.91	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	386.96	295.27	227.37	106.33	34.17	0	0	0	0	114.26	260.01	398.12	

Total (kWh/year) =$Sum(211)_{1...5,10....12}$= | 1822.5 | (211)

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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)

158.25	139.04	145	128.58	124.99	110.22	104.49	116.56	116.96	133.41	142.83	153.97

Efficiency of water heater 87.3 (216)

(217)m=	89.07	88.99	88.8	88.39	87.8	87.3	87.3	87.3	87.3	88.41	88.9	89.1	(217)

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

(219)m=	177.66	156.24	163.28	145.47	142.35	126.26	119.69	133.51	133.97	150.9	160.68	172.8

Total = Sum(219a)$_{1...12}$ = 1782.82 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			1822.5	
Water heating fuel used			1782.82	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			265.53	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	63.423	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	62.04	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	35.02	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost (245)...(247) + (250)…(254) = 290.38 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.21	(257)
SAP rating (Section 12)		83.17	(258)

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

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	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	393.66	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	385.09	(264)
Space and water heating	(261) + (262) + (263) + (264) =				778.75	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	137.81	(268)
Total CO2, kg/year			sum of (265)…(271) =		955.48	(272)
CO2 emissions per m²			(272) ÷ (4) =		17.03	(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	1.22	=	2223.45	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	2175.04	(264)
Space and water heating	(261) + (262) + (263) + (264) =				4398.49	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	815.18	(268)
‘Total Primary Energy			sum of (265)…(271) =		5443.92	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		97.04	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 1 Bed - 2 Person - Flat

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	56.1	(1a) x	2.5	(2a) =	140.25	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	56.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	140.25	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.14	(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		5.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.42	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.36	(21)

Infiltration rate modified for monthly wind speed

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

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

0.45	0.44	0.43	0.39	0.38	0.34	0.34	0.33	0.36	0.38	0.4	0.42

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=	0.6	0.6	0.59	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(24d)

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

(25)m=	0.6	0.6	0.59	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(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	1.1	=	2.2			(26)
Windows			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Floor			56.1	x	0.15	=	8.415			(28)
Walls	50	10.64	39.36	x	0.22	=	8.66			(29)
Total area of elements, m²			106.1							(31)
Party wall			15	x	0	=	0			(32)
Party ceiling			56.1							(32b)

** 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) = 29.95 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 13857.9 (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 5.3 (36)

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

Total fabric heat loss (33) + (36) = 35.26 (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=	27.88	27.7	27.52	26.67	26.51	25.77	25.77	25.64	26.06	26.51	26.83	27.17	(38)

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

(39)m=	63.14	62.96	62.78	61.92	61.77	61.03	61.03	60.89	61.31	61.77	62.09	62.42	

Average = Sum(39)$_{1…12}$ /12= 61.93 (39)

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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=	1.13	1.12	1.12	1.1	1.1	1.09	1.09	1.09	1.09	1.1	1.11	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 — 1.87 (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 — 82.74 (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=	91.01	87.7	84.39	81.08	77.77	74.46	74.46	77.77	81.08	84.39	87.7	91.01	

Total = Sum(44)$_{1…12}$ = 992.85 (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=	134.97	118.04	121.81	106.2	101.9	87.93	81.48	93.5	94.62	110.27	120.36	130.71	

Total = Sum(45)$_{1…12}$ = 1301.78 (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=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) — 0 (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	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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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=	114.72	100.34	103.54	90.27	86.61	74.74	69.26	79.48	80.42	93.73	102.31	111.1	(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=	114.72	100.34	103.54	90.27	86.61	74.74	69.26	79.48	80.42	93.73	102.31	111.1	

Output from water heater (annual)$_{1\ldots12}$ 1106.52 (64)

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

(65)m=	28.68	25.08	25.88	22.57	21.65	18.69	17.31	19.87	20.11	23.43	25.58	27.78	(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=	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	15.04	13.35	10.86	8.22	6.15	5.19	5.61	7.29	9.78	12.42	14.5	15.45	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	163.02	164.71	160.44	151.37	139.91	129.15	121.95	120.26	124.53	133.6	145.06	155.82	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	(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=	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	(71)
Water heating gains (Table 5)													
(72)m=	38.55	37.33	34.79	31.34	29.1	25.95	23.27	26.71	27.93	31.49	35.52	37.33	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	267.64	266.43	257.14	241.98	226.21	211.33	201.88	205.3	213.28	228.56	246.12	259.65	(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)

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

(83)m=	56.31	110.14	181.39	264.55	324.22	331.89	315.98	271.42	210.97	130.7	70.21	46.3	(83)

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

(84)m=	323.95	376.58	438.53	506.53	550.42	543.22	517.85	476.72	424.24	359.25	316.32	305.95	(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

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(86)m=	1	1	0.99	0.95	0.86	0.68	0.51	0.57	0.84	0.98	1	1	(86)

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

(87)m=	19.77	19.93	20.2	20.55	20.83	20.96	20.99	20.99	20.89	20.51	20.08	19.75	(87)

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

(88)m=	19.98	19.98	19.99	20	20	20.01	20.01	20.01	20.01	20	20	19.99	(88)

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

(89)m=	1	0.99	0.98	0.94	0.81	0.59	0.4	0.46	0.77	0.97	1	1	(89)

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

(90)m=	18.86	19.02	19.29	19.64	19.88	19.99	20.01	20.01	19.94	19.61	19.18	18.84	(90)

fLA = Living area ÷ (4) = 0.5 (91)

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

(92)m=	19.31	19.47	19.74	20.09	20.36	20.48	20.5	20.5	20.42	20.06	19.63	19.3	(92)

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

(93)m=	19.31	19.47	19.74	20.09	20.36	20.48	20.5	20.5	20.42	20.06	19.63	19.3	(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	0.94	0.83	0.63	0.46	0.52	0.8	0.97	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	323.07	374.24	430.64	475.33	454.87	343.86	235.88	245.56	338.97	347.69	314.55	305.34	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	947.98	917.3	831.24	693.2	534.61	358.75	238.08	249.57	387.2	584.15	777.72	942.33	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	464.93	364.94	298.05	156.87	59.33	0	0	0	0	175.93	333.48	473.92	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2327.44 (98)

Space heating requirement in kWh/m²/year 41.49 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	573.69	451.63	462.78	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.91	0.96	0.94	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	523.78	431.85	433.99	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	705.09	674.11	627.14	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	130.54	180.24	143.7	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 454.49 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

(107)m=	0	0	0	0	0	32.64	45.06	35.93	0	0	0	0

Total = Sum(107) = **113.62** (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = **2.03** (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = **43.51** (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 2 Beds - Flat

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.6	(1a) x	2.6	(2a) =	188.76	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	188.76	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.46	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.39	(21)

Infiltration rate modified for monthly wind speed

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

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

0.5	0.49	0.48	0.43	0.42	0.37	0.37	0.36	0.39	0.42	0.44	0.46

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=	0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.6	0.61	(24d)

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

(25)m=	0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.6	0.61	(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	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Walls	80	11.72	68.28	x	0.22	=	15.02			(29)
Roof	72.6	0	72.6	x	0.14	=	10.16			(30)
Total area of elements, m²			152.6							(31)
Party floor			72.6							(32a)

** 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) = 39.4 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15804.6 (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 7.63 (36)

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

Total fabric heat loss (33) + (36) = 47.03 (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=	38.85	38.55	38.26	36.88	36.62	35.42	35.42	35.2	35.89	36.62	37.14	37.69	(38)

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

(39)m=	85.88	85.58	85.29	83.91	83.65	82.45	82.45	82.23	82.91	83.65	84.17	84.72	

Average = Sum(39)$_{1…12}$ /12= 83.91 (39)

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

(40)m=	1.18	1.18	1.17	1.16	1.15	1.14	1.14	1.13	1.14	1.15	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 — 2.31 (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 — 93.69 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	103.06	99.31	95.56	91.82	88.07	84.32	84.32	88.07	91.82	95.56	99.31	103.06	
											Total = Sum(44)$_{1…12}$ =	1124.28	(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=	152.83	133.67	137.93	120.25	115.39	99.57	92.27	105.88	107.14	124.86	136.3	148.01	
											Total = Sum(45)$_{1…12}$ =	1474.11	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.92	20.05	20.69	18.04	17.31	14.94	13.84	15.88	16.07	18.73	20.44	22.2	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = — 0 (54)

Enter (50) or (54) in (55) — 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	23.41	21.12	23.32	22.49	23.19	22.37	23.08	23.15	22.44	23.26	22.6	23.39	(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=	176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4	(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=	176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4	

Output from water heater (annual)1…12 | 1747.93 | (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=	56.67	49.73	51.69	45.61	44.16	38.7	36.45	40.99	41.23	47.33	50.97	55.06	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	(66)

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

(67)m=	48.22	42.82	34.83	26.37	19.71	16.64	17.98	23.37	31.37	39.83	46.49	49.56	(67)

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

(68)m=	303.42	306.57	298.63	281.74	260.42	240.38	226.99	223.84	231.78	248.67	269.99	290.03	(68)

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

(69)m=	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	(71)

Water heating gains (Table 5)

(72)m=	76.17	74	69.48	63.34	59.36	53.75	48.99	55.1	57.27	63.62	70.79	74.01	(72)

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

(73)m=	528.11	523.69	503.24	471.76	439.79	411.08	394.27	402.61	420.72	452.42	487.57	513.9	(73)

6. Solar gains:

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

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

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

(83)m=	70.31	137.54	226.5	330.34	404.84	414.43	394.55	338.91	263.43	163.2	87.66	57.82	(83)

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

(84)m=	598.41	661.23	729.74	802.09	844.63	825.5	788.82	741.53	684.15	615.62	575.24	571.71	(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

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(86)m=	0.99	0.99	0.97	0.91	0.8	0.61	0.46	0.5	0.75	0.94	0.99	0.99	(86)

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

(87)m=	19.92	20.07	20.32	20.64	20.87	20.97	21	20.99	20.93	20.62	20.22	19.9	(87)

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

(88)m=	19.93	19.94	19.94	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.95	19.95	(88)

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

(89)m=	0.99	0.98	0.96	0.89	0.74	0.53	0.35	0.39	0.67	0.92	0.98	0.99	(89)

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

(90)m=	18.52	18.73	19.1	19.55	19.83	19.95	19.97	19.97	19.91	19.54	18.97	18.5	(90)

fLA = Living area ÷ (4) = 0.31 (91)

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

(92)m=	18.96	19.15	19.48	19.89	20.16	20.27	20.29	20.29	20.23	19.88	19.36	18.94	(92)

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

(93)m=	18.96	19.15	19.48	19.89	20.16	20.27	20.29	20.29	20.23	19.88	19.36	18.94	(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	0.95	0.89	0.75	0.55	0.38	0.43	0.69	0.91	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	590.16	646.02	695.08	710.5	635.42	456.09	302.83	317.37	473.36	562.74	561.09	565.25	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1258.78	1219.58	1106.91	922	707.41	467.78	304.3	319.91	508.19	776.42	1032.16	1248.36	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	497.46	385.44	306.4	152.28	53.56	0	0	0	0	158.98	339.18	508.23	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2401.52 (98)

Space heating requirement in kWh/m²/year 33.08 (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		89.9	(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)													
	497.46	385.44	306.4	152.28	53.56	0	0	0	0	158.98	339.18	508.23	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	553.34	428.74	340.82	169.39	59.58	0	0	0	0	176.84	377.28	565.33	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 2671.33 (211)

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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)

176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4

Efficiency of water heater 87.3 (216)

(217)m=	89.2	89.14	88.99	88.62	88.01	87.3	87.3	87.3	87.3	88.63	89.05	89.23	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	197.57	173.65	181.21	161.07	157.45	139.68	132.13	147.8	148.43	167.14	178.43	192.09

Total = Sum(219a)$_{1...12}$ = 1976.65 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		2671.33	
Water heating fuel used		1976.65	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		340.6	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year		**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211)	x	3.48	x 0.01 =	92.9621	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		3.48	x 0.01 =	68.79	(247)
Pumps, fans and electric keep-hot	(231)		13.19	x 0.01 =	9.89	(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)		13.19	x 0.01 =	44.93	(250)
Additional standing charges (Table 12)					120	(251)

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

Total energy cost (245)...(247) + (250)…(254) = 336.57 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.2	(257)
SAP rating (Section 12)		83.23	(258)

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

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	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	577.01	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	426.96	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1003.96	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	176.77	(268)
Total CO2, kg/year			sum of (265)…(271) =		1219.66	(272)
CO2 emissions per m²			(272) ÷ (4) =		16.8	(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	1.22	=	3259.02	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	2411.51	(264)
Space and water heating	(261) + (262) + (263) + (264) =				5670.53	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1045.65	(268)
‘Total Primary Energy			sum of (265)…(271) =		6946.43	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		95.68	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 2 Beds - Flat

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.6	(1a) x	2.6	(2a) =	188.76	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	188.76	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.46	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.39	(21)

Infiltration rate modified for monthly wind speed

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

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

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

0.5	0.49	0.48	0.43	0.42	0.37	0.37	0.36	0.39	0.42	0.44	0.46

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=	0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.6	0.61	(24d)

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

(25)m=	0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.6	0.61	(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	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Walls	80	11.72	68.28	x	0.22	=	15.02			(29)
Roof	72.6	0	72.6	x	0.14	=	10.16			(30)
Total area of elements, m²			152.6							(31)
Party floor			72.6							(32a)

** 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) =	39.4	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	15804.6	(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		7.63	(36)

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

Total fabric heat loss	(33) + (36) =	47.03	(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=	38.85	38.55	38.26	36.88	36.62	35.42	35.42	35.2	35.89	36.62	37.14	37.69	(38)

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

(39)m=	85.88	85.58	85.29	83.91	83.65	82.45	82.45	82.23	82.91	83.65	84.17	84.72	

Average = Sum(39)$_{1…12}$ /12= 83.91 (39)

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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=	1.18	1.18	1.17	1.16	1.15	1.14	1.14	1.13	1.14	1.15	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 2.31 (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 93.69 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)														
(44)m=	103.06	99.31	95.56	91.82	88.07	84.32	84.32	88.07	91.82	95.56	99.31	103.06		
												Total = Sum(44)$_{1…12}$ =	1124.28	(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=	152.83	133.67	137.93	120.25	115.39	99.57	92.27	105.88	107.14	124.86	136.3	148.01		
												Total = Sum(45)$_{1…12}$ =	1474.11	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	0	0	0	0	0	0	0	0	0	0	0	0		(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (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	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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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=	129.91	113.62	117.24	102.22	98.08	84.63	78.43	90	91.07	106.13	115.85	125.81	(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=	129.91	113.62	117.24	102.22	98.08	84.63	78.43	90	91.07	106.13	115.85	125.81	

Output from water heater (annual)$_{1...12}$ 1252.99 (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=	32.48	28.4	29.31	25.55	24.52	21.16	19.61	22.5	22.77	26.53	28.96	31.45	(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=	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	(66)

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

(67)m=	19.29	17.13	13.93	10.55	7.88	6.66	7.19	9.35	12.55	15.93	18.59	19.82	(67)

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

(68)m=	203.29	205.4	200.08	188.77	174.48	161.05	152.08	149.98	155.29	166.61	180.89	194.32	(68)

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

(69)m=	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	(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=	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	(71)

Water heating gains (Table 5)

(72)m=	43.65	42.27	39.4	35.49	32.96	29.39	26.35	30.24	31.62	35.66	40.23	42.27	(72)

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

(73)m=	323.84	322.41	311.02	292.42	272.94	254.71	243.24	247.18	257.07	275.82	297.33	314.03	(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)

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

(83)m=	70.31	137.54	226.5	330.34	404.84	414.43	394.55	338.91	263.43	163.2	87.66	57.82	(83)

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

(84)m=	394.15	459.95	537.53	622.76	677.78	669.14	637.8	586.09	520.5	439.01	384.99	371.85	(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

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

(86)m=	1	1	0.99	0.96	0.89	0.72	0.55	0.62	0.87	0.98	1	1	(86)

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

(87)m=	19.66	19.82	20.09	20.46	20.77	20.94	20.99	20.98	20.85	20.43	19.98	19.64	(87)

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

(88)m=	19.93	19.94	19.94	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.95	19.95	(88)

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

(89)m=	1	1	0.99	0.95	0.84	0.63	0.43	0.49	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=	18.71	18.87	19.15	19.52	19.8	19.95	19.97	19.97	19.88	19.5	19.05	18.71	(90)

fLA = Living area ÷ (4) = 0.31 (91)

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

(92)m=	19.01	19.17	19.44	19.82	20.11	20.26	20.29	20.28	20.18	19.79	19.34	19	(92)

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

(93)m=	19.01	19.17	19.44	19.82	20.11	20.26	20.29	20.28	20.18	19.79	19.34	19	(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	0.99	0.95	0.85	0.66	0.47	0.53	0.82	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	393.24	457.6	529.52	590.69	575.23	441.03	300.27	312.62	427.49	427.29	383.22	371.22	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1263.26	1220.92	1103.89	916.01	703.09	466.49	304.05	319.45	504.28	768.87	1030.51	1253.73	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	647.29	512.95	427.33	234.24	95.13	0	0	0	0	254.14	466.05	656.59	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3293.73 (98)

Space heating requirement in kWh/m²/year 45.37 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	775.05	610.14	624.93	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.88	0.93	0.91	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	681.19	570.06	568.56	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	868.11	829.8	770.89	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	134.58	193.25	150.54	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 478.36 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104) = 0 (106)

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

(107)m=	0	0	0	0	0	33.65	48.31	37.63	0	0	0	0

Total = Sum(107) = 119.59 (107)

