

ENERGY & SUSTAINABILITY STATEMENT

75-81 Southampton Street, Reading

Produced by XCO2 for Crossier Properties Limited

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XCO2
56 Kingsway Place, Sans Walk
London EC1R 0LU

+44 (0)20 7700 1000
mail@xco2.com
xco2.com



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Checked by	HP	HP	KM			
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EXECUTIVE SUMMARY

The sustainability and energy strategy for the 75-81 Southampton Street, Reading, development has been developed in line with the relevant policies of the Reading Borough Council Local Plan.

The proposals incorporate a range of sustainable design and construction measures, primarily addressing the sustainable management of resources, the protection and enhancement of the environment and the effective adaptation and mitigation of the development to climate change.

This report presents the sustainability strategy and assesses the predicted energy performance and carbon dioxide emissions of the proposed development at 75-81 Southampton Street, located in the Borough of Reading, Berkshire.

The proposed development comprises a residential only scheme with 19 units across 4 storeys.

This document is divided into three parts:

1. Planning policies;
2. Proposed sustainability measures; and,
3. Energy Strategy.

The Planning Policy section provides an overview of the site and planning policies applicable to this development in accordance with the Reading Borough Council Local Plan.

The second section on proposed sustainability measures outlines the sustainability measures that have been adopted in the team's aim to maximise sustainability within the site.

The third section describes the predicted energy performance and carbon dioxide emissions of the proposed development at 75-81 Southampton Street, Reading. The development will be compared to a notional building constructed to Part L1A standards.

Key sustainability features of the proposals include:

- The re-use of previously developed land;
- Effective site layout in response to the neighbouring context;
- Efficient design of the proposed massing, openings and internal layouts so that habitable spaces across the site benefit from abundant daylight and sunlight levels, whilst impacts to neighbouring buildings are kept to a minimum;
- The specification of water efficient fittings to limit water consumption to less than 110 litres per person per day for domestic uses;
- NOx emissions have been eliminated on-site;
- To reduce air pollution from vehicular transport, the development has been designed to encourage cycling via dedicated cycle parking;
- Specification of high-performance fabric and glazing to minimise heat losses;
- The incorporation of renewable technologies via the specification of air source heat pumps;
- Effective pollution management and control: the development is not expected to have any significant adverse effects to air, noise or land.

The energy strategy for the scheme focuses on the efficiency of the fabric and building services, so that the energy demand is reduced to the extent feasible. Energy efficiency is primarily achieved through a highly insulated building envelope, a good air permeability rate and a thermal bridging ψ -value in line with the Accredited Construction Details. Highly efficient lighting, space conditioning and hot water systems, as well as appropriate controls further reduce the regulated energy demand and consumption of the

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development. The proposal also incorporates individual ASHP.

In total, the development is expected to achieve regulated CO₂ savings of 45.5% compared to a notional development that meets the minimum Part L 2013 Regulations standards of performance.

The proposed development complies with the Reading Sustainable Design and Construction Supplementary Planning Document (Adopted December 2019) CO₂ savings target of 35% overall.

To achieve 'zero carbon' for the residential portion of the scheme, 9.2 tonnes per annum of regulated CO₂, equivalent to 274.6 tonnes over 30 years, from the new-build domestic portion should be offset offsite. The offset based on £60 per tonne over a 30-year period was determined as £16,560.

Any carbon offset contributions will be subject to viability discussions and detailed design stage calculations.

The proposals in their entirety reflect the client and design team's aspirations in delivering a high-quality, energy efficient development that underpins the sustainability of the built environment.

INTRODUCTION

The proposed residential development is located in within the Reading town centre, Berkshire. This section presents the description of the site and of the development proposal.

SITE & PROPOSAL

The site is located in Reading town centre at 75-81 Southampton Street. The site currently comprises a single-storey building formerly occupied by The Co-operative Funeralcare and is currently vacant. The site is surrounded by a parking lot to the east, an open plot to the north and residential units to the south and west.

The development is purely residential with the intention of providing 19 self-contained residential dwellings across 4 storeys.

The location of the development site is shown in Figure 1 below.



Figure 1: Location of the Southampton Street application site.

PLANNING POLICIES

The proposal will seek to respond to the energy and sustainability policies of Reading Borough Council Local Plan as well as the Draft Sustainable Design and Construction Supplementary Planning Guidance document.

The most relevant applicable energy and sustainability policies in the context of the proposed development are presented below.

READING BOROUGH LOCAL PLAN (2019)

CC2: SUSTAINABLE DESIGN AND CONSTRUCTION

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

CC3: ADAPTATION TO CLIMATE CHANGE

All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development:

- Wherever possible, new buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;
- Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc;
- Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and

streets and to help to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and

- All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change.

CC4: DECENTRALISED ENERGY

In meeting the sustainability requirements of this plan, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source. Any development of more than 20 dwellings and/ or non-residential development of over 1,000sqm shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

EN15: AIR QUALITY

Development should have regard to the need to improve air quality and reduce the effects of poor air quality.

Development that would detrimentally affect air quality will not be permitted unless the effect is to be mitigated. The following criteria should be taken into account:

- Whether the proposal, including when combined with the cumulative effect of other developments already permitted, would worsen air quality;
- Whether the development is within, or accessed via, an Air Quality Management Area; and

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- Whether it can be demonstrated that a local worsening in air quality that would not detrimentally affect human health or the environment would be offset by an overall improvement in air quality, for instance through reduction in the need to travel.

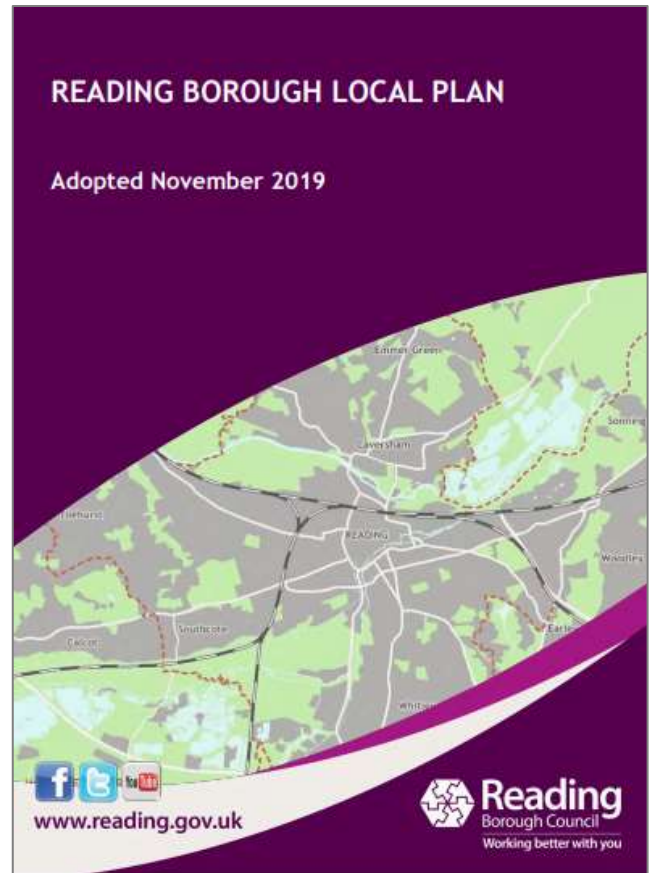
Where a development would introduce sensitive uses (such as residential, schools and nurseries, hospitals, care facilities) into, or intensify such uses within, an Air Quality Management Area, detrimental effects on that use will be mitigated.

EN16: POLLUTION AND WATER RESOURCES

Development will only be permitted where it would not be damaging to the environment and sensitive receptors through land, noise or light pollution; where it would result in no deterioration in, or ideally enhance, ground and surface water quality; and where adequate water resources, sewerage and wastewater treatment infrastructure will be in place to support the proposed development prior to occupation.

Proposals for development that are sensitive to the effects of noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution.

Development will only be permitted on land affected by contamination where it is demonstrated that the contamination and land gas can be satisfactorily managed or remediated so that it is suitable for the proposed end use and will not impact on the groundwater environment, human health, buildings and the wider environment, during demolition and construction phases as well as during the future use of the site.



EN18: FLOODING AND SUSTAINABLE DRAINAGE SYSTEMS

Developments will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change.

It will consider flooding from all sources, including fluvial, surface water, groundwater and sewer flooding. Where development in areas at risk of flooding is necessary, it will not reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding.

Wherever possible, developments should be designed to reduce flood risk, both on- and off-site.

All major developments must incorporate sustainable drainage systems (SuDS) as appropriate and in line with the Government's Technical Standards.

Smaller schemes are encouraged to incorporate SuDS, where possible. Runoff rates should aim to reflect

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greenfield conditions and, in any case, must be no greater than the existing conditions of the site. Schemes should ensure that the movement of water through vertical infiltration as well as horizontal run-off does not worsen contamination effects.

Wherever possible, SuDS provision should maximise ecological benefits, link into the existing Green Network, incorporate tree planting and landscaping and avoid damage to existing significant trees, including through changes to the site hydrology.

All new developments in areas of flood risk should give priority to SuDS.

DRAFT SUSTAINABLE DESIGN AND CONSTRUCTION SUPPLEMENTARY PLANNING GUIDANCE (2019)

This Draft Sustainable Design and Construction SPD has been published for public consultation. This consultation will include statutory bodies, business organisations, community and voluntary groups, adjoining authorities, infrastructure providers and interested individuals. The policies supported by this SPD were consulted upon extensively during the production of the Local Plan.

Reading's Climate Change Strategy 2013 – 2020, "Reading Means Business on Climate Change" sets a target of reducing the carbon footprint of the borough by 34% in 2020 compared with levels in 2005.

H5: Standards for New Housing

This policy outlines standards for new-build housing, including those for sustainable design and construction. All new-build housing must be built to the higher water efficiency standard under the Building Regulations. This policy will help to deliver high-quality new homes and achieve Reading's emissions targets, as well as mitigate the effects of climate change.

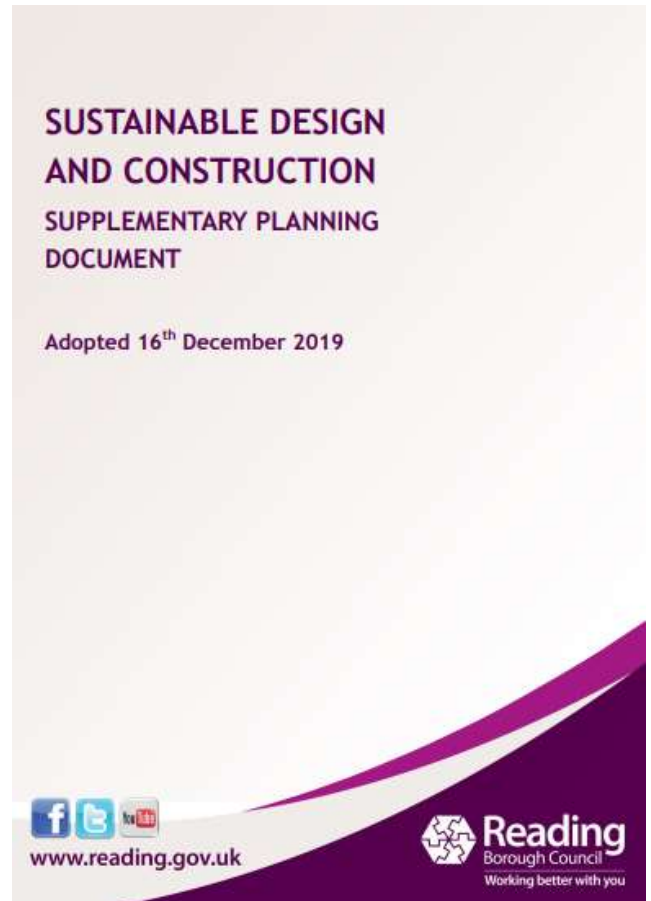
New build residential:

1. Minor (fewer than 10 dwellings)

19% improvement in the dwelling emission rate over the target emission rate, as defined in the 2013 Building Regulations.

2. Major (10 dwellings or more)

Zero Carbon (or if unachievable, a minimum 35% improvement in the dwelling emission rate over the target emission rate, as defined in the 2013 Building Regulations and planning contribution to offset remaining carbon emissions to zero).



PROPOSED SUSTAINABILITY MEASURES

This part of the report presents the key elements of the proposal that underpin environmental sustainability, demonstrating how the development complies with sustainable development policies and incorporates guidance on sustainable design and construction.

The following subsections detail the sustainability measures that will be incorporated into the design of the proposed dwellings.

ENERGY

DWELLING EMISSION RATE AND FABRIC ENERGY EFFICIENCY

The methodology set out by the Department of Energy and Climate Change (DECC) for assessing the energy use of dwellings is the Standard Assessment Procedure (SAP). The current version of the software is SAP 2012. SAP10 Carbon factors have been used in order to future-proof the scheme.