Space cooling requirement in kWh/m²/year	(107) ÷ (4) =	1.65	(108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency	(99) + (108) =	47.02	(109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**

Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 2 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	45.42	(1a)	x	2.6	(2a)	=	118.09	(3a)
First floor	45.42	(1b)	x	2.6	(2b)	=	118.09	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	90.84	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	236.18	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.13	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.43	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.36	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

	0.46	0.45	0.44	0.4	0.39	0.34	0.34	0.34	0.36	0.39	0.41	0.43

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=	0.61	0.6	0.6	0.58	0.58	0.56	0.56	0.56	0.57	0.58	0.58	0.59	(24d)

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

(25)m=	0.61	0.6	0.6	0.58	0.58	0.56	0.56	0.56	0.57	0.58	0.58	0.59	(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	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Floor			45.42	x	0.15	=	6.813			(28)
Walls	93.6	14.6	79	x	0.22	=	17.38			(29)
Roof	45.42	0	45.42	x	0.14	=	6.36			(30)
Total area of elements, m²			184.44							(31)
Party wall			52	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) =	48.32	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	21165.28	(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		9.22	(36)

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

Total fabric heat loss	(33) + (36) =	57.54	(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=	47.32	47	46.68	45.18	44.9	43.6	43.6	43.37	44.11	44.9	45.47	46.06	(38)

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

(39)m=	104.86	104.54	104.22	102.73	102.45	101.14	101.14	100.91	101.65	102.45	103.01	103.61

Average = Sum(39)$_{1...12}$ /12= 102.73 (39)

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

(40)m=	1.15	1.15	1.15	1.13	1.13	1.11	1.11	1.11	1.12	1.13	1.13	1.14

Average = Sum(40)$_{1...12}$ /12= 1.13 (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 2.64 (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) + 36 101.92 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	112.12	108.04	103.96	99.89	95.81	91.73	91.73	95.81	99.89	103.96	108.04	112.12

Total = Sum(44)$_{1...12}$ = 1223.1 (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=	166.27	145.42	150.06	130.82	125.53	108.32	100.38	115.18	116.56	135.84	148.28	161.02

Total = Sum(45)$_{1...12}$ = 1603.68 (45)

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

(46)m=	24.94	21.81	22.51	19.62	18.83	16.25	15.06	17.28	17.48	20.38	22.24	24.15	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	23.47	21.18	23.4	22.58	23.27	22.44	23.14	23.22	22.52	23.34	22.66	23.45	(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=	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47	(62)

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

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

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47

Output from water heater (annual)$_{1...12}$ | 1878.34 | (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=	61.15	53.65	55.74	49.14	47.56	41.63	39.16	44.1	44.39	51	54.97	59.4	(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=	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	(66)

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

(67)m=	56.64	50.31	40.92	30.98	23.15	19.55	21.12	27.46	36.85	46.79	54.61	58.22	(67)

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

(68)m=	359.12	362.85	353.46	333.47	308.23	284.51	268.67	264.94	274.33	294.32	319.56	343.28	(68)

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

(69)m=	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	(71)

Water heating gains (Table 5)

(72)m=	82.19	79.83	74.92	68.26	63.92	57.82	52.64	59.28	61.65	68.55	76.34	79.84	(72)

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

(73)m=	607.16	602.19	578.5	541.9	504.5	471.08	451.62	460.87	482.03	518.86	559.71	590.54	(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)

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

(83)m=	82.11	160.63	264.53	385.8	472.82	484.01	460.8	395.82	307.66	190.6	102.38	67.52	(83)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(84)m=	689.27	762.82	843.03	927.7	977.32	955.09	912.42	856.69	789.69	709.46	662.1	658.06	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.99	0.98	0.93	0.83	0.65	0.48	0.53	0.78	0.95	0.99	1	(86)

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

(87)m=	19.9	20.04	20.29	20.61	20.85	20.97	20.99	20.99	20.91	20.6	20.19	19.88	(87)

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

(88)m=	19.96	19.96	19.96	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.97	19.97	(88)

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

(89)m=	0.99	0.99	0.97	0.91	0.77	0.56	0.37	0.42	0.7	0.93	0.99	0.99	(89)

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

(90)m=	18.51	18.72	19.07	19.53	19.84	19.97	19.99	19.99	19.92	19.52	18.95	18.48	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	18.81	19.01	19.34	19.76	20.06	20.19	20.21	20.21	20.14	19.76	19.22	18.79	(92)

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

(93)m=	18.81	19.01	19.34	19.76	20.06	20.19	20.21	20.21	20.14	19.76	19.22	18.79	(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	0.9	0.78	0.58	0.4	0.44	0.72	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	682.1	749.16	810.57	837.34	758.79	549.27	363.14	380.97	566.29	658.73	649.45	652.47	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1521.97	1474.78	1338.25	1116.12	856.29	565.32	365.07	384.35	613.89	938.49	1248.94	1511.52	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	624.86	487.61	392.59	200.72	72.54	0	0	0	0	208.14	431.63	639.14	

Total per year (kWh/year) = Sum(98)1...5,9...12 = 3057.24 (98)

Space heating requirement in kWh/m²/year — 33.66 (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)

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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)														
	624.86	487.61	392.59	200.72	72.54	0	0	0	0	208.14	431.63	639.14		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)														(211)
	672.61	524.88	422.6	216.06	78.09	0	0	0	0	224.05	464.62	687.99		
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													3290.9	(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)	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47		
Efficiency of water heater													87.3	(216)
(217)m=	89.28	89.22	89.09	88.75	88.14	87.3	87.3	87.3	87.3	88.75	89.15	89.3		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	212.52	186.72	194.71	172.84	168.83	149.79	141.49	158.54	159.31	179.34	191.75	206.56		
Total = Sum(219a)$_{1...12}$ =													2122.38	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3290.9	
Water heating fuel used		2122.38	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		400.14	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	114.5232	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	73.86	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	52.78	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost	(245)...(247) + (250)…(254) =	371.05	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.15	(257)
SAP rating (Section 12)		84	(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	0.216	=	710.83	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	458.43	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1169.27	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	207.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		1415.86	(272)
CO2 emissions per m²		(272) ÷ (4) =		15.59	(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	1.22	=	4014.89	(261)
Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	1.22	=	2589.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =			6604.2	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	230.25	(267)
Electricity for lighting	(232) x	0	=	1228.42	(268)
'Total Primary Energy		sum of (265)…(271) =		8062.87	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		88.76	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 2 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	45.42	(1a) x	2.6	(2a) =	118.09	(3a)
First floor	45.42	(1b) x	2.6	(2b) =	118.09	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	90.84	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		236.18	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.13	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.43	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.36	(21)

Infiltration rate modified for monthly wind speed

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

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.46	0.45	0.44	0.4	0.39	0.34	0.34	0.34	0.36	0.39	0.41	0.43

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=	0.61	0.6	0.6	0.58	0.58	0.56	0.56	0.56	0.57	0.58	0.58	0.59	(24d)

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

(25)m=	0.61	0.6	0.6	0.58	0.58	0.56	0.56	0.56	0.57	0.58	0.58	0.59	(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	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Floor			45.42	x	0.15	=	6.813			(28)
Walls	93.6	14.6	79	x	0.22	=	17.38			(29)
Roof	45.42	0	45.42	x	0.14	=	6.36			(30)
Total area of elements, m²			184.44							(31)
Party wall			52	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) = 48.32 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 21165.28 (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 9.22 (36)

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

Total fabric heat loss (33) + (36) = 57.54 (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=	47.32	47	46.68	45.18	44.9	43.6	43.6	43.37	44.11	44.9	45.47	46.06	(38)

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

(39)m=	104.86	104.54	104.22	102.73	102.45	101.14	101.14	100.91	101.65	102.45	103.01	103.61	

Average = Sum(39)$_{1...12}$ /12= 102.73 (39)

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

(40)m=	1.15	1.15	1.15	1.13	1.13	1.11	1.11	1.11	1.12	1.13	1.13	1.14	

Average = Sum(40)$_{1...12}$ /12= 1.13 (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 2.64 (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) + 36 101.92 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	112.12	108.04	103.96	99.89	95.81	91.73	91.73	95.81	99.89	103.96	108.04	112.12	

Total = Sum(44)$_{1...12}$ = 1223.1 (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=	166.27	145.42	150.06	130.82	125.53	108.32	100.38	115.18	116.56	135.84	148.28	161.02	

Total = Sum(45)$_{1...12}$ = 1603.68 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	141.33	123.61	127.55	111.2	106.7	92.07	85.32	97.91	99.08	115.46	126.04	136.87	(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=	141.33	123.61	127.55	111.2	106.7	92.07	85.32	97.91	99.08	115.46	126.04	136.87

Output from water heater (annual)$_{1…12}$	1363.13	(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=	35.33	30.9	31.89	27.8	26.68	23.02	21.33	24.48	24.77	28.87	31.51	34.22	(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=	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	22.66	20.12	16.37	12.39	9.26	7.82	8.45	10.98	14.74	18.72	21.84	23.29	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	240.61	243.11	236.82	223.42	206.51	190.62	180.01	177.51	183.8	197.2	214.1	230	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	(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=	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	(71)
Water heating gains (Table 5)													
(72)m=	47.49	45.98	42.86	38.61	35.85	31.97	28.67	32.9	34.4	38.8	43.76	45.99	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	373.31	371.77	358.6	336.98	314.18	292.97	279.68	283.95	295.5	317.27	342.27	361.83	(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)

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

(83)m=	82.11	160.63	264.53	385.8	472.82	484.01	460.8	395.82	307.66	190.6	102.38	67.52	(83)

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

(84)m=	455.43	532.4	623.13	722.78	787	776.98	740.48	679.77	603.16	507.86	444.65	429.35	(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	0.9	0.75	0.58	0.65	0.89	0.99	1	1	(86)

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

(87)m=	19.66	19.81	20.08	20.44	20.75	20.94	20.99	20.98	20.83	20.41	19.98	19.64	(87)

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

(88)m=	19.96	19.96	19.96	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.97	19.97	(88)

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

(89)m=	1	1	0.99	0.96	0.87	0.66	0.46	0.52	0.83	0.98	1	1	(89)

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

(90)m=	18.73	18.88	19.15	19.52	19.81	19.96	19.99	19.98	19.89	19.5	19.06	18.72	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	18.94	19.09	19.35	19.72	20.01	20.17	20.21	20.2	20.09	19.7	19.26	18.92	(92)

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

(93)m=	18.94	19.09	19.35	19.72	20.01	20.17	20.21	20.2	20.09	19.7	19.26	18.92	(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	0.96	0.87	0.68	0.49	0.55	0.84	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	454.7	530.43	616.03	692.35	682.65	529.43	359.87	374.82	507.44	497.2	443.18	428.84	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1534.7	1482.98	1339.66	1111.47	851.66	563.79	364.77	383.79	609.31	932.27	1252.66	1525.43	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	803.52	640.11	538.38	301.76	125.75	0	0	0	0	323.69	582.82	815.86	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4131.9 (98)

Space heating requirement in kWh/m²/year 45.49 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	950.75	748.47	766.92	0	0	0	0	(100)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

Utilisation factor for loss hm

(101)m=	0	0	0	0	0	0.86	0.92	0.89	0	0	0	0	(101)

Useful loss, hmLm (Watts) = (100)m x (101)m

(102)m=	0	0	0	0	0	818.69	690.83	686.24	0	0	0	0	(102)

Gains (solar gains calculated for applicable weather region, see Table 10)

(103)m=	0	0	0	0	0	1007.96	963.25	894.14	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	136.27	202.68	154.68	0	0	0	0

Total = Sum(104)$_{6...8}$ = 493.63 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

(107)m=	0	0	0	0	0	34.07	50.67	38.67	0	0	0	0

Total = Sum(107)$_{6...8}$ = 123.41 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 1.36 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = 46.84 (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 3 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	50.94	(1a)	x	2.6	(2a)	=	132.46	(3a)
First floor	50.94	(1b)	x	2.6	(2b)	=	132.46	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	101.89	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	264.91	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.11	(8)

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed

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

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.36	0.35	0.35	0.31	0.3	0.27	0.27	0.26	0.28	0.3	0.32	0.33

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

(24d)m=	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(24d)

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

(25)m=	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Windows Type 3			1.26	x1/[1/(1.3)+ 0.04]		=	1.56			(27)
Windows Type 4			4.41	x1/[1/(1.3)+ 0.04]		=	5.45			(27)
Floor			50.945	x	0.15	=	7.64175			(28)
Walls	125	18.65	106.35	x	0.2	=	21.27			(29)
Roof	50.94	0	50.94	x	0.14	=	7.13			(30)
Total area of elements, m²			226.89							(31)
Party wall			25	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) = 58.82 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18554.9 (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 11.34 (36)

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

Total fabric heat loss (33) + (36) = 70.16 (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=	49.41	49.19	48.97	47.95	47.76	46.88	46.88	46.71	47.22	47.76	48.15	48.55	(38)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(39)m=	119.57	119.36	119.14	118.11	117.92	117.04	117.04	116.87	117.38	117.92	118.32	118.72

Average = $Sum(39)_{1...12}$ /12= 118.12 (39)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(40)m=	1.17	1.17	1.17	1.16	1.16	1.15	1.15	1.15	1.15	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 2.76 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.91 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	115.4	111.2	107.01	102.81	98.61	94.42	94.42	98.61	102.81	107.01	111.2	115.4

Total = $Sum(44)_{1...12}$ = 1258.89 (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=	171.13	149.67	154.45	134.65	129.2	111.49	103.31	118.55	119.97	139.81	152.62	165.73

Total = $Sum(45)_{1...12}$ = 1650.6 (45)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	25.67	22.45	23.17	20.2	19.38	16.72	15.5	17.78	18	20.97	22.89	24.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.41 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.76 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0.76 (55)

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

(56)m=	23.6	21.32	23.6	22.84	23.6	22.84	23.6	23.6	22.84	23.6	22.84	23.6	(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=	23.6	21.32	23.6	22.84	23.6	22.84	23.6	23.6	22.84	23.6	22.84	23.6	(57)

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

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

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

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

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6	(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=	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6	

Output from water heater (annual)1…12 — 2202.41 (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=	94.39	83.63	88.85	81.06	80.45	73.35	71.84	76.91	76.17	83.98	87.03	92.6	(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=	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	(66)

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

(67)m=	59.17	52.56	42.74	32.36	24.19	20.42	22.07	28.68	38.5	48.88	57.05	60.82	(67)

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

(68)m=	387.08	391.1	380.98	359.43	332.23	306.66	289.58	285.57	295.69	317.24	344.44	370	(68)

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

(69)m=	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	(71)

Water heating gains (Table 5)

(72)m=	126.87	124.45	119.42	112.58	108.14	101.88	96.57	103.38	105.8	112.88	120.87	124.46	(72)

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

(73)m=	685.55	680.53	655.56	616.79	576.97	541.39	520.64	530.05	552.4	591.42	634.78	667.7	(73)

6. Solar gains:

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

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

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

(83)m=	108.5	212.26	349.56	509.81	624.79	639.59	608.91	523.05	406.55	251.86	135.29	89.23	(83)

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

(84)m=	794.06	892.79	1005.12	1126.6	1201.77	1180.97	1129.55	1053.09	958.95	843.28	770.08	756.93	(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=	0.99	0.99	0.97	0.92	0.79	0.61	0.45	0.5	0.76	0.95	0.99	1	(86)

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

(87)m=	19.89	20.05	20.31	20.63	20.87	20.97	21	20.99	20.92	20.61	20.19	19.86	(87)

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

(88)m=	19.94	19.94	19.94	19.95	19.95	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=	0.99	0.98	0.96	0.89	0.74	0.52	0.35	0.39	0.67	0.92	0.98	0.99	(89)

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

(90)m=	18.49	18.71	19.09	19.54	19.83	19.94	19.96	19.96	19.9	19.52	18.92	18.44	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	18.84	19.04	19.39	19.81	20.09	20.2	20.22	20.22	20.16	19.79	19.24	18.8	(92)

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

(93)m=	18.84	19.04	19.39	19.81	20.09	20.2	20.22	20.22	20.16	19.79	19.24	18.8	(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	0.95	0.88	0.74	0.54	0.37	0.42	0.69	0.92	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	785	874.4	959.08	995.8	893.51	640.09	421.55	442.72	661.87	774.64	753.75	749.97	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1738.25	1688.13	1536.13	1289.2	989.58	655.6	423.49	446.15	710.92	1083.59	1436.21	1732.93	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	709.22	546.83	429.32	211.25	71.47	0	0	0	0	229.86	491.37	731.33	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 3420.65 (98)

Space heating requirement in kWh/m²/year 33.57 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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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		93.5	(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)	709.22	546.83	429.32	211.25	71.47	0	0	0	0	229.86	491.37	731.33		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	758.52	584.85	459.17	225.93	76.44	0	0	0	0	245.84	525.53	782.17		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3658.45	(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)	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6		
Efficiency of water heater													79.8	(216)
(217)m=	87.73	87.45	86.79	85.24	82.62	79.8	79.8	79.8	79.8	85.37	87.14	87.85		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	248.48	219.55	231.97	211.17	213.11	196.55	188.2	207.29	207.17	218.67	227.18	242.01		
Total = Sum(219a)$_{1...12}$ =													2611.34	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3658.45	
Water heating fuel used			2611.34	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			418.02	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	127.3139	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	90.87	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	55.14	(250)