Preliminary SAP calculations were carried out to assess the potential CO₂ savings achieved through

- Energy efficiency measures
- The efficient supply of energy and
- Renewable systems

The preliminary calculations showed an improvement over Part L Building Regulations 2013, amounting to a 4.5% reduction in regulated CO₂ emissions for the scheme.

The energy demand of the dwellings will be reduced through the adoption of high levels of insulation, accredited thermal bridging details and good levels of air tightness to improve the building fabric efficiency. SAP calculations were based on a building fabric with low U-values and an air permeability rate of 3m³/m².h at 50 Pa.

DRYING SPACE

The proposed dwellings will include provisions for internal or external clothes drying where appropriate,

thereby reducing the amount of electricity consumed through the use of tumble dryers.

ENERGY LABELLED WHITE GOODS

The dwellings will be supplied with an EU Energy Efficiency Labelling Scheme Leaflet to help the tenants choose energy efficient white goods or energy efficient white goods where the dwellings have been fitted out.

EXTERNAL LIGHTING

Energy efficient light fittings will be installed throughout the development where appropriate. In addition, external lights will be fitted with controls to reduce the energy consumption of the building during periods of infrequent use:

- External space lighting will include energy efficient fittings
- Security lighting will include daylight cut-off devices, with a maximum wattage of 150W and PIR.

LOW OR ZERO CARBON TECHNOLOGIES

A feasibility study was carried out to determine the energy strategy for the proposed development. The proposed strategy has surpassed Part L Building Regulations due to the reduction in the demand by a highly efficient shell. ASHPs were deemed to be the most appropriate technology for the development.

CYCLE STORAGE

Cycle storage spaces will be provided at ground floor level for use by the occupants to reduce the frequency of short car journeys. The cycle storage will be adequately sized and includes 22 adult cycle storage spaces.

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WATER

INDOOR WATER USE

The development at 75-81 Southampton Street, Reading aims to reduce water consumption in the dwellings to below 110 litres per person per day, through the use of water efficient fittings, and these are listed below.

Table 1: Recommended specification for sanitary fittings.

Fitting	Consumption per use
WC (full flush)	6 litres per flush
WC (half flush)	3 litres per flush
Kitchen sink tap	6 litres per min
Wash basin tap	3 litres per min
Bath	180 litres to overflow
Shower	8 litres per min
Washing machine	8.17 litres per kilogram
Dishwasher	1.25 litres per place setting

MATERIALS

Embodied energy is the energy that is used in the manufacture, processing and the transportation of the materials to site.

The construction build-ups for each of the main building elements are rated from A+ to E. Each element to be used in the building has been rated according to the BRE Green Guide to Specification whereby:

- A+ rated elements are least likely to affect the environment
- E rated elements are most likely to affect the environment

It is assumed that most of the main building elements within this development will achieve between an A+ to C rating where possible.

All timber used during site preparation and construction to be FSC certified, and all non-timber materials to be certified with Environmental Management Systems (ISO 14001 OR BES 6001) where possible.

WASTE

HOUSEHOLD WASTE

A dedicated external waste storage area for the dwellings will be provided to meet the Local Authority requirements.

Adequate internal storage for recyclable waste will be provided to all dwellings in a dedicated position. The Local Authority provides recyclable household waste collection and sorting.

CONSTRUCTION SITE WASTE MANAGEMENT

The development will minimise the impact of construction waste on the environment through a Resource Management Plan or Strategy where possible. This plan will include information such as:

- Benchmarks for resource efficiency
- Procedures and commitments to reduce hazardous and non-hazardous waste
- Monitoring hazardous and non-hazardous waste

POLLUTION

GLOBAL WARMING POTENTIAL (GWP) OF INSULANTS

Global warming potential (GWP) is a measure of how effective a gas is at preventing the passage of infrared radiation. Blowing agents, used in the production of insulation, are a common source of gases with high GWPs.

The development will aim to specify insulation materials that have a low Global Warming Potential (GWP).

NO_x EMISSIONS

Space heating and hot water requirements are to be met through high efficiency ASHP eliminating combustion and associated NO_x emissions on site.

HEALTH AND WELLBEING

DAYLIGHTING

The dwellings have been designed with daylight in mind and measures have been taken to maximise daylight where possible.

SOUND INSULATION

The development proposes that airborne sound insulation will comply or exceed current Building Regulations Part E standards.

PRIVATE/COMMUNAL OPEN SPACE

Private external spaces will be provided to most flats through terraces in this development with the aim of

improving the quality of life of the occupants. The units at the front without private terraces, will be able to access the communal amenity space to the rear.

ACCESSIBILITY

All dwellings will aim to be designed in line with Part M principles where possible, ensuring that they make reasonable provision for most people, including wheelchair users.

SURFACE WATER RUN-OFF

The Environment Agency flood map shows the proposed development to be located within an area at low risk of flooding.



Figure 2: Environment Agency Flood Risk Map for Planning .

MANAGEMENT

CONSTRUCTION SITE IMPACTS

To minimise the construction impacts of the site, the contractor will strive to monitor, report and set targets, where feasible, for:

- The production of CO₂ arising from site activities
- Water consumption from site activities

In addition, contractors will strive to adopt best practice policies for air (dust) and water (ground and surface) pollution occurring on site. All timber will be sourced following the Government's Timber Procurement Policy.

ECOLOGY

ECOLOGICAL VALUE OF SITE & PROTECTION OF ECOLOGICAL FEATURES

Due to its urban location, previous use as a funeral care site and absence of ecological features on the existing site, the site is considered to be of low ecological value. Native species should be incorporated within the landscaped areas and private terraces, to maximise ecological improvement on site.

ECOLOGICAL MITIGATION AND ENHANCEMENT

The architect will provide recommendations for the planting to enhance the existing biodiversity on site. The development will introduce landscaped areas and private gardens to increase the biodiversity of the post-developed site.

BUILDING FOOTPRINT

The proposed development will increase the density of the site. This will ensure that the land is used efficiently whilst maximising the building area.

MINIMISING OVERHEATING

The potential risk of overheating will be mitigated by incorporating passive and active design measures, including:

- Minimising internal heat generation through energy efficient design;
- Reducing the amount of heat entering the building in summer;
- Use of thermal mass and high ceilings to manage the heat within the building;
- Mechanical ventilation.

OVERHEATING RISK ASSESSMENT

The potential risk of overheating was assessed via the Part L Building Regulation compliance tool SAP.

A 'medium' or 'slight' overheating risk was found for all representative dwelling types modelled in SAP. The SAP overheating risk assessment outputs for a sample of the dwelling types modelled can be found in Appendix A.

ENERGY STRATEGY

This section describes the predicted energy performance and carbon dioxide emissions of the proposed 75-81 Southampton Street, Reading, development based on the information provided by the design team.

The overall regulated CO₂ savings *on site* against a Part L 2013 compliant scheme are estimated at 45.5% for the site as whole.

USE LESS ENERGY

The proposals incorporate a range of passive and active design measures that will reduce the energy demand for space conditioning, hot water, ventilation and lighting. Measures will also be put in place to reduce the risk of overheating.

PASSIVE DESIGN MEASURES

ENHANCED U-VALUES

The heat loss of different building fabric elements is dependent upon their U-value, which is a measure of the thermal transmittance through the element. An element with low U-value provides better levels of insulation and reduced heating demand.

The proposed development will incorporate high levels of insulation and high-performance glazing beyond Part L 2013 targets and notional building specifications, in order to reduce the demand for space conditioning.

The table to the right demonstrates the improved performance of the proposed building fabric beyond the Building Regulations requirements for both the domestic uses.

AIR TIGHTNESS IMPROVEMENT

Heat loss may also occur due to air infiltration. Although this cannot be eliminated altogether, good construction detailing and the use of best practice construction techniques can minimise the amount of air infiltration.

The proposed development will aim to improve upon the Part L 2013 minimum standards for air tightness by

targeting air permeability rates of 3m³/m² at 50Pa for all new build residential units.

Table 2: Thermal Envelope U-values

Domestic (U-values in W/m ² .K)			
Element	Building Regulations	Proposed	Improvement
Walls	0.30	0.15	50%
Floor	0.25	0.10	60%
Roof	0.20	0.10	50%
Windows	2.00	1.30	35%

REDUCING THE NEED FOR ARTIFICIAL LIGHTING

The design of the development incorporates large areas of glazing across all building elevations, to optimise daylight in occupied spaces. Good internal daylight levels will translate to less dependency on artificial lighting and will indirectly deliver energy and carbon savings, together with pleasant, healthy spaces for occupants.

ACTIVE DESIGN MEASURES

HIGH EFFICACY LIGHTING

The development intends to incorporate low energy lighting fittings throughout the residential spaces. All light fittings will be specified as low energy lighting and will primarily accommodate LEDs.

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HEAT RECOVERY VENTILATION

Mechanical ventilation heat recovery (MVHR) is proposed for the dwellings. The mechanical ventilation system will include heat recovery in order to supply ventilation to the residential units in the most energy-efficient way.

HEAT GENERATION

Space heating and domestic hot water will be provided to the residential units by individual highly efficient air source heat pumps. It is proposed that the gross efficiency of the ASHPs will be approximately 170%.

CONTROLS

Advanced lighting and space conditioning controls will be incorporated, specifically through heating controls in dwellings will comprise programmer and room thermostats.

MONITORING

Apart from the above design measures, the development will incorporate monitoring equipment and systems to enable occupiers to monitor and reduce their energy use.

Smart meters will be installed to monitor the heat and electricity consumption of each dwelling; the display board will demonstrate real-time and historical energy use data and will be installed at an accessible location within the dwellings.

MECHANICAL VENTILATION

The primary strategy for fresh air supply will be through the MVHR system, with a by-pass 'summer mode' activated to allow for free cooling of occupied spaces through the incoming outdoor air and the dissipation of built up heat.

The dwellings have allowed for passive ventilation as a secondary strategy for dissipating heat during peak summer conditions. The passive ventilation strategy includes single-sided ventilation, cross ventilation and night purge ventilation through openable windows and doors, operated by the occupants.

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ENERGY USE

The table below shows a breakdown of carbon dioxide emissions associated with the proposed development's fossil fuel and electricity consumption for the different uses. The site-wide data are presented. The figures provide a comparison between the baseline condition and the proposed development once energy efficiency measures have been applied.

Table 3: Breakdown of energy consumption and CO₂ emissions for the baseline and the proposed schemes after 'Use Less Energy' measures are implemented.

	Baseline			Use Less Energy		
	Energy (kWh/yr.)	kgCO ₂ /yr.	kgCO ₂ /m ²	Energy (kWh/yr.)	kgCO ₂ /yr.	kgCO ₂ /m ²
Hot Water	38,640	8,114	6.9	45,410	9,535	8.1
Space Heating	34,030	7,145	6.1	19,010	3,991	3.4
Cooling	0	0	0	0	0	0.0
Auxiliary	1,430	332	0.3	5,560	1,294	1.1
Lighting	5,120	1,193	1.0	5,120	1,193	1.0
Equipment	41,760	9,730	8.3	41,760	9,730	8.3
Total Part L	79,210	16,784	14.3	75,100	16,015	13.7
Total (incl. equipment)	120,970	26,514	22.6	116,860	25,745	22.0

USE RENEWABLE ENERGY

The renewable technologies feasibility study carried out for the development identified air source heat pumps as a suitable technology for the development. The regulated carbon saving achieved through renewable energy is 40.9% over the site wide baseline level.

RENEWABLE TECHNOLOGIES FEASIBILITY STUDY

Methods of generating on-site renewable energy were assessed, once fabric efficiency measures were taken into account.

The development of 75-81 Southampton Street will benefit from an energy efficient building fabric which will reduce the energy consumption of the proposed development in the first instance. A range of renewable technologies were subsequently considered including:

- Biomass;
- Ground/water source heat pumps;
- Air source heat pump;
- Wind energy;
- Photovoltaic panels, and,
- Solar thermal panels.

In determining the appropriate renewable technology for the site, the following factors were considered:

- CO₂ savings achieved;
- Site constraints; and,
- Any potential visual impacts.

RENEWABLE ENERGY APPRAISAL SUMMARY

The table overleaf summarises the factors taken into account in determining the appropriate renewable technologies for this project. This includes estimated capital cost, lifetime, level of maintenance and level of impact on external appearance. The final column indicates the feasibility of the technology in relation to the site conditions (10 being the most feasible and 0 being infeasible). It is important to note that the information provided is indicative and based upon early project stage estimates.

The feasibility study demonstrates that ASHPs would be the most feasible renewable technologies for the proposed 75-81 Southampton Street development. Detailed assessments for the proposed technologies can be found in the following sections.

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Table 4: Summary of renewable technologies feasibility study.