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Additional standing charges (Table 12)		120	(251)
Appendix Q items: repeat lines (253) and (254) as needed			
Total energy cost	(245)...(247) + (250)…(254) =	403.22	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.15	(257)
SAP rating (Section 12)		83.92	(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	0.216	=	790.22	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	564.05	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1354.27	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	216.95	(268)
Total CO2, kg/year			sum of (265)…(271) =		1610.15	(272)
CO2 emissions per m²			(272) ÷ (4) =		15.8	(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	1.22	=	4463.3	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	3185.84	(264)
Space and water heating	(261) + (262) + (263) + (264) =				7649.14	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1283.32	(268)
'Total Primary Energy			sum of (265)…(271) =		9162.71	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		89.93	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 3 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	50.94	(1a)	x	2.6	(2a)	=	132.46	(3a)
First floor	50.94	(1b)	x	2.6	(2b)	=	132.46	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	101.89	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	264.91	(5)

2. Ventilation rate:

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

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.15	(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		4.4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.37	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.4	0.39	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.35	0.37

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

(25)m=	0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m^2)	Openings m^2	Net Area A ,m^2		U-value W/m2K		A X U (W/K)	k-value kJ/m^2·K	A X k kJ/K	
Doors			2	x	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.3)+ 0.04]		=	3.56			(27)
Windows Type 2			3.96	x1/[1/(1.3)+ 0.04]		=	4.89			(27)
Windows Type 3			1.26	x1/[1/(1.3)+ 0.04]		=	1.56			(27)
Windows Type 4			4.41	x1/[1/(1.3)+ 0.04]		=	5.45			(27)
Floor			50.945	x	0.15	=	7.64175			(28)
Walls	125	18.65	106.35	x	0.2	=	21.27			(29)
Roof	50.94	0	50.94	x	0.14	=	7.13			(30)
Total area of elements, m^2			226.89							(31)
Party wall			25	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) = 58.82 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18554.9 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m^2K 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 11.34 (36)

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

Total fabric heat loss (33) + (36) = 70.16 (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=	50.77	50.5	50.23	48.96	48.73	47.64	47.64	47.43	48.06	48.73	49.21	49.71	(38)

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

(39)m=	120.94	120.67	120.4	119.13	118.89	117.8	117.8	117.59	118.22	118.89	119.37	119.87	

Average = $Sum(39)_{1...12}$ /12= 119.13 (39)

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

(40)m=	1.19	1.18	1.18	1.17	1.17	1.16	1.16	1.15	1.16	1.17	1.17	1.18

Average = $Sum(40)_{1...12}$ /12= 1.17 (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 2.76 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.91 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	115.4	111.2	107.01	102.81	98.61	94.42	94.42	98.61	102.81	107.01	111.2	115.4

Total = $Sum(44)_{1...12}$ = 1258.89 (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=	171.13	149.67	154.45	134.65	129.2	111.49	103.31	118.55	119.97	139.81	152.62	165.73

Total = $Sum(45)_{1...12}$ = 1650.6 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	145.46	127.22	131.28	114.46	109.82	94.77	87.82	100.77	101.97	118.84	129.72	140.87	(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=	145.46	127.22	131.28	114.46	109.82	94.77	87.82	100.77	101.97	118.84	129.72	140.87	

Output from water heater (annual)$_{1...12}$ — 1403.01 (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=	36.37	31.81	32.82	28.61	27.46	23.69	21.95	25.19	25.49	29.71	32.43	35.22	(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=	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	(66)

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

(67)m=	23.67	21.02	17.1	12.94	9.68	8.17	8.83	11.47	15.4	19.55	22.82	24.33	(67)

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

(68)m=	259.35	262.04	255.25	240.82	222.59	205.46	194.02	191.33	198.11	212.55	230.77	247.9	(68)

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

(69)m=	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	(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=	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	(71)

Water heating gains (Table 5)

(72)m=	48.88	47.33	44.11	39.74	36.9	32.91	29.51	33.86	35.41	39.93	45.04	47.34	(72)

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

(73)m=	396.24	394.73	380.81	357.85	333.52	310.88	296.7	301.01	313.26	336.38	362.98	383.91	(73)

6. Solar gains:

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

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

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

(83)m=	108.5	212.26	349.56	509.81	624.79	639.59	608.91	523.05	406.55	251.86	135.29	89.23	(83)

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

(84)m=	504.74	606.99	730.37	867.66	958.31	950.47	905.61	824.06	719.81	588.24	498.28	473.14	(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	0.89	0.72	0.56	0.63	0.88	0.99	1	1	(86)

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

(87)m=	19.61	19.78	20.06	20.45	20.76	20.94	20.99	20.98	20.83	20.4	19.93	19.59	(87)

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

(88)m=	19.93	19.93	19.93	19.94	19.95	19.96	19.96	19.96	19.95	19.95	19.94	19.94	(88)

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

(89)m=	1	1	0.99	0.95	0.84	0.63	0.43	0.5	0.82	0.98	1	1	(89)

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

(90)m=	18.66	18.83	19.11	19.5	19.79	19.93	19.95	19.95	19.86	19.45	18.99	18.64	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	18.9	19.06	19.35	19.73	20.03	20.18	20.21	20.21	20.1	19.69	19.23	18.88	(92)

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

(93)m=	18.9	19.06	19.35	19.73	20.03	20.18	20.21	20.21	20.1	19.69	19.23	18.88	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.95	0.85	0.65	0.46	0.53	0.83	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	503.99	604.56	720.66	823.84	810.63	621.51	420.11	437.82	595.21	574.83	496.63	472.62	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1765.6	1708.97	1547.3	1290.54	990.52	657.44	425.35	447.7	709.33	1080.79	1447.63	1759.46	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	938.64	742.16	615.02	336.02	133.83	0	0	0	0	376.44	684.72	957.41	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4784.25 (98)

Space heating requirement in kWh/m²/year 46.96 (99)

8c. Space cooling requirement

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

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1107.32	871.72	893.68	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.87	0.93	0.9	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	963.59	808.87	803.06	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1216.98	1162.29	1068.88	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	182.44	262.95	197.77	0	0	0	0	

	Total = Sum(104)$_{6..8}$ =	643.16	(104)
Cooled fraction	f C = cooled area ÷ (4) =	1	(105)

Intermittency factor (Table 10b)

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(107)m=	0	0	0	0	0	45.61	65.74	49.44	0	0	0	0

	Total = Sum(107)$_{6..8}$ =	160.79	(107)
Space cooling requirement in kWh/m²/year	(107) ÷ (4) =	1.58	(108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency	(99) + (108) =	48.53	(109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 4 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	58.19	(1a)	x	2.6	(2a)	=	151.28	(3a)
First floor	58.19	(1b)	x	2.6	(2b)	=	151.28	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	116.37	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	302.56	(5)

2. Ventilation rate:

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

				Air changes per hour	
Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.13	(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		4.7	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.37	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.31	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

(25)m=	0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1.1	=	2.2			(26)
Doors Type 2			2	x	1.1	=	2.2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			58.185	x	0.15	=	8.727751			(28)
Walls	120	20.56	99.44	x	0.2	=	19.89			(29)
Roof	58.19	0	58.19	x	0.11	=	6.4			(30)
Total area of elements, m²			236.37							(31)
Party wall			30	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) = 58.38 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18703.36 (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.

SAP WorkSheet: New dwelling design stage

Thermal bridges : S (L x Y) calculated using Appendix K | 11.82 | (36)

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

Total fabric heat loss | (33) + (36) = | 70.2 | (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=	57.83	57.52	57.22	55.8	55.54	54.32	54.32	54.09	54.79	55.54	56.07	56.63	(38)

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

(39)m=	128.03	127.72	127.42	126	125.74	124.51	124.51	124.28	124.98	125.74	126.27	126.83	

Average = $\text{Sum}(39)_{1...12}$ /12= | 126 | (39)

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

(40)m=	1.1	1.1	1.09	1.08	1.08	1.07	1.07	1.07	1.07	1.08	1.09	1.09	

Average = $\text{Sum}(40)_{1...12}$ /12= | 1.08 | (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 | 2.85 | (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 107.2 | (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=	117.92	113.63	109.35	105.06	100.77	96.48	96.48	100.77	105.06	109.35	113.63	117.92	

Total = $\text{Sum}(44)_{1...12}$ = | 1286.43 | (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=	174.88	152.95	157.83	137.6	132.03	113.93	105.57	121.15	122.59	142.87	155.96	169.36	

Total = $\text{Sum}(45)_{1...12}$ = | 1686.71 | (45)

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

(46)m=	26.23	22.94	23.67	20.64	19.8	17.09	15.84	18.17	18.39	21.43	23.39	25.4	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 180 | (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 1.51 | (48)

Temperature factor from Table 2b | 0.54 | (49)

Energy lost from water storage, kWh/year | (48) x (49) = | 0.82 | (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

SAP WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0.82	(55)

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

(56)m=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(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=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(57)

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

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

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

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

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9	(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=	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9	

Output from water heater (annual)$_{1...12}$ | 2258.23 | (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=	96.98	85.93	91.31	83.33	82.73	75.46	73.94	79.11	78.34	86.34	89.43	95.14	(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=	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	(66)

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

(67)m=	65.67	58.32	47.43	35.91	26.84	22.66	24.49	31.83	42.72	54.24	63.31	67.49	(67)

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

(68)m=	418.52	422.86	411.92	388.62	359.21	331.57	313.1	308.76	319.7	343	372.41	400.05	(68)

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

(69)m=	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	(71)

Water heating gains (Table 5)

(72)m=	130.35	127.87	122.73	115.74	111.2	104.81	99.38	106.34	108.81	116.04	124.21	127.88	(72)

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

(73)m=	729.43	723.96	696.98	655.17	612.15	573.94	551.86	561.82	586.13	628.19	674.84	710.32	(73)

6. Solar gains:

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

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

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

(83)m=	107.92	211.11	347.67	507.06	621.42	636.13	605.62	520.22	404.35	250.5	134.56	88.75	(83)

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

(84)m=	837.35	935.07	1044.65	1162.22	1233.57	1210.07	1157.48	1082.04	990.49	878.69	809.4	799.07	(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	0.93	0.82	0.63	0.47	0.52	0.78	0.96	0.99	1	(86)

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

(87)m=	19.94	20.08	20.33	20.64	20.87	20.97	21	20.99	20.92	20.62	20.22	19.91	(87)

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

(88)m=	20	20	20	20.01	20.02	20.03	20.03	20.03	20.02	20.02	20.01	20.01	(88)

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

(89)m=	0.99	0.99	0.97	0.91	0.76	0.55	0.37	0.41	0.7	0.94	0.99	1	(89)

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

(90)m=	18.6	18.8	19.16	19.6	19.89	20.01	20.02	20.02	19.97	19.58	19.02	18.56	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	18.93	19.12	19.45	19.86	20.14	20.25	20.27	20.27	20.21	19.84	19.32	18.9	(92)

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

(93)m=	18.93	19.12	19.45	19.86	20.14	20.25	20.27	20.27	20.21	19.84	19.32	18.9	(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	0.9	0.77	0.57	0.39	0.44	0.72	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	830.32	920.67	1007.35	1050.18	951.57	686.59	454.54	476.96	708.69	819.64	796.29	793.72	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1873.18	1816.46	1650.24	1381.04	1060.91	703.52	456.55	480.5	763.05	1162.25	1542.92	1864.41	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	775.89	601.98	478.31	238.22	81.35	0	0	0	0	254.9	537.57	796.6	

Total per year (kWh/year) = Sum(98)1...5,9...12 = 3764.8 (98)

Space heating requirement in kWh/m²/year 32.35 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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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)	775.89	601.98	478.31	238.22	81.35	0	0	0	0	254.9	537.57	796.6		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	836.09	648.68	515.42	256.7	87.66	0	0	0	0	274.67	579.28	858.4		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4056.9	(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)	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9		
Efficiency of water heater													79.1	(216)
(217)m=	87.16	86.9	86.28	84.79	82.14	79.1	79.1	79.1	79.1	84.88	86.59	87.26		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	256.32	226.45	239.18	217.68	219.83	203.42	194.83	214.52	214.37	225.52	234.36	249.7		
Total = Sum(219a)$_{1...12}$ =													2696.17	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4056.9	
Water heating fuel used			2696.17	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			463.88	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	141.1801	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	93.83	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	61.19	(250)

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Additional standing charges (Table 12)				120	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			426.08	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.11	(257)
SAP rating (Section 12)		84.53	(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	0.216	=	876.29	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	582.37	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1458.66	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	240.75	(268)
Total CO2, kg/year			sum of (265)…(271) =		1738.34	(272)
CO2 emissions per m²			(272) ÷ (4) =		14.94	(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	1.22	=	4949.42	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	3289.33	(264)
Space and water heating	(261) + (262) + (263) + (264) =				8238.75	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1424.11	(268)
'Total Primary Energy			sum of (265)…(271) =		9893.1	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		85.01	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name: **Stroma Number:**
Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.0.28

Property Address: 4 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	58.19	(1a)	x	2.6	(2a)	=	151.28	(3a)
First floor	58.19	(1b)	x	2.6	(2b)	=	151.28	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	116.37	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	302.56	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.13	(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		4.7	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.37	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.31	(21)

Infiltration rate modified for monthly wind speed

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

(25)m=	0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1.1	=	2.2			(26)
Doors Type 2			2	x	1.1	=	2.2			(26)
Windows Type 1			2.88		x1/[1/(1.2)+ 0.04]	=	3.3			(27)
Windows Type 2			3.96		x1/[1/(1.2)+ 0.04]	=	4.53			(27)
Windows Type 3			1.26		x1/[1/(1.2)+ 0.04]	=	1.44			(27)
Windows Type 4			1.44		x1/[1/(1.2)+ 0.04]	=	1.65			(27)
Floor			58.185	x	0.15	=	8.727751			(28)
Walls	120	20.56	99.44	x	0.2	=	19.89			(29)
Roof	58.19	0	58.19	x	0.11	=	6.4			(30)
Total area of elements, m²			236.37							(31)
Party wall			30	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) = 58.38 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18703.36 (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.

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Thermal bridges : S (L x Y) calculated using Appendix K	11.82	(36)
if details of thermal bridging are not known (36) = 0.15 x (31)		
Total fabric heat loss (33) + (36) =	70.2	(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=	57.83	57.52	57.22	55.8	55.54	54.32	54.32	54.09	54.79	55.54	56.07	56.63	(38)

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

(39)m=	128.03	127.72	127.42	126	125.74	124.51	124.51	124.28	124.98	125.74	126.27	126.83	

Average = $Sum(39)_{1...12}$ /12= 126 (39)

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

(40)m=	1.1	1.1	1.09	1.08	1.08	1.07	1.07	1.07	1.07	1.08	1.09	1.09	

Average = $Sum(40)_{1...12}$ /12= 1.08 (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 2.85 (42)

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

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 107.2 (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=	117.92	113.63	109.35	105.06	100.77	96.48	96.48	100.77	105.06	109.35	113.63	117.92	

Total = $Sum(44)_{1...12}$ = 1286.43 (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=	174.88	152.95	157.83	137.6	132.03	113.93	105.57	121.15	122.59	142.87	155.96	169.36	

Total = $Sum(45)_{1...12}$ = 1686.71 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel	180	(47)
If community heating and no tank in dwelling, enter 110 litres in (47)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)		
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day):	0	(48)
Temperature factor from Table 2b	0	(49)
Energy lost from water storage, kWh/year (48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)
If community heating see section 4.3		
Volume factor from Table 2a	0	(52)
Temperature factor from Table 2b	0	(53)

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Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	148.64	130.01	134.15	116.96	112.22	96.84	89.74	102.98	104.21	121.44	132.56	143.95	(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=	148.64	130.01	134.15	116.96	112.22	96.84	89.74	102.98	104.21	121.44	132.56	143.95	

Output from water heater (annual)$_{1...12}$ | 1433.71 | (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=	37.16	32.5	33.54	29.24	28.06	24.21	22.43	25.74	26.05	30.36	33.14	35.99	(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=	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	(66)

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

(67)m=	26.27	23.33	18.97	14.36	10.74	9.06	9.79	12.73	17.09	21.7	25.32	27	(67)

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

(68)m=	280.41	283.32	275.99	260.38	240.67	222.15	209.78	206.87	214.2	229.81	249.52	268.04	(68)

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

(69)m=	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	(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=	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	(71)

Water heating gains (Table 5)

(72)m=	49.95	48.37	45.08	40.61	37.71	33.63	30.15	34.6	36.18	40.81	46.03	48.37	(72)

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

(73)m=	422.34	420.73	405.76	381.07	354.84	330.56	315.45	319.92	333.19	358.04	386.59	409.13	(73)

6. Solar gains:

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

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

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

(83)m=	107.92	211.11	347.67	507.06	621.42	636.13	605.62	520.22	404.35	250.5	134.56	88.75	(83)

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

(84)m=	530.26	631.85	753.43	888.13	976.25	966.69	921.07	840.14	737.55	608.54	521.15	497.87	(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=	1	1	0.99	0.98	0.91	0.75	0.58	0.65	0.9	0.99	1	1	(86)

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

(87)m=	19.69	19.84	20.1	20.46	20.77	20.94	20.99	20.98	20.84	20.42	19.99	19.67	(87)

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

(88)m=	20	20	20	20.01	20.02	20.03	20.03	20.03	20.02	20.02	20.01	20.01	(88)

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

(89)m=	1	1	0.99	0.96	0.87	0.66	0.46	0.53	0.84	0.99	1	1	(89)

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

(90)m=	18.8	18.94	19.21	19.57	19.85	20	20.02	20.02	19.93	19.54	19.11	18.78	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	19.02	19.17	19.43	19.79	20.08	20.23	20.26	20.26	20.15	19.76	19.33	19	(92)