		Comments	Lifetime	Maintenance	Impact on external appearance	Site feasibility
Biomass		Not adopted – Burning of wood pellets releases high NOx emissions and there are limitations for their storage and delivery within an urban location.	20 yrs.	High	High	2
PV		Not adopted – Roof space to be allocated to individual ASHP units, which results in insufficient space for meaningful savings from PV panels.	25 yrs.	Low	Med	4
Solar thermal		Not adopted – Roof space to be allocated to individual ASHP, which results in insufficient space for Solar panels.	25 yrs.	Low	Med	4
GSHP		Not adopted – The installation of ground loops requires significant space, additional time at the beginning of the construction process and very high capital costs.	20 yrs.	Med	Low	3
ASHP		Adopted	20 yrs.	Med	Med	9
Wind		Not adopted – Wind turbines located at the site will have a significant visual.	25 yrs.	Med	High	2

DETAILED ASSESSMENT OF AIR SOURCE HEAT PUMPS

Air source heat pumps (ASHPs) employ the same technology as ground source heat pump (GSHPs). However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

The efficiency of heat pumps is very much dependent on the temperature difference between the heat source and the space required to be heated. As a result, ASHPs tend to have a lower COP than GSHPs. This is due to the varying levels of air temperature throughout the year when compared to the relatively stable ground temperature. The lower the difference between internal and external air temperature, the more efficient the system.

ASHP is considered a suitable technology for the development for the following reasons:

- It is a high efficiency system that can cater for the space heating and cooling of the most energy-intensive areas of the proposed development;
- Requires less capital cost than GSHP and other renewable technologies;
- It can be integrated with the proposed ventilation strategy; and,
- It is simple to install when compared to other renewable technologies.

The table below summarises the technical data for the proposed ASHP and estimated CO₂ savings from the application of this technology. In total the ASHP technology would produce regulated CO₂ savings of 40.9% for the development.

Table 5: Summary of technical/operational data and estimated CO₂ savings for ASHP.

ASHP for domestic spaces		
COP heating	1.7	
Carbon intensity of electricity	0.519	kgCO ₂ /kWh
Proportion of domestic space heating and hot water met by ASHP	100	%
Energy met by ASHP	31,742	kWh/yr.
Energy used by ASHP	30,263	kWh/yr.
Total CO ₂ savings	6.9	t/yr.
Regulated baseline CO ₂ emissions	16.8	t/yr.
Total baseline CO ₂ emissions	26.5	t/yr.
% Regulated CO ₂ reduction*	40.9	%
% Total CO ₂ reduction*	25.9	%

* % reduction from site baseline



Figure 3: Outdoor unit of an ASHP.

RENEWABLE TECHNOLOGY CO₂ EMISSIONS & SAVINGS

The incorporation of renewable technologies will further reduce CO₂ emissions by a further 40.9% (6.9 tonnes per annum) across the whole site.

CUMULATIVE ON-SITE SAVINGS

The total regulated CO₂ savings for the site are 7.6 tonnes, equivalent to 45.5% of the baseline emissions against a Part L 2013 compliant scheme.

CONCLUSIONS

The sustainability strategy for the scheme at 75-81 Southampton Street has been developed in line with the relevant policies of the Reading Borough Council Local Plan and aims at the efficient management of resources, environmental protection and the effective adaptation and mitigation of the development to climate change.

The energy strategy has been developed in line with specific fabric efficiency measures and has sought to incorporate suitable low and zero carbon technologies where appropriate. The cumulative CO₂ savings on site are estimated at 45.5% against a Part L 2013 compliant scheme.

SUSTAINABILITY

The proposed 75-81 Southampton Street development will meet the targets set out by Reading Borough Council.

Key sustainability features of the proposals include:

- The re-use of previously developed land;
- Effective site layout in response to the neighbouring context;
- Efficient design of the proposed massing, openings and internal layouts so that habitable spaces across the site benefit from abundant daylight and sunlight levels, whilst impacts to neighbouring buildings are kept to a minimum;
- The specification of water efficient fittings to limit water consumption to less than 110 litres per person per day for domestic uses;
- NOx emissions have been eliminated on-site;
- To reduce air pollution from vehicular transport, the development has been designed to encourage cycling via dedicated cycle parking;
- Specification of high-performance fabric and glazing to minimise heat losses;
- The incorporation of renewable technologies via the specification of air source heat pumps;
- Effective pollution management and control: the development is not expected to have any significant adverse effects to air, noise or land.

The sustainability measures incorporated reflect the client and design team's aspirations in integrating sustainability measures and demonstrates that the

project is designed to exceed the planning policy sustainability requirements.

ENERGY STRATEGY

By implementing energy reduction methods, improving fabric efficiency and introducing renewable technologies as detailed in the previous sections, the Regulated CO₂ emissions for the development have been reduced against a Part L 2013 compliant scheme through on-site measures alone by 45.3% (7.3 tonnes per annum) across the whole site.

The proposed development complies with the Reading Sustainable Design and Construction Supplementary Planning Document (Adopted December 2019) CO₂ savings target of 35% overall.

To achieve 'zero carbon' for the residential portion of the scheme, 9.2 tonnes per annum of regulated CO₂, equivalent to 274.6 tonnes over 30 years, from the new-build domestic portion should be offset offsite. The offset based on £60 per tonne over a 30 year period was determined as £16,560.

Any carbon offset contributions will be subject to viability discussions and detailed design stage calculations.

The tables in the following pages summarise the implementation of the energy efficiency measures and renewable technologies for the proposed scheme and detail the CO₂ emissions and savings against the baseline scheme for each measure; as well as the savings achieved through carbon offset.

ENERGY & SUSTAINABILITY STATEMENT

Overall, the proposed development has been designed to meet energy policies set out by the Reading Borough Council, which demonstrates the client and the design team's commitment to enhancing sustainability of the scheme.

SITE-WIDE CUMULATIVE SAVINGS

Table 6: CO₂ emissions after each method incorporated for the domestic part of the development.

	Carbon dioxide emissions for domestic buildings (tonnes CO ₂ per annum)	
	Regulated	Unregulated
Baseline	16.8	9.7
After energy demand reduction	16.0	9.7
After heat network/CHP	16.0	9.7
After renewable energy	9.2	9.7

Table 7: Site wide regulated CO₂ emissions and savings.

	Total regulated emissions (tonnes CO ₂ /year)	Regulated CO ₂ savings (tonnes CO ₂ /year)	Percentage saving (%)
Baseline	16.8		
Use Less Energy	16.0	0.8	4.6%
Renewable Technologies	9.2	6.9	40.9%
Total		7.6	45.5%
Offset to zero carbon for domestic		274.6 tonnes over 30 years	

APPENDIX A -SAP RESULTS

The table below lists a sample of the typical flats that were modelled using SAP methodology, the TER and DER outputs and the % CO₂ reduction achieved after the energy efficiency and reduction measures have been applied.