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

(93)m=	19.02	19.17	19.43	19.79	20.08	20.23	20.26	20.26	20.15	19.76	19.33	19	(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	0.96	0.87	0.68	0.49	0.56	0.85	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	529.73	630.2	746.57	854.38	850.61	661.31	450.68	469.14	628.39	598.5	520.01	497.52	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1884.42	1822.33	1648.15	1372.6	1054.08	701.48	456.19	479.78	756.54	1151.82	1543.98	1877.21	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1007.89	801.11	670.78	373.12	151.38	0	0	0	0	411.67	737.26	1026.48	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 5179.69 (98)

Space heating requirement in kWh/m²/year 44.51 (99)

8c. Space cooling requirement

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

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1170.42	921.39	944.55	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.87	0.93	0.9	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1013.82	854.5	847.54	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1243.28	1187.51	1095.14	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(104)m=	0	0	0	0	0	165.22	247.76	184.21	0	0	0	0

Total = Sum(104)$_{6..8}$ = 597.19 (104)

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

Intermittency factor (Table 10b)

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

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(107)m=	0	0	0	0	0	41.3	61.94	46.05	0	0	0	0

Total = Sum(107)$_{6..8}$ = 149.3 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 1.28 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = 45.79 (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 5 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	42.67	(1a)	x	2.6	(2a)	=	110.94	(3a)
First floor	42.67	(1b)	x	2.6	(2b)	=	110.94	(3b)
Second floor	42.66	(1c)	x	2.6	(2c)	=	110.92	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	128	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			332.8	(5)

2. Ventilation rate:

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

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(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		4.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(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=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			42.67	x	0.15	=	6.4005			(28)
Walls	210	34.06	175.94	x	0.2	=	35.19			(29)
Roof	42.67	0	42.67	x	0.11	=	4.69			(30)
Total area of elements, m²			295.34							(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) = 84.7 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 27336.18 (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 14.77 (36)

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

Total fabric heat loss (33) + (36) = 99.47 (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=	62.82	62.51	62.22	60.8	60.54	59.3	59.3	59.07	59.78	60.54	61.07	61.63	(38)

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

(39)m=	162.29	161.98	161.68	160.27	160	158.77	158.77	158.54	159.25	160	160.54	161.1	

Average = $Sum(39)_{1...12}$ /12= 160.27 (39)

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

(40)m=	1.27	1.27	1.26	1.25	1.25	1.24	1.24	1.24	1.24	1.25	1.25	1.26	

Average = $Sum(40)_{1...12}$ /12= 1.25 (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 2.89 (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) + 36 108.24 (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=	119.06	114.73	110.4	106.08	101.75	97.42	97.42	101.75	106.08	110.4	114.73	119.06	

Total = $Sum(44)_{1...12}$ = 1298.88 (44)

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

(45)m=	176.57	154.43	159.36	138.93	133.31	115.03	106.6	122.32	123.78	144.25	157.47	171	

Total = $Sum(45)_{1...12}$ = 1703.04 (45)

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

(46)m=	26.49	23.16	23.9	20.84	20	17.26	15.99	18.35	18.57	21.64	23.62	25.65	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.51 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.82 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0.82 (55)

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

(56)m=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(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=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(57)

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

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

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

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

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54	(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=	225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54	

Output from water heater (annual)1…12 | 2274.55 | (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=	97.54	86.42	91.82	83.77	83.16	75.83	74.27	79.5	78.74	86.8	89.94	95.69	(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=	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	(66)

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

(67)m=	65.81	58.46	47.54	35.99	26.9	22.71	24.54	31.9	42.82	54.37	63.45	67.64	(67)

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

(68)m=	440.74	445.31	433.78	409.25	378.28	349.17	329.72	325.15	336.67	361.21	392.18	421.29	(68)

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

(69)m=	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	(71)

Water heating gains (Table 5)

(72)m=	131.1	128.6	123.41	116.35	111.77	105.32	99.83	106.86	109.36	116.66	124.91	128.61	(72)

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

(73)m=	753.67	748.39	720.75	677.61	632.97	593.22	570.12	579.93	604.87	648.26	696.56	733.57	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
South	0.9x	0.77	x	2.88	x	46.75	x	0.63	x	0.76	=	178.71	(78)
South	0.9x	0.77	x	2.88	x	76.57	x	0.63	x	0.76	=	292.68	(78)
South	0.9x	0.77	x	2.88	x	97.53	x	0.63	x	0.76	=	372.82	(78)
South	0.9x	0.77	x	2.88	x	110.23	x	0.63	x	0.76	=	421.36	(78)
South	0.9x	0.77	x	2.88	x	114.87	x	0.63	x	0.76	=	439.09	(78)
South	0.9x	0.77	x	2.88	x	110.55	x	0.63	x	0.76	=	422.56	(78)
South	0.9x	0.77	x	2.88	x	108.01	x	0.63	x	0.76	=	412.87	(78)
South	0.9x	0.77	x	2.88	x	104.89	x	0.63	x	0.76	=	400.95	(78)
South	0.9x	0.77	x	2.88	x	101.89	x	0.63	x	0.76	=	389.45	(78)
South	0.9x	0.77	x	2.88	x	82.59	x	0.63	x	0.76	=	315.68	(78)
South	0.9x	0.77	x	2.88	x	55.42	x	0.63	x	0.76	=	211.83	(78)
South	0.9x	0.77	x	2.88	x	40.4	x	0.63	x	0.76	=	154.42	(78)

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

(83)m=	299.53	529.03	762.06	989.05	1134.8	1134.75	1090.9	983.37	842.15	596.13	362.48	253.78	(83)

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

(84)m=	1053.2	1277.41	1482.81	1666.66	1767.77	1727.97	1661.02	1563.3	1447.02	1244.39	1059.04	987.34	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.95	0.88	0.75	0.57	0.42	0.46	0.7	0.92	0.98	0.99	(86)

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

(87)m=	19.8	20.03	20.33	20.66	20.88	20.97	21	20.99	20.93	20.63	20.14	19.76	(87)

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

(88)m=	19.87	19.87	19.87	19.88	19.88	19.89	19.89	19.89	19.88	19.88	19.88	19.87	(88)

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

(89)m=	0.99	0.98	0.94	0.85	0.68	0.48	0.31	0.35	0.61	0.89	0.98	0.99	(89)

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

(90)m=	18.31	18.63	19.06	19.51	19.77	19.87	19.89	19.89	19.84	19.48	18.81	18.25	(90)

fLA = Living area ÷ (4) = 0.17 (91)

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

(92)m=	18.56	18.86	19.27	19.7	19.96	20.06	20.07	20.07	20.02	19.67	19.03	18.5	(92)

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

(93)m=	18.56	18.86	19.27	19.7	19.96	20.06	20.07	20.07	20.02	19.67	19.03	18.5	(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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	0.99	0.97	0.93	0.84	0.69	0.49	0.33	0.37	0.62	0.88	0.97	0.99	(94)

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

(95)m=	1038.25	1236.92	1377.53	1399.66	1216.58	849.47	549.13	578.58	895.41	1097.05	1028.65	976.58	(95)

Monthly average external temperature from Table 8

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

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

(97)m=	2313.44	2261.38	2064.89	1731.16	1321.33	866.3	551.12	581.98	943.07	1451.48	1915.04	2303.36	(97)

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

(98)m=	948.74	688.44	511.39	238.68	77.93	0	0	0	0	263.69	638.2	987.12

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4354.21 (98)

Space heating requirement in kWh/m²/year 34.02 (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		89.8	(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)													
	948.74	688.44	511.39	238.68	77.93	0	0	0	0	263.69	638.2	987.12	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	1056.51	766.63	569.48	265.79	86.78	0	0	0	0	293.64	710.69	1099.25	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 4848.78 (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)

	225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54

Efficiency of water heater 79.1 (216)

(217)m=	87.53	87.16	86.42	84.78	82.03	79.1	79.1	79.1	79.1	84.95	86.95	87.64	(217)

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

(219)m=	257.18	227.47	240.56	219.28	221.68	204.81	196.13	216	215.87	226.96	235.13	250.49

Total = Sum(219a)$_{1...12}$ = 2711.57 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4848.78	
Water heating fuel used		2711.57	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)

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boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			464.92	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	168.7377	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	94.36	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	61.32	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost	(245)...(247) + (250)…(254) =	454.32	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.1	(257)
SAP rating (Section 12)		84.61	(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	0.216	=	1047.34	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	585.7	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1633.04	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	241.29	(268)
Total CO2, kg/year		sum of (265)…(271) =		1913.25	(272)
CO2 emissions per m²		(272) ÷ (4) =		14.95	(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	1.22	=	5915.52	(261)

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Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	3308.11	(264)
Space and water heating	(261) + (262) + (263) + (264) =				9223.63	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1427.3	(268)
'Total Primary Energy			sum of (265)…(271) =		10881.18	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		85.01	(273)

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User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 5 Beds - House

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	42.67	(1a)	x	2.6	(2a)	=	110.94	(3a)
First floor	42.67	(1b)	x	2.6	(2b)	=	110.94	(3b)
Second floor	42.66	(1c)	x	2.6	(2c)	=	110.92	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	128	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	332.8	(5)

2. Ventilation rate:

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

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(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		4.6	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(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=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			42.67	x	0.15	=	6.4005			(28)
Walls	210	34.06	175.94	x	0.2	=	35.19			(29)
Roof	42.67	0	42.67	x	0.11	=	4.69			(30)
Total area of elements, m²			295.34							(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) = 84.7 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 27336.18 (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 14.77 (36)

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

Total fabric heat loss (33) + (36) = 99.47 (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=	62.82	62.51	62.22	60.8	60.54	59.3	59.3	59.07	59.78	60.54	61.07	61.63	(38)

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

(39)m=	162.29	161.98	161.68	160.27	160	158.77	158.77	158.54	159.25	160	160.54	161.1	

Average = $Sum(39)_{1...12}$ /12= 160.27 (39)

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

(40)m=	1.27	1.27	1.26	1.25	1.25	1.24	1.24	1.24	1.24	1.25	1.25	1.26	

Average = $Sum(40)_{1...12}$ /12= 1.25 (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 2.89 (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) + 36 108.24 (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=	119.06	114.73	110.4	106.08	101.75	97.42	97.42	101.75	106.08	110.4	114.73	119.06	

Total = $Sum(44)_{1...12}$ = 1298.88 (44)

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

(45)m=	176.57	154.43	159.36	138.93	133.31	115.03	106.6	122.32	123.78	144.25	157.47	171	

Total = $Sum(45)_{1...12}$ = 1703.04 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	150.08	131.26	135.45	118.09	113.31	97.78	90.61	103.97	105.21	122.62	133.85	145.35	(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=	150.08	131.26	135.45	118.09	113.31	97.78	90.61	103.97	105.21	122.62	133.85	145.35

Output from water heater (annual)$_{1...12}$ 1447.58 (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=	37.52	32.82	33.86	29.52	28.33	24.44	22.65	25.99	26.3	30.65	33.46	36.34	(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=	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	(66)

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

(67)m=	26.33	23.38	19.02	14.4	10.76	9.09	9.82	12.76	17.13	21.75	25.38	27.06	(67)

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

(68)m=	295.29	298.36	290.64	274.2	253.45	233.94	220.91	217.85	225.57	242.01	262.76	282.26	(68)

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

(69)m=	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	(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=	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	(71)

Water heating gains (Table 5)

(72)m=	50.43	48.83	45.51	41	38.07	33.95	30.45	34.94	36.53	41.2	46.47	48.84	(72)

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

(73)m=	438.39	436.92	421.51	395.94	368.63	343.32	327.52	331.89	345.57	371.3	400.96	424.5	(73)

6. Solar gains:

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

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
South	0.9x	0.77	x	2.88	x	46.75	x	0.63	x	0.76	=	178.71	(78)
South	0.9x	0.77	x	2.88	x	76.57	x	0.63	x	0.76	=	292.68	(78)
South	0.9x	0.77	x	2.88	x	97.53	x	0.63	x	0.76	=	372.82	(78)
South	0.9x	0.77	x	2.88	x	110.23	x	0.63	x	0.76	=	421.36	(78)
South	0.9x	0.77	x	2.88	x	114.87	x	0.63	x	0.76	=	439.09	(78)
South	0.9x	0.77	x	2.88	x	110.55	x	0.63	x	0.76	=	422.56	(78)
South	0.9x	0.77	x	2.88	x	108.01	x	0.63	x	0.76	=	412.87	(78)
South	0.9x	0.77	x	2.88	x	104.89	x	0.63	x	0.76	=	400.95	(78)
South	0.9x	0.77	x	2.88	x	101.89	x	0.63	x	0.76	=	389.45	(78)
South	0.9x	0.77	x	2.88	x	82.59	x	0.63	x	0.76	=	315.68	(78)
South	0.9x	0.77	x	2.88	x	55.42	x	0.63	x	0.76	=	211.83	(78)
South	0.9x	0.77	x	2.88	x	40.4	x	0.63	x	0.76	=	154.42	(78)

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

(83)m=	299.53	529.03	762.06	989.05	1134.8	1134.75	1090.9	983.37	842.15	596.13	362.48	253.78	(83)

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

(84)m=	737.92	965.94	1183.57	1384.99	1503.43	1478.07	1418.42	1315.26	1187.73	967.43	763.44	678.28	(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	0.93	0.82	0.65	0.48	0.54	0.79	0.97	1	1	(86)

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

(87)m=	19.58	19.82	20.15	20.53	20.82	20.96	20.99	20.99	20.89	20.47	19.94	19.54	(87)

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

(88)m=	19.87	19.87	19.87	19.88	19.88	19.89	19.89	19.89	19.88	19.88	19.88	19.87	(88)

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

(89)m=	1	0.99	0.97	0.91	0.76	0.55	0.37	0.42	0.71	0.95	0.99	1	(89)

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

(90)m=	18.58	18.81	19.14	19.52	19.76	19.87	19.89	19.89	19.83	19.47	18.95	18.54	(90)

fLA = Living area ÷ (4) = 0.17 (91)

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

(92)m=	18.75	18.98	19.31	19.69	19.94	20.05	20.07	20.07	20	19.64	19.11	18.71	(92)

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

(93)m=	18.75	18.98	19.31	19.69	19.94	20.05	20.07	20.07	20	19.64	19.11	18.71	(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	0.9	0.77	0.57	0.39	0.44	0.72	0.94	0.99	1	(94)

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

(95)m=	735.56	955.71	1144.63	1249.4	1152.38	835.56	547.09	574.77	851.96	913.64	757.41	676.79	(95)

Monthly average external temperature from Table 8

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

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

(97)m=	2344.64	2280.87	2071.21	1728.55	1318.32	865.35	550.93	581.63	940.01	1446.28	1928.43	2337.59	(97)

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

(98)m=	1197.16	890.51	689.38	344.99	123.46	0	0	0	0	396.28	843.14	1235.64

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5720.55 (98)

Space heating requirement in kWh/m²/year 44.69 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1492.48	1174.93	1204.93	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.9	0.95	0.93	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1343.97	1112.42	1117.93	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1845.18	1772.81	1654.4	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	360.87	491.33	399.13	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1251.33 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

(107)m=	0	0	0	0	0	90.22	122.83	99.78	0	0	0	0

Total = Sum(107)$_{6...8}$ = 312.83 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 2.44 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency (99) + (108) = 47.14 (109)

Appendix D: SAP Worksheets – Enhanced Fabric

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 1 Bed - Flat Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	56.1	(1a) x	2.5	(2a) =	140.25	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	56.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	140.25	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.14	(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		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.34	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

SAP WorkSheet: New dwelling design stage

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

0.37	0.36	0.36	0.32	0.31	0.28	0.28	0.27	0.29	0.31	0.33	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Floor			56.1	x	0.14	=	7.854			(28)
Walls	50	10.64	39.36	x	0.18	=	7.08			(29)
Total area of elements, m²			106.1							(31)
Party wall			15	x	0	=	0			(32)
Party ceiling			56.1							(32b)

** 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) = 26.83 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 8741.1 (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 5.3 (36)

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

Total fabric heat loss (33) + (36) = 32.14 (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=	26.33	26.21	26.08	25.52	25.41	24.91	24.91	24.82	25.1	25.41	25.63	25.85	(38)

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

(39)m=	58.47	58.34	58.22	57.65	57.55	57.05	57.05	56.96	57.24	57.55	57.76	57.99	

Average = Sum(39)$_{1…12}$ /12= 57.65 (39)

SAP WorkSheet: New dwelling design stage

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

(40)m=	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.03	

Average = Sum(40)$_{1…12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 1.87 (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 78.6 (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=	86.46	83.32	80.17	77.03	73.88	70.74	70.74	73.88	77.03	80.17	83.32	86.46	
												Total = Sum(44)$_{1…12}$ = 943.21	(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=	128.22	112.14	115.72	100.89	96.8	83.53	77.41	88.83	89.89	104.75	114.35	124.17	
												Total = Sum(45)$_{1…12}$ = 1236.69	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	19.23	16.82	17.36	15.13	14.52	12.53	11.61	13.32	13.48	15.71	17.15	18.63	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	23.23	20.95	23.15	22.35	23.05	22.26	22.98	23.03	22.31	23.11	22.42	23.21	(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=	151.44	133.09	138.87	123.23	119.86	105.8	100.39	111.85	112.2	127.86	136.77	147.38	(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=	151.44	133.09	138.87	123.23	119.86	105.8	100.39	111.85	112.2	127.86	136.77	147.38

Output from water heater (annual)$_{1...12}$ 1508.74 (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=	48.44	42.52	44.26	39.13	37.95	33.34	31.48	35.29	35.46	40.61	43.63	47.09	(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=	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	112.17	(66)