The results from these 5 flats were extrapolated over the entire development, in order to predict the energy consumption and carbon dioxide emissions for the domestic spaces of the development.

The following pages show the DER/TER FSAP2012 worksheets for a sample flat. The SAP outputs for all sample flats are available on request.

SAP Ref No.	Unit Ref.	TER (kgCO ₂ /m ² /yr.)	DER (kgCO ₂ /m ² /yr.)	% CO ₂ reduction	Overheating
1	Unit 1	21.94	19.96	9.0%	Medium
2	Unit 2	20.13	18.42	8.5%	Medium
3	Unit 5	17.42	12.22	29.9%	Slight
4	Unit 9	16.47	13.06	20.7%	Slight
5	Unit 17	17.92	15.33	14.5%	Slight

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.5.12

Property Address: Unit 1

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Basement	47.9 (1a)	2.8 (2a)	134.12 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	134.12 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				0	0 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)
Air changes per hour					
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =				0	0 (8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)					
Number of storeys in the dwelling (ns)					0 (9)
Additional infiltration					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					3 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)					0.15 (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) =	0.13 (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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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
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SAP WorkSheet: New dwelling design stage

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

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

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

0.5 (23b)

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

75.65 (23c)

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

(24a)m= 0.28 0.28 0.28 0.26 0.26 0.24 0.24 0.24 0.25 0.26 0.27 0.27 (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 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

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

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

(24d)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24d)

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

(25)m= 0.28 0.28 0.28 0.26 0.26 0.24 0.24 0.24 0.25 0.26 0.27 0.27 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			1.53	1.8	2.754		
Windows Type 1			7.7	$\times 1/[1/(1.3) + 0.04]$	9.52		
Windows Type 2			2.75	$\times 1/[1/(1.3) + 0.04]$	3.4		
Floor			47.9	0.1	4.79		
Walls Type1	43.4	10.45	32.95	0.15	4.94		
Walls Type2	25.8	1.53	24.27	0.27	6.5		
Total area of elements, m²			117.1				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ 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) = 31.9 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 11.2 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 43.1 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	12.58	12.44	12.3	11.6	11.45	10.75	10.75	10.61	11.03	11.45	11.74	12.02

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

(39)m=	55.68	55.54	55.4	54.7	54.56	53.85	53.85	53.71	54.13	54.56	54.84	55.12
Average = Sum(39) _{1...12} /12=												54.66 (39)

SAP WorkSheet: New dwelling design stage

Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

(40)m=	1.16	1.16	1.16	1.14	1.14	1.12	1.12	1.12	1.13	1.14	1.14	1.15		
Average = Sum(40) _{1...12} /12=													1.14	(40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

1.63

(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

72.88

(43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
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Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	80.16	77.25	74.33	71.42	68.5	65.59	65.59	68.5	71.42	74.33	77.25	80.16		
Total = Sum(44) _{1...12} =													874.52	(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=	118.88	103.97	107.29	93.54	89.75	77.45	71.77	82.36	83.34	97.12	106.02	115.13		
Total = Sum(45) _{1...12} =													1146.63	(45)

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

(46)m=	17.83	15.6	16.09	14.03	13.46	11.62	10.77	12.35	12.5	14.57	15.9	17.27		(46)
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Water storage loss:

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

80

(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

$$(48) \times (49) =$$

80

(50)

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

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

0.03

(51)

If community heating see section 4.3

Volume factor from Table 2a

1.14

(52)

Temperature factor from Table 2b

0.54

(53)

Energy lost from water storage, kWh/year

$$(47) \times (51) \times (52) \times (53) =$$

1.24

(54)

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

1.24

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

(56)m=	38.39	34.68	38.39	37.16	38.39	37.16	38.39	38.39	37.16	38.39	37.16	38.39		(56)
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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=	38.39	34.68	38.39	37.16	38.39	37.16	38.39	38.39	37.16	38.39	37.16	38.39		(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 x (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)
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SAP WorkSheet: New dwelling design stage

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	(61)
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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=	180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79	(62)
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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	(63)
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Output from water heater

(64)m=	180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79	
Output from water heater (annual) _{1...12}												1872.6	(64)

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

(65)m=	88.85	79.12	85	78.84	79.17	73.49	73.19	76.71	75.45	81.62	82.99	87.61	(65)
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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=	97.71	97.71	97.71	97.71	97.71	97.71	97.71	97.71	97.71	97.71	97.71	97.71	(66)

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

(67)m=	31.62	28.08	22.84	17.29	12.93	10.91	11.79	15.33	20.57	26.12	30.49	32.5	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	211.62	213.81	208.28	196.5	181.63	167.65	158.31	156.12	161.65	173.43	188.3	202.28	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	(69)
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Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
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Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	(71)
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Water heating gains (Table 5)

(72)m=	119.43	117.74	114.25	109.5	106.41	102.07	98.37	103.1	104.79	109.7	115.26	117.75	(72)
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Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	444.63	441.61	427.33	405.25	382.93	362.6	350.45	356.52	368.98	391.22	416.02	434.5	(73)
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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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
West	0.9x	0.77	x	7.7	x	19.64	x	0.63	x	0.7	=	46.22	(80)
West	0.9x	0.77	x	2.75	x	19.64	x	0.63	x	0.7	=	16.51	(80)
West	0.9x	0.77	x	7.7	x	38.42	x	0.63	x	0.7	=	90.41	(80)
West	0.9x	0.77	x	2.75	x	38.42	x	0.63	x	0.7	=	32.29	(80)
West	0.9x	0.77	x	7.7	x	63.27	x	0.63	x	0.7	=	148.9	(80)