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

(67)m=	37.59	33.39	27.15	20.56	15.37	12.97	14.02	18.22	24.45	31.05	36.24	38.63	(67)

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

(68)m=	243.31	245.83	239.47	225.92	208.83	192.76	182.02	179.5	185.86	199.4	216.5	232.57	(68)

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

(69)m=	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	48.09	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	(71)

Water heating gains (Table 5)

(72)m=	65.11	63.28	59.49	54.35	51.01	46.31	42.32	47.43	49.26	54.58	60.59	63.29	(72)

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

(73)m=	434.48	430.97	414.59	389.31	363.68	340.51	326.83	333.63	348.05	373.51	401.81	422.97	(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)

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

(83)m=	71.5	139.87	230.34	335.94	411.7	421.45	401.24	344.66	267.9	165.96	89.15	58.8	(83)

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

(84)m=	505.98	570.84	644.93	725.24	775.38	761.97	728.07	678.29	615.94	539.47	490.96	481.77	(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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(86)m=	0.99	0.97	0.93	0.83	0.66	0.48	0.34	0.39	0.62	0.89	0.97	0.99		(86)
Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)														
(87)m=	20.18	20.34	20.59	20.84	20.96	20.99	21	21	20.98	20.79	20.44	20.15		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)														
(88)m=	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.06		(88)
Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)														
(89)m=	0.98	0.97	0.92	0.79	0.6	0.41	0.27	0.31	0.54	0.85	0.96	0.99		(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)														
(90)m=	18.99	19.22	19.56	19.89	20.03	20.07	20.07	20.07	20.05	19.85	19.37	18.94		(90)
										fLA = Living area ÷ (4) =			0.5	(91)
Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2														
(92)m=	19.59	19.78	20.07	20.36	20.49	20.53	20.53	20.53	20.51	20.32	19.91	19.55		(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate														
(93)m=	19.59	19.78	20.07	20.36	20.49	20.53	20.53	20.53	20.51	20.32	19.91	19.55		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	0.98	0.96	0.92	0.8	0.63	0.44	0.31	0.35	0.58	0.86	0.96	0.98		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	495.81	549.55	591.4	583.31	488.18	336.26	224.25	235.03	358.42	464.7	472.3	473.97		(95)
Monthly average external temperature from Table 8														
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]														
(97)m=	893.77	868.17	790.17	660.75	506.02	338.32	224.45	235.48	367.19	559.38	739.71	889.88		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	296.08	214.11	147.89	55.75	13.28	0	0	0	0	70.44	192.53	309.44		
									Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ =				1299.53	(98)
Space heating requirement in kWh/m²/year													23.16	(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		89.9	(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)														
	296.08	214.11	147.89	55.75	13.28	0	0	0	0	70.44	192.53	309.44		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)														(211)
	329.35	238.17	164.5	62.02	14.77	0	0	0	0	78.35	214.16	344.21		
									Total (kWh/year) = $Sum(211)_{1...5,10...12}$ =				1445.52	(211)

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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)

151.44	133.09	138.87	123.23	119.86	105.8	100.39	111.85	112.2	127.86	136.77	147.38

Efficiency of water heater 87.3 (216)

(217)m=	89	88.89	88.62	88.09	87.55	87.3	87.3	87.3	87.3	88.21	88.8	89.04	(217)

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

(219)m=	170.16	149.73	156.69	139.89	136.9	121.19	114.99	128.12	128.52	144.96	154.02	165.52

Total = Sum(219a)$_{1...12}$ = 1710.68 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		1445.52	
Water heating fuel used		1710.68	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75	(231)
Electricity for lighting		265.53	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	50.3042	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	59.53	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	35.02	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost (245)...(247) + (250)…(254) = 274.75 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.14	(257)
SAP rating (Section 12)		84.08	(258)

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

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	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	312.23	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	369.51	(264)
Space and water heating	(261) + (262) + (263) + (264) =				681.74	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	137.81	(268)
Total CO2, kg/year			sum of (265)…(271) =		858.48	(272)
CO2 emissions per m²			(272) ÷ (4) =		15.3	(273)
EI rating (section 14)					89	(274)

13a. Primary Energy

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211)	x	1.22	=	1763.54	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	2087.03	(264)
Space and water heating	(261) + (262) + (263) + (264) =				3850.57	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	815.18	(268)
'Total Primary Energy			sum of (265)…(271) =		4896	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		87.27	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 1 Bed - Flat Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	56.1	(1a) x	2.5	(2a) =	140.25	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	56.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	140.25	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.14	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.34	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed

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

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

0.37	0.36	0.36	0.32	0.31	0.28	0.28	0.27	0.29	0.31	0.33	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows			2.88	x	1/[1/(1.2)+ 0.04]	=	3.3			(27)
Floor			56.1	x	0.14	=	7.854			(28)
Walls	50	10.64	39.36	x	0.18	=	7.08			(29)
Total area of elements, m²			106.1							(31)
Party wall			15	x	0	=	0			(32)
Party ceiling			56.1							(32b)

** 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) = 26.83 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 8741.1 (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 5.3 (36)

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

Total fabric heat loss (33) + (36) = 32.14 (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=	26.33	26.21	26.08	25.52	25.41	24.91	24.91	24.82	25.1	25.41	25.63	25.85	(38)

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

(39)m=	58.47	58.34	58.22	57.65	57.55	57.05	57.05	56.96	57.24	57.55	57.76	57.99	

Average = Sum(39)$_{1…12}$ /12= 57.65 (39)

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

(40)m=	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.03

Average = $Sum(40)_{1...12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 1.87 (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 78.6 (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=	86.46	83.32	80.17	77.03	73.88	70.74	70.74	73.88	77.03	80.17	83.32	86.46	
											Total = $Sum(44)_{1...12}$ =	943.21	(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=	128.22	112.14	115.72	100.89	96.8	83.53	77.41	88.83	89.89	104.75	114.35	124.17	
											Total = $Sum(45)_{1...12}$ =	1236.69	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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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=	108.99	95.32	98.36	85.75	82.28	71	65.8	75.5	76.4	89.04	97.19	105.55	(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=	108.99	95.32	98.36	85.75	82.28	71	65.8	75.5	76.4	89.04	97.19	105.55	

Output from water heater (annual)1…12 | 1051.19 | (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=	27.25	23.83	24.59	21.44	20.57	17.75	16.45	18.88	19.1	22.26	24.3	26.39	(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=	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	93.48	(66)

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

(67)m=	15.04	13.35	10.86	8.22	6.15	5.19	5.61	7.29	9.78	12.42	14.5	15.45	(67)

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

(68)m=	163.02	164.71	160.44	151.37	139.91	129.15	121.95	120.26	124.53	133.6	145.06	155.82	(68)

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

(69)m=	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	32.35	(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=	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	-74.78	(71)

Water heating gains (Table 5)

(72)m=	36.62	35.46	33.05	29.78	27.65	24.65	22.11	25.37	26.53	29.92	33.75	35.47	(72)

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

(73)m=	265.71	264.56	255.4	240.41	224.75	210.03	200.71	203.96	211.88	226.98	244.34	257.78	(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)

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

(83)m=	71.5	139.87	230.34	335.94	411.7	421.45	401.24	344.66	267.9	165.96	89.15	58.8	(83)

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

(84)m=	337.21	404.43	485.74	576.35	636.46	631.49	601.95	548.62	479.77	392.95	333.49	316.58	(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

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(86)m=	1	0.99	0.98	0.91	0.76	0.57	0.42	0.47	0.75	0.96	1	1	(86)

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

(87)m=	19.91	20.08	20.37	20.71	20.92	20.99	21	21	20.94	20.62	20.19	19.87	(87)

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

(88)m=	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.06	(88)

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

(89)m=	1	0.99	0.97	0.89	0.71	0.49	0.33	0.38	0.68	0.95	0.99	1	(89)

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

(90)m=	19.05	19.23	19.51	19.84	20.01	20.06	20.07	20.07	20.04	19.77	19.34	19.02	(90)

fLA = Living area ÷ (4) = 0.5 (91)

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

(92)m=	19.48	19.65	19.94	20.27	20.46	20.53	20.53	20.53	20.49	20.2	19.77	19.45	(92)

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

(93)m=	19.48	19.65	19.94	20.27	20.46	20.53	20.53	20.53	20.49	20.2	19.77	19.45	(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	0.9	0.73	0.53	0.37	0.43	0.71	0.95	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	336.13	400.91	471.46	515.95	467.09	333.11	223.81	234.15	342.51	373.46	331.06	315.85	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	887.46	860.78	782.49	655.62	504.32	338.05	224.4	235.4	365.8	552.18	731.82	884.28	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	410.19	309.03	231.41	100.56	27.7	0	0	0	0	132.97	288.55	422.91	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1923.31 (98)

Space heating requirement in kWh/m²/year 34.28 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	536.28	422.18	432.88	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.96	0.98	0.97	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	516.44	415.38	421.76	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	808.47	772.61	711.41	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	210.26	265.78	215.5	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 691.54 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

(107)m=	0	0	0	0	0	52.57	66.44	53.88	0	0	0	0

Total = Sum(107) $_{6...8}$ = **172.89** (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = **3.08** (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = **37.37** (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 2 Beds - Flat Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.6	(1a) x	2.6	(2a) =	188.76	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.6	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		188.76	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.31	(21)

Infiltration rate modified for monthly wind speed

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

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

0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	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=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	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	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Walls	80	11.72	68.28	x	0.18	=	12.29			(29)
Roof	72.6	0	72.6	x	0.1	=	7.26			(30)
Total area of elements, m²			152.6							(31)
Party floor			72.6							(32a)

** 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) = 32.68 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15804.6 (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 7.63 (36)

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

Total fabric heat loss (33) + (36) = 40.31 (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=	35.86	35.67	35.49	34.65	34.5	33.76	33.76	33.62	34.04	34.5	34.81	35.15	(38)

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

(39)m=	76.17	75.98	75.8	74.96	74.81	74.07	74.07	73.93	74.35	74.81	75.12	75.46	

Average = Sum(39)$_{1…12}$ /12= 74.96 (39)

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

(40)m=	1.05	1.05	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.04

Average = Sum(40)1…12 /12= 1.03 (40)

Number of days in month (Table 1a)

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

(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.31 (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 — 93.69 (43)

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

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

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=	103.06	99.31	95.56	91.82	88.07	84.32	84.32	88.07	91.82	95.56	99.31	103.06
(45)m=	152.83	133.67	137.93	120.25	115.39	99.57	92.27	105.88	107.14	124.86	136.3	148.01
(46)m=	22.92	20.05	20.69	18.04	17.31	14.94	13.84	15.88	16.07	18.73	20.44	22.2

Total = Sum(44)1…12 = 1124.28 (44)

Total = Sum(45)1…12 = 1474.11 (45)

(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = — 0 (54)

Enter (50) or (54) in (55) — 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0

(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	0	0	0	0	0	0	0	0	0	0	0

(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0

(59)

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

(61)m=	23.41	21.12	23.32	22.49	23.19	22.37	23.08	23.15	22.44	23.26	22.6	23.39	(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=	176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4	(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=	176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4

Output from water heater (annual)$_{1...12}$ 1747.93 (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=	56.67	49.73	51.69	45.61	44.16	38.7	36.45	40.99	41.23	47.33	50.97	55.06	(65)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	138.46	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	48.22	42.82	34.83	26.37	19.71	16.64	17.98	23.37	31.37	39.83	46.49	49.56	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	303.42	306.57	298.63	281.74	260.42	240.38	226.99	223.84	231.78	248.67	269.99	290.03	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	51.15	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	(71)
Water heating gains (Table 5)													
(72)m=	76.17	74	69.48	63.34	59.36	53.75	48.99	55.1	57.27	63.62	70.79	74.01	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	528.11	523.69	503.24	471.76	439.79	411.08	394.27	402.61	420.72	452.42	487.57	513.9	(73)

6. Solar gains:

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

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

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

(83)m=	80.44	157.35	259.13	377.93	463.17	474.13	451.39	387.74	301.38	186.71	100.29	66.15	(83)

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

(84)m=	608.54	681.04	762.38	849.69	902.96	885.21	845.66	790.36	722.1	639.13	587.87	580.04	(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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(86)m=	0.99	0.98	0.95	0.87	0.72	0.53	0.38	0.43	0.68	0.92	0.98	0.99		(86)
Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)														
(87)m=	20.12	20.27	20.51	20.78	20.94	20.99	21	21	20.97	20.75	20.38	20.09		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)														
(88)m=	20.04	20.04	20.05	20.06	20.06	20.07	20.07	20.07	20.06	20.06	20.05	20.05		(88)
Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)														
(89)m=	0.99	0.98	0.94	0.84	0.66	0.45	0.3	0.34	0.6	0.89	0.97	0.99		(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)														
(90)m=	18.89	19.11	19.45	19.82	20	20.06	20.07	20.07	20.04	19.78	19.28	18.85		(90)
										fLA = Living area ÷ (4) =			0.31	(91)
Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2														
(92)m=	19.27	19.47	19.78	20.12	20.3	20.35	20.36	20.36	20.33	20.08	19.62	19.24		(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate														
(93)m=	19.27	19.47	19.78	20.12	20.3	20.35	20.36	20.36	20.33	20.08	19.62	19.24		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	0.98	0.97	0.94	0.84	0.68	0.48	0.33	0.37	0.62	0.89	0.97	0.99		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	598.87	661.36	713.28	714.93	610.76	422.16	277.97	291.88	448.06	566.59	570.23	572.62		(95)
Monthly average external temperature from Table 8														
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]														
(97)m=	1140.47	1107.01	1006.64	840.98	643.03	426.04	278.34	292.64	463.2	709.52	940.86	1134.58		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	402.95	299.48	218.26	90.76	24.01	0	0	0	0	106.34	266.85	418.1		
									Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ =				1826.75	(98)
Space heating requirement in kWh/m²/year													25.16	(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		89.9	(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)														
	402.95	299.48	218.26	90.76	24.01	0	0	0	0	106.34	266.85	418.1		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)														(211)
	448.22	333.12	242.78	100.95	26.71	0	0	0	0	118.29	296.83	465.07		
									Total (kWh/year) = $Sum(211)_{1...5,10...12}$ =				2031.98	(211)

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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)

176.24	154.79	161.25	142.75	138.57	121.94	115.35	129.03	129.58	148.13	158.9	171.4

Efficiency of water heater 87.3 (216)

(217)m=	89.09	89	88.78	88.29	87.67	87.3	87.3	87.3	87.3	88.37	88.91	89.13	(217)

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

(219)m=	197.82	173.93	181.64	161.67	158.05	139.68	132.13	147.8	148.43	167.62	178.72	192.31

Total = Sum(219a)$_{1...12}$ = 1979.8 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		2031.98	
Water heating fuel used		1979.8	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75	(231)
Electricity for lighting		340.6	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	70.713	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	68.9	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	44.93	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost (245)...(247) + (250)…(254) = 314.43 (255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.12	(257)
SAP rating (Section 12)		84.33	(258)

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

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	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	438.91	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	427.64	(264)
Space and water heating	(261) + (262) + (263) + (264) =				866.55	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	176.77	(268)
Total CO2, kg/year			sum of (265)…(271) =		1082.24	(272)
CO2 emissions per m²			(272) ÷ (4) =		14.91	(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	1.22	=	2479.02	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	2415.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =				4894.38	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1045.65	(268)
'Total Primary Energy			sum of (265)…(271) =		6170.28	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		84.99	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**

Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 2 Beds - Flat Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.6	(1a) x	2.6	(2a) =	188.76	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	188.76	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.31	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	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=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	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	=	2			(26)
Windows Type 1			2.88	x	1/[1/(1.2)+ 0.04]	=	3.3			(27)
Windows Type 2			3.96	x	1/[1/(1.2)+ 0.04]	=	4.53			(27)
Walls	80	11.72	68.28	x	0.18	=	12.29			(29)
Roof	72.6	0	72.6	x	0.1	=	7.26			(30)
Total area of elements, m²			152.6							(31)
Party floor			72.6							(32a)

** 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) = 32.68 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 15804.6 (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 7.63 (36)

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

Total fabric heat loss (33) + (36) = 40.31 (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=	35.86	35.67	35.49	34.65	34.5	33.76	33.76	33.62	34.04	34.5	34.81	35.15	(38)

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

(39)m=	76.17	75.98	75.8	74.96	74.81	74.07	74.07	73.93	74.35	74.81	75.12	75.46	

Average = Sum(39)$_{1…12}$ /12= 74.96 (39)

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

(40)m=	1.05	1.05	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.04

Average = Sum(40)$_{1…12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.31 (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 — 93.69 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	103.06	99.31	95.56	91.82	88.07	84.32	84.32	88.07	91.82	95.56	99.31	103.06	
Total = Sum(44)$_{1…12}$ =												1124.28	(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=	152.83	133.67	137.93	120.25	115.39	99.57	92.27	105.88	107.14	124.86	136.3	148.01	
Total = Sum(45)$_{1…12}$ =												1474.11	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 0 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = — 0 (54)

Enter (50) or (54) in (55) — 0 (55)

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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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=	129.91	113.62	117.24	102.22	98.08	84.63	78.43	90	91.07	106.13	115.85	125.81	(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=	129.91	113.62	117.24	102.22	98.08	84.63	78.43	90	91.07	106.13	115.85	125.81	

Output from water heater (annual)1…12 | 1252.99 | (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=	32.48	28.4	29.31	25.55	24.52	21.16	19.61	22.5	22.77	26.53	28.96	31.45	(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=	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	115.38	(66)