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West	0.9x	0.77	x	2.75	x	63.27	x	0.63	x	0.7	=	53.18	(80)
West	0.9x	0.77	x	7.7	x	92.28	x	0.63	x	0.7	=	217.16	(80)
West	0.9x	0.77	x	2.75	x	92.28	x	0.63	x	0.7	=	77.56	(80)
West	0.9x	0.77	x	7.7	x	113.09	x	0.63	x	0.7	=	266.13	(80)
West	0.9x	0.77	x	2.75	x	113.09	x	0.63	x	0.7	=	95.05	(80)
West	0.9x	0.77	x	7.7	x	115.77	x	0.63	x	0.7	=	272.43	(80)
West	0.9x	0.77	x	2.75	x	115.77	x	0.63	x	0.7	=	97.3	(80)
West	0.9x	0.77	x	7.7	x	110.22	x	0.63	x	0.7	=	259.37	(80)
West	0.9x	0.77	x	2.75	x	110.22	x	0.63	x	0.7	=	92.63	(80)
West	0.9x	0.77	x	7.7	x	94.68	x	0.63	x	0.7	=	222.79	(80)
West	0.9x	0.77	x	2.75	x	94.68	x	0.63	x	0.7	=	79.57	(80)
West	0.9x	0.77	x	7.7	x	73.59	x	0.63	x	0.7	=	173.17	(80)
West	0.9x	0.77	x	2.75	x	73.59	x	0.63	x	0.7	=	61.85	(80)
West	0.9x	0.77	x	7.7	x	45.59	x	0.63	x	0.7	=	107.28	(80)
West	0.9x	0.77	x	2.75	x	45.59	x	0.63	x	0.7	=	38.31	(80)
West	0.9x	0.77	x	7.7	x	24.49	x	0.63	x	0.7	=	57.63	(80)
West	0.9x	0.77	x	2.75	x	24.49	x	0.63	x	0.7	=	20.58	(80)
West	0.9x	0.77	x	7.7	x	16.15	x	0.63	x	0.7	=	38.01	(80)
West	0.9x	0.77	x	2.75	x	16.15	x	0.63	x	0.7	=	13.57	(80)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	62.72	122.7	202.07	294.71	361.18	369.73	352	302.36	235.02	145.6	78.21	51.58	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	507.36	564.31	629.41	699.96	744.11	732.33	702.45	658.88	604	536.82	494.23	486.08	(84)
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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
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Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.98	0.96	0.92	0.81	0.65	0.47	0.34	0.37	0.6	0.86	0.96	0.98	(86)

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

(87)m=	20.31	20.43	20.61	20.81	20.91	20.94	20.95	20.95	20.93	20.79	20.52	20.29	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(88)m=	19.95	19.95	19.95	19.97	19.97	19.98	19.98	19.98	19.98	19.97	19.96	19.96	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.97	0.95	0.9	0.77	0.59	0.39	0.26	0.29	0.52	0.81	0.94	0.98	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.06	19.23	19.48	19.74	19.86	19.9	19.9	19.91	19.89	19.73	19.37	19.03	(90)
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fLA = Living area ÷ (4) =

0.35 (91)

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

(92)m=	19.49	19.64	19.88	20.11	20.22	20.26	20.26	20.27	20.25	20.1	19.77	19.47	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

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(93)m=	19.49	19.64	19.88	20.11	20.22	20.26	20.26	20.27	20.25	20.1	19.77	19.47	(93)
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8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ 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, h_m :

(94)m=	0.97	0.95	0.89	0.78	0.6	0.41	0.28	0.31	0.54	0.82	0.94	0.97	(94)
--------	------	------	------	------	-----	------	------	------	------	------	------	------	------

Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	490.67	533.69	562.35	542.59	447.85	302.83	197.12	207.25	325.39	440.18	464.88	472.54	(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, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	845.85	818.91	741.03	613.26	464.95	304.84	197.34	207.63	332.74	518.13	694.74	841.45	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	264.26	191.67	132.94	50.88	12.72	0	0	0	0	58	165.5	274.46	
Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$												1150.44	(98)

Space heating requirement in $kWh/m^2/year$

24.02	(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

$$(204) = (202) \times [1 - (203)] =$$

1	(204)
---	-------

Efficiency of main space heating system 1

170	(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)

264.26	191.67	132.94	50.88	12.72	0	0	0	0	58	165.5	274.46
--------	--------	--------	-------	-------	---	---	---	---	----	-------	--------

$$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206)$$

155.44	112.75	78.2	29.93	7.49	0	0	0	0	34.12	97.35	161.45
--------	--------	------	-------	------	---	---	---	---	-------	-------	--------

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

676.73	(211)
--------	-------

Space heating fuel (secondary), $kWh/month$

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

(215)m=	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)

180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

170	(216)
-----	-------

(217)m=	170	170	170	170	170	170	170	170	170	170	170
---------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Fuel for water heating, $kWh/month$

$$(219)m = (64)m \times 100 \div (217)m$$

(219)m=	106.2	93.92	99.38	90.12	89.07	80.66	78.49	84.71	84.12	93.4	97.46	103.99
---------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	--------

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

1101.53	(219)
---------	-------

Annual totals

$kWh/year$

Space heating fuel used, main system 1

$kWh/year$	676.73
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Water heating fuel used		1101.53	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	229.08		(230a)
central heating pump:	30		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	259.08	(231)
Electricity for lighting		223.37	(232)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	Fuel Price (Table 12)	Fuel Cost £/year
Space heating - main system 1	(211) x	13.19	x 0.01 = 89.26 (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)	13.19	x 0.01 = 145.29 (247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 = 34.17 (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 = 29.46 (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) =		418.19 (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] =	1.89	(257)
SAP rating (Section 12)		73.63	(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	0.519	= 351.22 (261)
Space heating (secondary)	(215) x	0.519	= 0 (263)
Water heating	(219) x	0.216	= 237.93 (264)
Space and water heating	(261) + (262) + (263) + (264) =		589.15 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	= 134.46 (267)
Electricity for lighting	(232) x	0.519	= 115.93 (268)
Total CO2, kg/year	sum of (265)...(271) =		839.54 (272)
CO2 emissions per m²	(272) ÷ (4) =		17.53 (273)
El rating (section 14)			88 (274)

13a. Primary Energy

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	Energy kWh/year	Primary factor		P. Energy kWh/year
Space heating (main system 1)	(211) x	3.07	=	2077.55 (261)
Space heating (secondary)	(215) x	3.07	=	0 (263)
Energy for water heating	(219) x	1.22	=	1343.87 (264)
Space and water heating	(261) + (262) + (263) + (264) =			3421.42 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	795.37 (267)
Electricity for lighting	(232) x	0	=	685.74 (268)
'Total Primary Energy		sum of (265)...(271) =		4902.53 (272)
Primary energy kWh/m²/year		(272) ÷ (4) =		102.35 (273)

DRAFT

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User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.5.12

Property Address: Unit 1

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Basement	47.9 (1a) x	2.8 (2a) =	134.12 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	134.12 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ 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)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) =	0.15 (8)
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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)

Additional infiltration [(9)-1]x0.1 = (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction (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 (12)