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

(67)m=	19.29	17.13	13.93	10.55	7.88	6.66	7.19	9.35	12.55	15.93	18.59	19.82	(67)

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

(68)m=	203.29	205.4	200.08	188.77	174.48	161.05	152.08	149.98	155.29	166.61	180.89	194.32	(68)

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

(69)m=	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	34.54	(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=	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	-92.3	(71)

Water heating gains (Table 5)

(72)m=	43.65	42.27	39.4	35.49	32.96	29.39	26.35	30.24	31.62	35.66	40.23	42.27	(72)

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

(73)m=	323.84	322.41	311.02	292.42	272.94	254.71	243.24	247.18	257.07	275.82	297.33	314.03	(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)

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

(83)m=	80.44	157.35	259.13	377.93	463.17	474.13	451.39	387.74	301.38	186.71	100.29	66.15	(83)

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

(84)m=	404.28	479.76	570.16	670.35	736.1	728.85	694.64	634.92	558.46	462.53	397.62	380.18	(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

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(86)m=	1	1	0.99	0.94	0.82	0.63	0.47	0.53	0.81	0.98	1	1	(86)

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

(87)m=	19.86	20.02	20.29	20.64	20.88	20.98	21	20.99	20.92	20.57	20.14	19.83	(87)

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

(88)m=	20.04	20.04	20.05	20.06	20.06	20.07	20.07	20.07	20.06	20.06	20.05	20.05	(88)

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

(89)m=	1	0.99	0.98	0.92	0.77	0.55	0.37	0.42	0.74	0.96	1	1	(89)

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

(90)m=	18.99	19.16	19.43	19.77	19.98	20.06	20.07	20.07	20.02	19.71	19.29	18.97	(90)

fLA = Living area ÷ (4) = 0.31 (91)

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

(92)m=	19.26	19.43	19.7	20.04	20.26	20.35	20.36	20.36	20.3	19.98	19.56	19.24	(92)

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

(93)m=	19.26	19.43	19.7	20.04	20.26	20.35	20.36	20.36	20.3	19.98	19.56	19.24	(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	0.78	0.57	0.4	0.46	0.76	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	403.31	476.79	558.3	618.13	575.34	416.32	277.23	290.35	421.91	445.41	395.52	379.53	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1139.79	1103.74	1000.59	835.06	640.46	425.56	278.27	292.49	461.05	701.68	935.92	1134.95	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	547.94	421.31	329.07	156.19	48.45	0	0	0	0	190.66	389.09	562.03	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2644.74 (98)

Space heating requirement in kWh/m²/year 36.43 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	696.27	548.13	561.9	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.94	0.97	0.96	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	656.1	533.55	539.04	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	937.89	896.23	827.96	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	202.89	269.84	214.96	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 687.69 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)	=	0	(106)

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

(107)m=	0	0	0	0	0	50.72	67.46	53.74	0	0	0	0

Total = Sum(107)	=	171.92	(107)
Space cooling requirement in kWh/m²/year	(107) ÷ (4) =	2.37	(108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency	(99) + (108) =	38.8	(109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 2 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	45.42	(1a)	x	2.6	(2a)	=	118.09	(3a)
First floor	45.42	(1b)	x	2.6	(2b)	=	118.09	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	90.84	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	236.18	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.13	(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	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	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	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Floor			45.42	x	0.14	=	6.3588			(28)
Walls	93.6	14.6	79	x	0.18	=	14.22			(29)
Roof	45.42	0	45.42	x	0.1	=	4.54			(30)
Total area of elements, m²			184.44							(31)
Party wall			52	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) = 41.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 22465.28 (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 9.22 (36)

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

Total fabric heat loss (33) + (36) = 50.77 (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=	43.86	43.68	43.49	42.62	42.45	41.69	41.69	41.55	41.98	42.45	42.78	43.13		(38)
Heat transfer coefficient, W/K								(39)m = (37) + (38)m						
(39)m=	94.64	94.45	94.26	93.39	93.22	92.46	92.46	92.32	92.75	93.22	93.55	93.9		
									Average = Sum(39)$_{1…12}$ /12=				93.38	(39)
Heat loss parameter (HLP), W/m²K								(40)m = (39)m ÷ (4)						
(40)m=	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.03		
									Average = Sum(40)$_{1…12}$ /12=				1.03	(40)
Number of days in month (Table 1a)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 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	2.64	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 *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)*	101.92	(43)

	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=	112.12	108.04	103.96	99.89	95.81	91.73	91.73	95.81	99.89	103.96	108.04	112.12		
									Total = Sum(44)$_{1…12}$ =				1223.1	(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=	166.27	145.42	150.06	130.82	125.53	108.32	100.38	115.18	116.56	135.84	148.28	161.02		
									Total = Sum(45)$_{1…12}$ =				1603.68	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	24.94	21.81	22.51	19.62	18.83	16.25	15.06	17.28	17.48	20.38	22.24	24.15		(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel		0	(47)
If community heating and no tank in dwelling, enter 110 litres in (47)			
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)			
Water storage loss:			
a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)
Water storage loss calculated for each month	((56)m = (55) × (41)m		

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

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

(61)m=	23.47	21.18	23.4	22.58	23.27	22.44	23.14	23.22	22.52	23.34	22.66	23.45	(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=	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47	(62)

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

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

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47

Output from water heater (annual)$_{1…12}$ | 1878.34 | (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=	61.15	53.65	55.74	49.14	47.56	41.63	39.16	44.1	44.39	51	54.97	59.4	(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=	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	158.22	(66)

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

(67)m=	56.64	50.31	40.92	30.98	23.15	19.55	21.12	27.46	36.85	46.79	54.61	58.22	(67)

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

(68)m=	359.12	362.85	353.46	333.47	308.23	284.51	268.67	264.94	274.33	294.32	319.56	343.28	(68)

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

(69)m=	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	53.46	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	(71)

Water heating gains (Table 5)

(72)m=	82.19	79.83	74.92	68.26	63.92	57.82	52.64	59.28	61.65	68.55	76.34	79.84	(72)

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

(73)m=	607.16	602.19	578.5	541.9	504.5	471.08	451.62	460.87	482.03	518.86	559.71	590.54	(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)

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

(83)m=	104.27	203.97	335.91	489.91	600.4	614.62	585.14	502.63	390.68	242.03	130.01	85.75	(83)

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

(84)m=	711.43	806.16	914.41	1031.81	1104.9	1085.69	1036.77	963.5	872.71	760.89	689.72	676.28	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.96	0.88	0.73	0.54	0.39	0.44	0.69	0.93	0.99	0.99	(86)

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

(87)m=	20.08	20.23	20.48	20.77	20.93	20.99	21	21	20.96	20.72	20.34	20.04	(87)

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

(88)m=	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.06	(88)

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

(89)m=	0.99	0.98	0.95	0.85	0.67	0.46	0.31	0.35	0.61	0.9	0.98	0.99	(89)

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

(90)m=	18.84	19.06	19.42	19.8	20	20.06	20.07	20.07	20.04	19.76	19.23	18.79	(90)

fLA = Living area ÷ (4) = 0.22 (91)

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

(92)m=	19.11	19.32	19.65	20.02	20.21	20.27	20.27	20.27	20.24	19.97	19.47	19.07	(92)

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

(93)m=	19.11	19.32	19.65	20.02	20.21	20.27	20.27	20.27	20.24	19.97	19.47	19.07	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.94	0.85	0.68	0.48	0.33	0.37	0.63	0.9	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	702.61	786.65	861.47	875.8	752.44	519.18	339.13	356.69	549.81	683.58	672.96	669.65	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1401.43	1361.84	1239.77	1038.17	793.15	523.94	339.6	357.58	569.72	873.46	1157.6	1396.01	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	519.92	386.53	281.46	116.91	30.29	0	0	0	0	141.27	348.94	540.41	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2365.73 (98)

Space heating requirement in kWh/m²/year — 26.04 (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	92.9	(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)	519.92	386.53	281.46	116.91	30.29	0	0	0	0	141.27	348.94	540.41		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	559.66	416.07	302.97	125.84	32.61	0	0	0	0	152.06	375.61	581.71		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2546.53	(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)	189.74	166.6	173.46	153.4	148.8	130.76	123.52	138.41	139.08	159.17	170.94	184.47		
Efficiency of water heater													87.3	(216)
(217)m=	89.19	89.1	88.89	88.41	87.73	87.3	87.3	87.3	87.3	88.5	89.03	89.22		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	212.73	186.97	195.14	173.52	169.61	149.79	141.49	158.54	159.31	179.85	192	206.75		
Total = Sum(219a)$_{1...12}$ =													2125.7	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		2546.53	
Water heating fuel used		2125.7	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		400.14	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	88.6192	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	73.97	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	52.78	(250)
Additional standing charges (Table 12)				120	(251)

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

Total energy cost	(245)...(247) + (250)…(254) =	345.26	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.07	(257)
SAP rating (Section 12)		85.11	(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	0.216	=	550.05	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	459.15	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1009.2	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	207.67	(268)
Total CO2, kg/year			sum of (265)…(271) =		1255.8	(272)
CO2 emissions per m²			(272) ÷ (4) =		13.82	(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	1.22	=	3106.77	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	2593.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =				5700.12	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1228.42	(268)
'Total Primary Energy			sum of (265)…(271) =		7158.79	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		78.81	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 2 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	45.42	(1a)	x	2.6	(2a)	=	118.09	(3a)
First floor	45.42	(1b)	x	2.6	(2b)	=	118.09	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	90.84	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	236.18	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.13	(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		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	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	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Floor			45.42	x	0.14	=	6.3588			(28)
Walls	93.6	14.6	79	x	0.18	=	14.22			(29)
Roof	45.42	0	45.42	x	0.1	=	4.54			(30)
Total area of elements, m²			184.44							(31)
Party wall			52	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) = 41.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 22465.28 (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 9.22 (36)

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

Total fabric heat loss (33) + (36) = 50.77 (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

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(38)m=	43.86	43.68	43.49	42.62	42.45	41.69	41.69	41.55	41.98	42.45	42.78	43.13	(38)

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

(39)m=	94.64	94.45	94.26	93.39	93.22	92.46	92.46	92.32	92.75	93.22	93.55	93.9	

Average = Sum(39)1…12 /12= 93.38 (39)

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

(40)m=	1.04	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.03	1.03	1.03	

Average = Sum(40)1…12 /12= 1.03 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.64 (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) + 36 101.92 (43)
Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	112.12	108.04	103.96	99.89	95.81	91.73	91.73	95.81	99.89	103.96	108.04	112.12	

Total = Sum(44)1…12 = 1223.1 (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=	166.27	145.42	150.06	130.82	125.53	108.32	100.38	115.18	116.56	135.84	148.28	161.02	

Total = Sum(45)1…12 = 1603.68 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:
Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)
If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:
a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)
Temperature factor from Table 2b 0 (49)
Energy lost from water storage, kWh/year (48) x (49) = 0 (50)
b) If manufacturer's declared cylinder loss factor is not known:
Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)
If community heating see section 4.3
Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	141.33	123.61	127.55	111.2	106.7	92.07	85.32	97.91	99.08	115.46	126.04	136.87	(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=	141.33	123.61	127.55	111.2	106.7	92.07	85.32	97.91	99.08	115.46	126.04	136.87

Output from water heater (annual) $_{1…12}$ | 1363.13 | (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=	35.33	30.9	31.89	27.8	26.68	23.02	21.33	24.48	24.77	28.87	31.51	34.22	(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=	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	131.85	(66)

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

(67)m=	22.66	20.12	16.37	12.39	9.26	7.82	8.45	10.98	14.74	18.72	21.84	23.29	(67)

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

(68)m=	240.61	243.11	236.82	223.42	206.51	190.62	180.01	177.51	183.8	197.2	214.1	230	(68)

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

(69)m=	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	36.18	(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=	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	-105.48	(71)

Water heating gains (Table 5)

(72)m=	47.49	45.98	42.86	38.61	35.85	31.97	28.67	32.9	34.4	38.8	43.76	45.99	(72)

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

(73)m=	373.31	371.77	358.6	336.98	314.18	292.97	279.68	283.95	295.5	317.27	342.27	361.83	(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)

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

(83)m=	104.27	203.97	335.91	489.91	600.4	614.62	585.14	502.63	390.68	242.03	130.01	85.75	(83)

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

(84)m=	477.58	575.74	694.51	826.89	914.59	907.59	864.82	786.57	686.18	559.3	472.28	447.57	(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	0.94	0.82	0.63	0.47	0.53	0.82	0.98	1	1	(86)

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

(87)m=	19.84	20	20.28	20.63	20.88	20.98	21	20.99	20.92	20.55	20.12	19.81	(87)

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

(88)m=	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.06	(88)

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

(89)m=	1	1	0.98	0.93	0.77	0.55	0.37	0.43	0.74	0.97	1	1	(89)

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

(90)m=	18.98	19.15	19.42	19.77	19.98	20.06	20.07	20.07	20.02	19.7	19.27	18.95	(90)

fLA = Living area ÷ (4) = | 0.22 | (91)

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

(92)m=	19.17	19.33	19.61	19.96	20.18	20.26	20.27	20.27	20.22	19.89	19.46	19.14	(92)

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

(93)m=	19.17	19.33	19.61	19.96	20.18	20.26	20.27	20.27	20.22	19.89	19.46	19.14	(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	0.78	0.56	0.39	0.45	0.76	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	476.72	572.69	681.11	763.38	712.19	512.7	338.4	354.98	519.16	540.39	470.25	446.99	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1407.07	1363.27	1236.07	1032.65	790.55	523.47	339.53	357.44	567.37	865.93	1156.44	1403.13	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	692.18	531.27	412.89	193.87	58.3	0	0	0	0	242.2	494.06	711.37	

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 3336.13 | (98)

Space heating requirement in kWh/m²/year | 36.73 | (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	869.13	684.21	701.64	0	0	0	0	(100)

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Utilisation factor for loss hm

(101)m=	0	0	0	0	0	0.94	0.97	0.96	0	0	0	0	(101)

Useful loss, hmLm (Watts) = (100)m x (101)m

(102)m=	0	0	0	0	0	817.51	665.39	671.54	0	0	0	0	(102)

Gains (solar gains calculated for applicable weather region, see Table 10)

(103)m=	0	0	0	0	0	1160.61	1108.59	1018.98	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	247.04	329.74	258.5	0	0	0	0

Total = Sum(104)$_{6...8}$ = 835.27 (104)

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

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

(107)m=	0	0	0	0	0	61.76	82.43	64.62	0	0	0	0

Total = Sum(107)$_{6...8}$ = 208.82 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.3 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = 39.02 (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 3 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	50.94	(1a)	x	2.6	(2a)	=	132.46	(3a)
First floor	50.94	(1b)	x	2.6	(2b)	=	132.46	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	101.89	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	264.91	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							3	x 10 =	30	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.11	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.34	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.32	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

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

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			4.41	x1/[1/(1.2)+ 0.04]		=	5.05			(27)
Floor			50.945	x	0.14	=	7.1323			(28)
Walls	125	18.65	106.35	x	0.2	=	21.27			(29)
Roof	50.94	0	50.94	x	0.1	=	5.09			(30)
Total area of elements, m²			226.89							(31)
Party wall			25	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) = 54.56 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18554.9 (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 11.34 (36)

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

Total fabric heat loss — (33) + (36) = 65.91 (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=	49.59	49.36	49.13	48.08	47.89	46.97	46.97	46.81	47.32	47.89	48.28	48.7	(38)

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

(39)m=	115.49	115.26	115.04	113.99	113.8	112.88	112.88	112.71	113.23	113.8	114.19	114.61	

Average = $Sum(39)_{1...12}$ /12= 113.99 (39)

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

(40)m=	1.13	1.13	1.13	1.12	1.12	1.11	1.11	1.11	1.11	1.12	1.12	1.12	

Average = $Sum(40)_{1...12}$ /12= 1.12 (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 — 2.76 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 104.91 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	115.4	111.2	107.01	102.81	98.61	94.42	94.42	98.61	102.81	107.01	111.2	115.4	

Total = $Sum(44)_{1...12}$ = 1258.89 (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=	171.13	149.67	154.45	134.65	129.2	111.49	103.31	118.55	119.97	139.81	152.62	165.73	

Total = $Sum(45)_{1...12}$ = 1650.6 (45)

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

(46)m=	25.67	22.45	23.17	20.2	19.38	16.72	15.5	17.78	18	20.97	22.89	24.86	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 1.41 (48)

Temperature factor from Table 2b — 0.54 (49)

Energy lost from water storage, kWh/year — (48) x (49) = 0.76 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) — 0.76 (55)

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

(56)m=	23.6	21.32	23.6	22.84	23.6	22.84	23.6	23.6	22.84	23.6	22.84	23.6	(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=	23.6	21.32	23.6	22.84	23.6	22.84	23.6	23.6	22.84	23.6	22.84	23.6	(57)

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

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

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

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

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6	(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=	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6

Output from water heater (annual)$_{1...12}$ | 2202.41 | (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=	94.39	83.63	88.85	81.06	80.45	73.35	71.84	76.91	76.17	83.98	87.03	92.6	(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=	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	165.38	(66)

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

(67)m=	59.17	52.56	42.74	32.36	24.19	20.42	22.07	28.68	38.5	48.88	57.05	60.82	(67)

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

(68)m=	387.08	391.1	380.98	359.43	332.23	306.66	289.58	285.57	295.69	317.24	344.44	370	(68)

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

(69)m=	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	54.29	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

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

(71)m=	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	(71)

Water heating gains (Table 5)

(72)m=	126.87	124.45	119.42	112.58	108.14	101.88	96.57	103.38	105.8	112.88	120.87	124.46	(72)

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

(73)m=	685.55	680.53	655.56	616.79	576.97	541.39	520.64	530.05	552.4	591.42	634.78	667.7	(73)

6. Solar gains:

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

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

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

(83)m=	137.78	269.53	443.88	647.38	793.39	812.17	773.22	664.19	516.26	319.83	171.8	113.31	(83)

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

(84)m=	823.34	950.06	1099.44	1264.17	1370.36	1353.56	1293.86	1194.23	1068.66	911.24	806.58	781.01	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.96	0.87	0.71	0.52	0.38	0.43	0.69	0.92	0.98	0.99	(86)

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

(87)m=	19.97	20.15	20.43	20.74	20.93	20.99	21	21	20.95	20.68	20.26	19.94	(87)

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

(88)m=	19.97	19.98	19.98	19.99	19.99	19.99	19.99	20	19.99	19.99	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.94	0.84	0.65	0.45	0.3	0.34	0.6	0.9	0.98	0.99	(89)

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

(90)m=	18.63	18.88	19.28	19.71	19.92	19.99	19.99	19.99	19.96	19.65	19.06	18.58	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	18.96	19.2	19.57	19.97	20.17	20.24	20.24	20.24	20.21	19.9	19.36	18.92	(92)

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

(93)m=	18.96	19.2	19.57	19.97	20.17	20.24	20.24	20.24	20.21	19.9	19.36	18.92	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.97	0.94	0.84	0.66	0.47	0.32	0.36	0.62	0.89	0.97	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	812.39	924.79	1029.08	1056.97	911.29	629.54	410.67	431.95	663.96	813.83	785.69	772.81	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1693.42	1648	1503.27	1261.32	964.2	636.33	411.43	433.37	691.67	1058.87	1399.99	1686.81	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	655.49	486	352.8	147.14	39.37	0	0	0	0	182.31	442.3	680.02	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 2985.42 (98)

Space heating requirement in kWh/m²/year 29.3 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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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		93.5	(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)	655.49	486	352.8	147.14	39.37	0	0	0	0	182.31	442.3	680.02		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	701.06	519.79	377.32	157.36	42.1	0	0	0	0	194.98	473.04	727.29		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3192.96	(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)	218	192	201.32	180.01	176.07	156.85	150.18	165.42	165.32	186.68	197.97	212.6		
Efficiency of water heater													79.8	(216)
(217)m=	87.57	87.19	86.3	84.28	81.56	79.8	79.8	79.8	79.8	84.75	86.9	87.7		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	248.94	220.21	233.28	213.58	215.87	196.55	188.2	207.29	207.17	220.27	227.82	242.42		
Total = Sum(219a)$_{1...12}$ =													2621.61	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3192.96	
Water heating fuel used		2621.61	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year (sum of (230a)…(230g) =)		75	(231)
Electricity for lighting		418.02	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	111.1149	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	91.23	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	55.14	(250)

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Additional standing charges (Table 12)		120	(251)
Appendix Q items: repeat lines (253) and (254) as needed			
Total energy cost	(245)...(247) + (250)…(254) =	387.38	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.11	(257)
SAP rating (Section 12)		84.55	(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	0.216	=	689.68	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	566.27	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1255.95	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	216.95	(268)
Total CO2, kg/year		sum of (265)…(271) =		1511.82	(272)
CO2 emissions per m²		(272) ÷ (4) =		14.84	(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	1.22	=	3895.41	(261)
Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	1.22	=	3198.36	(264)
Space and water heating	(261) + (262) + (263) + (264) =			7093.77	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	230.25	(267)
Electricity for lighting	(232) x	0	=	1283.32	(268)
'Total Primary Energy		sum of (265)…(271) =		8607.34	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		84.48	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 3 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	50.94	(1a)	x	2.6	(2a)	=	132.46	(3a)
First floor	50.94	(1b)	x	2.6	(2b)	=	132.46	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	101.89	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	264.91	(5)

2. Ventilation rate:

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

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.15	(8)

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.38	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.41	0.4	0.39	0.35	0.34	0.3	0.3	0.3	0.32	0.34	0.36	0.38

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

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

(25)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			4.41	x1/[1/(1.2)+ 0.04]		=	5.05			(27)
Floor			50.945	x	0.14	=	7.1323			(28)
Walls	125	18.65	106.35	x	0.2	=	21.27			(29)
Roof	50.94	0	50.94	x	0.1	=	5.09			(30)
Total area of elements, m²			226.89							(31)
Party wall			25	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) = 54.56 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18554.9 (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 11.34 (36)

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

Total fabric heat loss (33) + (36) = 65.91 (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=	50.97	50.69	50.41	49.11	48.87	47.74	47.74	47.53	48.18	48.87	49.37	49.87	(38)

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

(39)m=	116.87	116.59	116.31	115.02	114.77	113.65	113.65	113.44	114.08	114.77	115.27	115.78	

Average = $Sum(39)_{1...12}$ /12= 115.02 (39)

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

(40)m=	1.15	1.14	1.14	1.13	1.13	1.12	1.12	1.11	1.12	1.13	1.13	1.14	

Average = $Sum(40)_{1...12}$ /12= 1.13 (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 2.76 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.91 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	115.4	111.2	107.01	102.81	98.61	94.42	94.42	98.61	102.81	107.01	111.2	115.4	

Total = $Sum(44)_{1...12}$ = 1258.89 (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=	171.13	149.67	154.45	134.65	129.2	111.49	103.31	118.55	119.97	139.81	152.62	165.73	

Total = $Sum(45)_{1...12}$ = 1650.6 (45)

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

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

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

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

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

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

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	145.46	127.22	131.28	114.46	109.82	94.77	87.82	100.77	101.97	118.84	129.72	140.87	(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=	145.46	127.22	131.28	114.46	109.82	94.77	87.82	100.77	101.97	118.84	129.72	140.87	

Output from water heater (annual)$_{1...12}$ 1403.01 (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=	36.37	31.81	32.82	28.61	27.46	23.69	21.95	25.19	25.49	29.71	32.43	35.22	(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=	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	137.82	(66)

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

(67)m=	23.67	21.02	17.1	12.94	9.68	8.17	8.83	11.47	15.4	19.55	22.82	24.33	(67)

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

(68)m=	259.35	262.04	255.25	240.82	222.59	205.46	194.02	191.33	198.11	212.55	230.77	247.9	(68)

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

(69)m=	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	36.78	(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=	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	-110.25	(71)

Water heating gains (Table 5)

(72)m=	48.88	47.33	44.11	39.74	36.9	32.91	29.51	33.86	35.41	39.93	45.04	47.34	(72)

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

(73)m=	396.24	394.73	380.81	357.85	333.52	310.88	296.7	301.01	313.26	336.38	362.98	383.91	(73)

6. Solar gains:

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

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

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

(83)m=	137.78	269.53	443.88	647.38	793.39	812.17	773.22	664.19	516.26	319.83	171.8	113.31	(83)

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

(84)m=	534.02	664.27	824.7	1005.23	1126.9	1123.06	1069.92	965.2	829.52	656.2	534.78	497.22	(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	0.94	0.81	0.62	0.46	0.53	0.81	0.98	1	1	(86)

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

(87)m=	19.69	19.88	20.19	20.59	20.86	20.97	21	20.99	20.9	20.49	20.01	19.66	(87)

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

(88)m=	19.96	19.96	19.97	19.98	19.98	19.99	19.99	19.99	19.98	19.98	19.98	19.97	(88)

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

(89)m=	1	1	0.98	0.92	0.76	0.53	0.36	0.42	0.74	0.97	1	1	(89)

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

(90)m=	18.77	18.95	19.27	19.65	19.89	19.98	19.99	19.99	19.93	19.57	19.1	18.74	(90)

fLA = Living area ÷ (4) = 0.25 (91)

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

(92)m=	19	19.19	19.5	19.89	20.13	20.23	20.24	20.24	20.17	19.8	19.32	18.97	(92)

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

(93)m=	19	19.19	19.5	19.89	20.13	20.23	20.24	20.24	20.17	19.8	19.32	18.97	(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	0.77	0.56	0.38	0.45	0.75	0.96	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	533.01	660.42	806.72	920.18	864.11	623.75	411.71	431.44	624.96	633.11	532.38	496.57	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1717.75	1665.58	1512.01	1263.53	967.85	639.34	413.57	435.4	692.65	1055.93	1409.17	1710.39	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	881.45	675.47	524.73	247.21	77.18	0	0	0	0	314.58	631.29	903.08	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 4255 (98)

Space heating requirement in kWh/m²/year 41.76 (99)

8c. Space cooling requirement

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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1068.28	840.99	862.12	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.93	0.97	0.95	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	994.14	812.06	816.17	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1418.7	1354.35	1233.85	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	305.68	403.46	310.75	0	0	0	0	
Intermittency factor (Table 10b)													
(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0	
Space cooling requirement for month = (104)m × (105) × (106)m													
(107)m=	0	0	0	0	0	76.42	100.87	77.69	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1019.9 (104)

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

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

Total = Sum(107)$_{6...8}$ = 254.97 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.5 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = 44.26 (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 4 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	58.19	(1a) x	2.6	(2a) =	151.28	(3a)
First floor	58.19	(1b) x	2.6	(2b) =	151.28	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	116.37	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		302.56	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.13	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(21)

Infiltration rate modified for monthly wind speed

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

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Wind Factor (22a)m = (22)m ÷ 4

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

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

0.39	0.38	0.37	0.33	0.33	0.29	0.29	0.28	0.3	0.33	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	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.57	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	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 Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			58.185	x	0.14	=	8.1459			(28)
Walls	120	20.56	99.44	x	0.2	=	19.89			(29)
Roof	58.19	0	58.19	x	0.1	=	5.82			(30)
Total area of elements, m²			236.37							(31)
Party wall			30	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) = 56.81 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18703.36 (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.

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Thermal bridges : S (L x Y) calculated using Appendix K | 11.82 | (36)

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

Total fabric heat loss (33) + (36) = | 68.63 | (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=	57.4	57.11	56.83	55.49	55.24	54.08	54.08	53.86	54.53	55.24	55.74	56.27	(38)

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

(39)m=	126.03	125.74	125.46	124.13	123.88	122.71	122.71	122.49	123.16	123.88	124.38	124.91	

Average = Sum(39)$_{1…12}$ /12= | 124.12 | (39)

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

(40)m=	1.08	1.08	1.08	1.07	1.06	1.05	1.05	1.05	1.06	1.06	1.07	1.07	

Average = Sum(40)$_{1…12}$ /12= | 1.07 | (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 | 2.85 | (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 107.2 | (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=	117.92	113.63	109.35	105.06	100.77	96.48	96.48	100.77	105.06	109.35	113.63	117.92

Total = Sum(44)$_{1…12}$ = | 1286.43 | (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=	174.88	152.95	157.83	137.6	132.03	113.93	105.57	121.15	122.59	142.87	155.96	169.36

Total = Sum(45)$_{1…12}$ = | 1686.71 | (45)

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

(46)m=	26.23	22.94	23.67	20.64	19.8	17.09	15.84	18.17	18.39	21.43	23.39	25.4	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 180 | (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 1.51 | (48)

Temperature factor from Table 2b | 0.54 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 0.82 | (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0.82	(55)

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

(56)m=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(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=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(57)

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

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

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

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

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9	(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=	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9	

Output from water heater (annual)$_{1...12}$ | 2258.23 | (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=	96.98	85.93	91.31	83.33	82.73	75.46	73.94	79.11	78.34	86.34	89.43	95.14	(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=	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	170.89	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	65.67	58.32	47.43	35.91	26.84	22.66	24.49	31.83	42.72	54.24	63.31	67.49	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	418.52	422.86	411.92	388.62	359.21	331.57	313.1	308.76	319.7	343	372.41	400.05	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	(71)
Water heating gains (Table 5)													
(72)m=	130.35	127.87	122.73	115.74	111.2	104.81	99.38	106.34	108.81	116.04	124.21	127.88	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	729.43	723.96	696.98	655.17	612.15	573.94	551.86	561.82	586.13	628.19	674.84	710.32	(73)

6. Solar gains:

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

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

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

(83)m=	137.04	268.08	441.49	643.88	789.1	807.78	769.04	660.6	513.47	318.1	170.87	112.69	(83)

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

(84)m=	866.47	992.03	1138.46	1299.05	1401.25	1381.72	1320.91	1222.42	1099.6	946.29	845.71	823.02	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.99	0.97	0.9	0.75	0.56	0.41	0.46	0.72	0.94	0.99	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.98	20.15	20.41	20.72	20.92	20.99	21	21	20.95	20.67	20.27	19.95	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.01	20.02	20.02	20.03	20.03	20.04	20.04	20.04	20.04	20.03	20.03	20.02	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.96	0.87	0.69	0.48	0.32	0.36	0.64	0.92	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.67	18.91	19.29	19.72	19.96	20.03	20.04	20.04	20	19.67	19.1	18.63	(90)

fLA = Living area ÷ (4) = 0.25 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19	19.22	19.57	19.97	20.2	20.27	20.28	20.28	20.24	19.92	19.39	18.96	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19	19.22	19.57	19.97	20.2	20.27	20.28	20.28	20.24	19.92	19.39	18.96	(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	0.95	0.86	0.7	0.5	0.34	0.39	0.66	0.91	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	858.07	972.49	1082.45	1123.67	984.8	686.99	450.3	473.2	721.12	864.15	829.22	816.68	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1852.91	1800.56	1640.05	1374.36	1052.47	695.65	451.26	474.98	755.86	1154.52	1528.5	1844.15	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	740.17	556.46	414.85	180.49	50.35	0	0	0	0	216.04	503.48	764.43	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3426.28 (98)

Space heating requirement in kWh/m²/year 29.44 (99)

9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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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)	740.17	556.46	414.85	180.49	50.35	0	0	0	0	216.04	503.48	764.43		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	797.59	599.64	447.04	194.5	54.26	0	0	0	0	232.8	542.55	823.74		(211)
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													3692.12	(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)	223.42	196.79	206.37	184.57	180.57	160.91	154.11	169.69	169.57	191.41	202.93	217.9		
Efficiency of water heater													79.1	(216)
(217)m=	87.07	86.73	85.94	84.05	81.21	79.1	79.1	79.1	79.1	84.43	86.44	87.18		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	256.6	226.89	240.14	219.59	222.35	203.42	194.83	214.52	214.37	226.7	234.76	249.93		
Total = Sum(219a)$_{1...12}$ =													2704.1	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3692.12	
Water heating fuel used			2704.1	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			463.88	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	128.4857	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	94.1	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	61.19	(250)

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Additional standing charges (Table 12)		120	(251)
Appendix Q items: repeat lines (253) and (254) as needed			
Total energy cost	(245)...(247) + (250)…(254) =	413.67	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.08	(257)
SAP rating (Section 12)		84.98	(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	0.216	=	797.5	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	584.09	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1381.58	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	240.75	(268)
Total CO2, kg/year			sum of (265)…(271) =		1661.26	(272)
CO2 emissions per m²			(272) ÷ (4) =		14.28	(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	1.22	=	4504.38	(261)
Space heating (secondary)	(215)	x	3.07	=	0	(263)
Energy for water heating	(219)	x	1.22	=	3299	(264)
Space and water heating	(261) + (262) + (263) + (264) =				7803.38	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	230.25	(267)
Electricity for lighting	(232)	x	0	=	1424.11	(268)
'Total Primary Energy			sum of (265)…(271) =		9457.74	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		81.27	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.0.28

Property Address: 4 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	58.19	(1a)	x	2.6	(2a)	=	151.28	(3a)
First floor	58.19	(1b)	x	2.6	(2b)	=	151.28	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	116.37	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	302.56	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.13	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.39	0.38	0.37	0.33	0.33	0.29	0.29	0.28	0.3	0.33	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	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.57	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	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 Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			58.185	x	0.14	=	8.1459			(28)
Walls	120	20.56	99.44	x	0.2	=	19.89			(29)
Roof	58.19	0	58.19	x	0.1	=	5.82			(30)
Total area of elements, m²			236.37							(31)
Party wall			30	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) = 56.81 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18703.36 (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.

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

Thermal bridges : S (L x Y) calculated using Appendix K — 11.82 (36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss — (33) + (36) = 68.63 (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=	57.4	57.11	56.83	55.49	55.24	54.08	54.08	53.86	54.53	55.24	55.74	56.27	(38)

Heat transfer coefficient, W/K — (39)m = (37) + (38)m

(39)m=	126.03	125.74	125.46	124.13	123.88	122.71	122.71	122.49	123.16	123.88	124.38	124.91	

Average = Sum(39)$_{1...12}$ /12= 124.12 (39)

Heat loss parameter (HLP), W/m²K — (40)m = (39)m ÷ (4)

(40)m=	1.08	1.08	1.08	1.07	1.06	1.05	1.05	1.05	1.06	1.06	1.07	1.07	

Average = Sum(40)$_{1...12}$ /12= 1.07 (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 — 2.85 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 107.2 (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=	117.92	113.63	109.35	105.06	100.77	96.48	96.48	100.77	105.06	109.35	113.63	117.92	

Total = Sum(44)$_{1...12}$ = 1286.43 (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=	174.88	152.95	157.83	137.6	132.03	113.93	105.57	121.15	122.59	142.87	155.96	169.36	

Total = Sum(45)$_{1...12}$ = 1686.71 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 180 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0 (48)

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = 0 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0 (51)

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	148.64	130.01	134.15	116.96	112.22	96.84	89.74	102.98	104.21	121.44	132.56	143.95	(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=	148.64	130.01	134.15	116.96	112.22	96.84	89.74	102.98	104.21	121.44	132.56	143.95	

Output from water heater (annual)$_{1...12}$ 1433.71 (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=	37.16	32.5	33.54	29.24	28.06	24.21	22.43	25.74	26.05	30.36	33.14	35.99	(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=	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	142.4	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	26.27	23.33	18.97	14.36	10.74	9.06	9.79	12.73	17.09	21.7	25.32	27	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	280.41	283.32	275.99	260.38	240.67	222.15	209.78	206.87	214.2	229.81	249.52	268.04	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	37.24	(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=	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	-113.92	(71)

Water heating gains (Table 5)

(72)m=	49.95	48.37	45.08	40.61	37.71	33.63	30.15	34.6	36.18	40.81	46.03	48.37	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	422.34	420.73	405.76	381.07	354.84	330.56	315.45	319.92	333.19	358.04	386.59	409.13	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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Orientation:	Access Factor Table 6d	Area m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	137.04	268.08	441.49	643.88	789.1	807.78	769.04	660.6	513.47	318.1	170.87	112.69	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	559.38	688.81	847.24	1024.95	1143.94	1138.35	1084.49	980.52	846.66	676.13	557.46	521.82	(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=	1	1	0.99	0.95	0.85	0.66	0.49	0.56	0.84	0.98	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.74	19.91	20.2	20.57	20.85	20.97	20.99	20.99	20.89	20.49	20.04	19.71	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.01	20.02	20.02	20.03	20.03	20.04	20.04	20.04	20.04	20.03	20.03	20.02	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.94	0.8	0.57	0.39	0.45	0.78	0.98	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.85	19.02	19.32	19.68	19.93	20.02	20.04	20.04	19.97	19.61	19.16	18.83	(90)

fLA = Living area ÷ (4) = 0.25 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19.07	19.24	19.54	19.91	20.16	20.26	20.28	20.27	20.2	19.83	19.38	19.05	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.07	19.24	19.54	19.91	20.16	20.26	20.28	20.27	20.2	19.83	19.38	19.05	(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	0.98	0.94	0.8	0.59	0.41	0.48	0.79	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	558.71	686.19	834.45	959.15	919.04	674.93	448.76	469.77	667.93	658.89	555.85	521.35	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1862.05	1803.8	1635.61	1366.13	1048	694.69	451.13	474.65	751.6	1143.71	1527.8	1855.02	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	969.68	751.03	596.06	293.02	95.95	0	0	0	0	360.7	699.81	992.25	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 4758.52 (98)

Space heating requirement in kWh/m²/year 40.89 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1153.47	908.05	930.92	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.92	0.96	0.94	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1062.69	873	875.34	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	1443.92	1378.52	1259.21	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(104)m=	0	0	0	0	0	274.49	376.11	285.6	0	0	0	0

Total = Sum(104)$_{6...8}$ = 936.2 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)$_{6...8}$ = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(107)m=	0	0	0	0	0	68.62	94.03	71.4	0	0	0	0

Total = Sum(107)$_{6...8}$ = 234.05 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.01 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency — (99) + (108) = 42.9 (109)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.0.28

Property Address: 5 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	42.67	(1a)	x	2.6	(2a)	=	110.94	(3a)
First floor	42.67	(1b)	x	2.6	(2b)	=	110.94	(3b)
Second floor	42.66	(1c)	x	2.6	(2c)	=	110.92	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	128	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	332.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

DRAFT

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	0	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			42.67	x	0.14	=	5.9738			(28)
Walls	210	34.06	175.94	x	0.2	=	35.19			(29)
Roof	42.67	0	42.67	x	0.1	=	4.27			(30)
Total area of elements, m²			295.34							(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) =	83.85	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	27336.18	(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	14.77	(36)

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if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	98.62	(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=	62.6	62.3	62.01	60.63	60.37	59.17	59.17	58.95	59.63	60.37	60.9	61.44	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	161.22	160.92	160.62	159.25	158.99	157.79	157.79	157.57	158.25	158.99	159.51	160.05	

Average = Sum(39)$_{1\ldots12}$ /12= 159.24 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	1.26	1.26	1.25	1.24	1.24	1.23	1.23	1.23	1.24	1.24	1.25	1.25	

Average = Sum(40)$_{1\ldots12}$ /12= 1.24 (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 2.89 (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) + 36 108.24 (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=	119.06	114.73	110.4	106.08	101.75	97.42	97.42	101.75	106.08	110.4	114.73	119.06	

Total = Sum(44)$_{1\ldots12}$ = 1298.88 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	176.57	154.43	159.36	138.93	133.31	115.03	106.6	122.32	123.78	144.25	157.47	171	

Total = Sum(45)$_{1\ldots12}$ = 1703.04 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	26.49	23.16	23.9	20.84	20	17.26	15.99	18.35	18.57	21.64	23.62	25.65	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel		180	(47)
If community heating and no tank in dwelling, enter 110 litres in (47)			
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)			
Water storage loss:			
a) If manufacturer's declared loss factor is known (kWh/day):		1.51	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.82	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0.82	(55)

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Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(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=	25.28	22.83	25.28	24.46	25.28	24.46	25.28	25.28	24.46	25.28	24.46	25.28	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54	(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=	225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54

Output from water heater (annual)$_{1...12}$ | 2274.55 | (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=	97.54	86.42	91.82	83.77	83.16	75.83	74.27	79.5	78.74	86.8	89.94	95.69	(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=	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	173.38	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	65.81	58.46	47.54	35.99	26.9	22.71	24.54	31.9	42.82	54.37	63.45	67.64	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	440.74	445.31	433.78	409.25	378.28	349.17	329.72	325.15	336.67	361.21	392.18	421.29	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	55.23	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	(71)

Water heating gains (Table 5)

(72)m=	131.1	128.6	123.41	116.35	111.77	105.32	99.83	106.86	109.36	116.66	124.91	128.61	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	753.67	748.39	720.75	677.61	632.97	593.22	570.12	579.93	604.87	648.26	696.56	733.57	(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	2.88	x	46.75	x	0.8	x	0.76	=	226.93	(78)
South	0.9x	0.77	x	2.88	x	76.57	x	0.8	x	0.76	=	371.65	(78)
South	0.9x	0.77	x	2.88	x	97.53	x	0.8	x	0.76	=	473.42	(78)
South	0.9x	0.77	x	2.88	x	110.23	x	0.8	x	0.76	=	535.07	(78)
South	0.9x	0.77	x	2.88	x	114.87	x	0.8	x	0.76	=	557.57	(78)
South	0.9x	0.77	x	2.88	x	110.55	x	0.8	x	0.76	=	536.59	(78)
South	0.9x	0.77	x	2.88	x	108.01	x	0.8	x	0.76	=	524.28	(78)
South	0.9x	0.77	x	2.88	x	104.89	x	0.8	x	0.76	=	509.15	(78)
South	0.9x	0.77	x	2.88	x	101.89	x	0.8	x	0.76	=	494.54	(78)
South	0.9x	0.77	x	2.88	x	82.59	x	0.8	x	0.76	=	400.86	(78)
South	0.9x	0.77	x	2.88	x	55.42	x	0.8	x	0.76	=	268.99	(78)
South	0.9x	0.77	x	2.88	x	40.4	x	0.8	x	0.76	=	196.09	(78)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	380.35	671.78	967.69	1255.93	1441.02	1440.95	1385.27	1248.73	1069.4	756.99	460.29	322.26	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	1134.03	1420.17	1688.44	1933.54	2073.99	2034.17	1955.39	1828.65	1674.27	1405.25	1156.85	1055.82	(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=	0.99	0.97	0.93	0.82	0.66	0.49	0.35	0.39	0.62	0.89	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.87	20.13	20.45	20.76	20.93	20.99	21	21	20.96	20.7	20.22	19.82	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.87	19.87	19.88	19.88	19.89	19.89	19.89	19.9	19.89	19.89	19.88	19.88	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.96	0.91	0.78	0.6	0.41	0.27	0.3	0.53	0.85	0.97	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.41	18.78	19.23	19.63	19.83	19.89	19.89	19.89	19.87	19.58	18.91	18.33	(90)

fLA = Living area ÷ (4) = | 0.17 | (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	18.65	19	19.43	19.82	20.01	20.07	20.08	20.08	20.05	19.77	19.13	18.58	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.65	19	19.43	19.82	20.01	20.07	20.08	20.08	20.05	19.77	19.13	18.58	(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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	0.98	0.96	0.9	0.78	0.61	0.42	0.28	0.32	0.55	0.84	0.96	0.99	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	1113.05	1356.54	1515.72	1505.84	1259.53	854.55	547.7	577.85	913.48	1180.69	1112.08	1041.04	(95)

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	2313.49	2269.34	2076.88	1739.15	1321.08	863.06	548.66	579.49	941.22	1457.66	1919.04	2301.84	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	893.13	613.4	417.5	167.98	45.79	0	0	0	0	206.07	581.01	938.03

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 3862.91 (98)

Space heating requirement in kWh/m²/year 30.18 (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 89.8 (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)													
	893.13	613.4	417.5	167.98	45.79	0	0	0	0	206.07	581.01	938.03	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	994.58	683.07	464.93	187.06	50.99	0	0	0	0	229.47	647	1044.58	

Total (kWh/year) =$Sum(211)_{1...5,10....12}$= 4301.68 (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)

225.11	198.27	207.9	185.9	181.85	162.01	155.14	170.86	170.75	192.79	204.44	219.54

Efficiency of water heater 79.1 (216)

(217)m=	87.42	86.93	85.94	83.84	81.04	79.1	79.1	79.1	79.1	84.29	86.75	87.55	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	257.5	228.09	241.92	221.73	224.38	204.81	196.13	216	215.87	228.73	235.68	250.75

Total = $Sum(219a)_{1...12}$ = 2721.6 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4301.68	
Water heating fuel used		2721.6	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)

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boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			464.92	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	149.6985	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	94.71	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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)	13.19	x 0.01 =	61.32	(250)
Additional standing charges (Table 12)				120	(251)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			435.63	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.06	(257)
SAP rating (Section 12)		85.25	(258)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO_2/kWh		**Emissions** kg CO_2/year	
Space heating (main system 1)	(211) x	0.216	=	929.16	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	587.86	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1517.03	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	241.29	(268)
Total CO_2, kg/year		sum of (265)…(271) =		1797.24	(272)
CO_2 emissions per m²		(272) ÷ (4) =		14.04	(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	1.22	=	5248.05	(261)

Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	1.22	=	3320.35	(264)
Space and water heating	(261) + (262) + (263) + (264) =			8568.4	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	230.25	(267)
Electricity for lighting	(232) x	0	=	1427.3	(268)
'Total Primary Energy		sum of (265)…(271) =		10225.94	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		79.89	(273)

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.0.28

Property Address: 5 Beds - House Enhanced

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	42.67	(1a)	x	2.6	(2a)	=	110.94	(3a)
First floor	42.67	(1b)	x	2.6	(2b)	=	110.94	(3b)
Second floor	42.66	(1c)	x	2.6	(2c)	=	110.92	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	128	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	332.8	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			2	x	1	=	2			(26)
Doors Type 2			2	x	1	=	2			(26)
Windows Type 1			2.88	x1/[1/(1.2)+ 0.04]		=	3.3			(27)
Windows Type 2			3.96	x1/[1/(1.2)+ 0.04]		=	4.53			(27)
Windows Type 3			1.26	x1/[1/(1.2)+ 0.04]		=	1.44			(27)
Windows Type 4			1.44	x1/[1/(1.2)+ 0.04]		=	1.65			(27)
Floor			42.67	x	0.14	=	5.9738			(28)
Walls	210	34.06	175.94	x	0.2	=	35.19			(29)
Roof	42.67	0	42.67	x	0.1	=	4.27			(30)
Total area of elements, m²			295.34							(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) = 83.85 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 27336.18 (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 14.77 (36)

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if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	98.62	(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=	62.6	62.3	62.01	60.63	60.37	59.17	59.17	58.95	59.63	60.37	60.9	61.44	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	161.22	160.92	160.62	159.25	158.99	157.79	157.79	157.57	158.25	158.99	159.51	160.05	

Average = $Sum(39)_{1...12}$ /12= 159.24 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	1.26	1.26	1.25	1.24	1.24	1.23	1.23	1.23	1.24	1.24	1.25	1.25	

Average = $Sum(40)_{1...12}$ /12= 1.24 (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 2.89 (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) + 36 108.24 (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=	119.06	114.73	110.4	106.08	101.75	97.42	97.42	101.75	106.08	110.4	114.73	119.06	

Total = $Sum(44)_{1...12}$ = 1298.88 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	176.57	154.43	159.36	138.93	133.31	115.03	106.6	122.32	123.78	144.25	157.47	171	

Total = $Sum(45)_{1...12}$ = 1703.04 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	0	0	0	0	0	0	0	0	0	0	0	0	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		0	(48)
Temperature factor from Table 2b		0	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

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Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	150.08	131.26	135.45	118.09	113.31	97.78	90.61	103.97	105.21	122.62	133.85	145.35	(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=	150.08	131.26	135.45	118.09	113.31	97.78	90.61	103.97	105.21	122.62	133.85	145.35

Output from water heater (annual)$_{1\ldots12}$ | 1447.58 | (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=	37.52	32.82	33.86	29.52	28.33	24.44	22.65	25.99	26.3	30.65	33.46	36.34	(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=	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	144.48	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	26.33	23.38	19.02	14.4	10.76	9.09	9.82	12.76	17.13	21.75	25.38	27.06	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	295.29	298.36	290.64	274.2	253.45	233.94	220.91	217.85	225.57	242.01	262.76	282.26	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	37.45	(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=	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	-115.58	(71)

Water heating gains (Table 5)

(72)m=	50.43	48.83	45.51	41	38.07	33.95	30.45	34.94	36.53	41.2	46.47	48.84	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	438.39	436.92	421.51	395.94	368.63	343.32	327.52	331.89	345.57	371.3	400.96	424.5	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
South	0.9x	0.77	x	2.88	x	46.75	x	0.8	x	0.76	=	226.93	(78)
South	0.9x	0.77	x	2.88	x	76.57	x	0.8	x	0.76	=	371.65	(78)
South	0.9x	0.77	x	2.88	x	97.53	x	0.8	x	0.76	=	473.42	(78)
South	0.9x	0.77	x	2.88	x	110.23	x	0.8	x	0.76	=	535.07	(78)
South	0.9x	0.77	x	2.88	x	114.87	x	0.8	x	0.76	=	557.57	(78)
South	0.9x	0.77	x	2.88	x	110.55	x	0.8	x	0.76	=	536.59	(78)
South	0.9x	0.77	x	2.88	x	108.01	x	0.8	x	0.76	=	524.28	(78)
South	0.9x	0.77	x	2.88	x	104.89	x	0.8	x	0.76	=	509.15	(78)
South	0.9x	0.77	x	2.88	x	101.89	x	0.8	x	0.76	=	494.54	(78)
South	0.9x	0.77	x	2.88	x	82.59	x	0.8	x	0.76	=	400.86	(78)
South	0.9x	0.77	x	2.88	x	55.42	x	0.8	x	0.76	=	268.99	(78)
South	0.9x	0.77	x	2.88	x	40.4	x	0.8	x	0.76	=	196.09	(78)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	380.35	671.78	967.69	1255.93	1441.02	1440.95	1385.27	1248.73	1069.4	756.99	460.29	322.26	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	818.75	1108.7	1389.2	1651.87	1809.65	1784.28	1712.79	1580.62	1414.97	1128.29	861.25	746.76	(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	0.96	0.88	0.73	0.55	0.4	0.45	0.71	0.94	0.99	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.65	19.92	20.29	20.66	20.89	20.98	21	20.99	20.93	20.57	20.02	19.6	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.87	19.87	19.88	19.88	19.89	19.89	19.89	19.9	19.89	19.89	19.88	19.88	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.95	0.85	0.67	0.46	0.3	0.35	0.62	0.92	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.65	18.93	19.28	19.63	19.82	19.89	19.89	19.89	19.86	19.57	19.03	18.61	(90)

fLA = Living area ÷ (4) = 0.17 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	18.82	19.09	19.45	19.8	20	20.07	20.08	20.08	20.04	19.73	19.19	18.77	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.82	19.09	19.45	19.8	20	20.07	20.08	20.08	20.04	19.73	19.19	18.77	(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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	1	0.98	0.94	0.85	0.68	0.48	0.32	0.36	0.63	0.91	0.99	1	(94)

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Useful gains, hmGm , W = (94)m x (84)m

(95)m=	814.82	1089.07	1311.82	1396.16	1223.5	848.42	546.89	576.29	889.59	1028.44	850.48	744.37	(95)

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	2340.8	2283.94	2079.64	1736.58	1319.47	862.68	548.62	579.35	939.63	1452.26	1928.94	2332.52	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	1135.33	802.95	571.26	245.1	71.4	0	0	0	0	315.32	776.49	1181.58

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5099.43 (98)

Space heating requirement in kWh/m²/year 39.84 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	1483.21	1167.64	1197.53	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.94	0.97	0.96	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	1400.9	1135.64	1150.46	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	2203.08	2116.88	1964.56	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m set (104)m to zero if (104)m < 3 × (98)m													
(104)m=	0	0	0	0	0	577.57	730.04	605.69	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1913.3 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)$_{6...8}$ = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	144.39	182.51	151.42	0	0	0	0

Total = Sum(107)$_{6...8}$ = 478.32 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 3.74 (108)

8f. Fabric Energy Efficiency (calculated only under special conditions, see section 11)

Fabric Energy Efficiency (99) + (108) = 43.58 (109)