If no draught lobby, enter 0.05, else enter 0 (13)

Percentage of windows and doors draught stripped (14)

Window infiltration 0.25 - [0.2 x (14) ÷ 100] = (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) (18)

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

Number of sides sheltered (19)

Shelter factor (20) = 1 - [0.075 x (19)] = (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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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
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.43	0.42	0.42	0.37	0.36	0.32	0.32	0.31	0.34	0.36	0.38	0.4
------	------	------	------	------	------	------	------	------	------	------	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x 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) x [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 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (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= 0.59 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (24d)

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

(25)m= 0.59 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			1.53	x 1	= 1.53		(26)
Windows Type 1			7.7	x 1/[1/(1.4)+0.04]	= 10.21		(27)
Windows Type 2			2.75	x 1/[1/(1.4)+0.04]	= 3.65		(27)
Floor			47.9	x 0.13	= 6.227		(28)
Walls Type1	43.4	10.45	32.95	x 0.18	= 5.93		(29)
Walls Type2	25.8	1.53	24.27	x 0.18	= 4.37		(29)
Total area of elements, m²			117.1				(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) = 31.91 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 7 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 38.91 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	26.27	26.11	25.95	25.21	25.07	24.43	24.43	24.31	24.68	25.07	25.35	25.65

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

(39)m=	65.18	65.02	64.86	64.12	63.98	63.34	63.34	63.22	63.59	63.98	64.26	64.56
Average = Sum(39) _{1...12} /12=												64.12 (39)

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Heat loss parameter (HLP), W/m²K

(40)m = (39)m ÷ (4)

(40)m=	1.36	1.36	1.35	1.34	1.34	1.32	1.32	1.32	1.33	1.34	1.34	1.35	
	Average = Sum(40) _{1...12} /12=												1.34 (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

1.63

(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

72.88

(43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 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=	80.16	77.25	74.33	71.42	68.5	65.59	65.59	68.5	71.42	74.33	77.25	80.16	
	Total = Sum(44) _{1...12} =												874.52 (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=	118.88	103.97	107.29	93.54	89.75	77.45	71.77	82.36	83.34	97.12	106.02	115.13	
	Total = Sum(45) _{1...12} =												1146.63 (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)
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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)

Water storage loss calculated for each month

((56)m = (55) x (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 x (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	(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=	101.05	88.38	91.2	79.51	76.29	65.83	61	70	70.84	82.56	90.12	97.86	(62)
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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	(63)
--------	---	---	---	---	---	---	---	---	---	---	---	------

Output from water heater

(64)m=	101.05	88.38	91.2	79.51	76.29	65.83	61	70	70.84	82.56	90.12	97.86	
Output from water heater (annual) _{1...12}												974.64	(64)

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

(65)m=	25.26	22.09	22.8	19.88	19.07	16.46	15.25	17.5	17.71	20.64	22.53	24.47	(65)
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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=	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	(66)

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

(67)m=	12.65	11.23	9.14	6.92	5.17	4.36	4.72	6.13	8.23	10.45	12.19	13	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	----	------

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

(68)m=	141.78	143.25	139.55	131.65	121.69	112.33	106.07	104.6	108.31	116.2	126.16	135.53	(68)
--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	-------	--------	--------	------

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

(69)m=	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	(69)
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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=	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	33.95	32.88	30.64	27.61	25.64	22.86	20.5	23.52	24.6	27.74	31.29	32.88	(72)
--------	-------	-------	-------	-------	-------	-------	------	-------	------	-------	-------	-------	------

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

(73)m=	235.81	234.79	226.75	213.6	199.92	186.98	178.71	181.68	188.56	201.81	217.07	228.84	(73)
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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 m ²	Flux Table 6a			g_ Table 6b	FF Table 6c			Gains (W)	
West	0.9x	0.77	x	7.7	x	19.64	x	0.63	x	0.7	=	46.22	(80)
West	0.9x	0.77	x	2.75	x	19.64	x	0.63	x	0.7	=	16.51	(80)
West	0.9x	0.77	x	7.7	x	38.42	x	0.63	x	0.7	=	90.41	(80)
West	0.9x	0.77	x	2.75	x	38.42	x	0.63	x	0.7	=	32.29	(80)
West	0.9x	0.77	x	7.7	x	63.27	x	0.63	x	0.7	=	148.9	(80)

TFEE WorkSheet: New dwelling design stage

West	0.9x	0.77	x	2.75	x	63.27	x	0.63	x	0.7	=	53.18	(80)
West	0.9x	0.77	x	7.7	x	92.28	x	0.63	x	0.7	=	217.16	(80)
West	0.9x	0.77	x	2.75	x	92.28	x	0.63	x	0.7	=	77.56	(80)
West	0.9x	0.77	x	7.7	x	113.09	x	0.63	x	0.7	=	266.13	(80)
West	0.9x	0.77	x	2.75	x	113.09	x	0.63	x	0.7	=	95.05	(80)
West	0.9x	0.77	x	7.7	x	115.77	x	0.63	x	0.7	=	272.43	(80)
West	0.9x	0.77	x	2.75	x	115.77	x	0.63	x	0.7	=	97.3	(80)
West	0.9x	0.77	x	7.7	x	110.22	x	0.63	x	0.7	=	259.37	(80)
West	0.9x	0.77	x	2.75	x	110.22	x	0.63	x	0.7	=	92.63	(80)
West	0.9x	0.77	x	7.7	x	94.68	x	0.63	x	0.7	=	222.79	(80)
West	0.9x	0.77	x	2.75	x	94.68	x	0.63	x	0.7	=	79.57	(80)
West	0.9x	0.77	x	7.7	x	73.59	x	0.63	x	0.7	=	173.17	(80)
West	0.9x	0.77	x	2.75	x	73.59	x	0.63	x	0.7	=	61.85	(80)
West	0.9x	0.77	x	7.7	x	45.59	x	0.63	x	0.7	=	107.28	(80)
West	0.9x	0.77	x	2.75	x	45.59	x	0.63	x	0.7	=	38.31	(80)
West	0.9x	0.77	x	7.7	x	24.49	x	0.63	x	0.7	=	57.63	(80)
West	0.9x	0.77	x	2.75	x	24.49	x	0.63	x	0.7	=	20.58	(80)
West	0.9x	0.77	x	7.7	x	16.15	x	0.63	x	0.7	=	38.01	(80)
West	0.9x	0.77	x	2.75	x	16.15	x	0.63	x	0.7	=	13.57	(80)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	62.72	122.7	202.07	294.71	361.18	369.73	352	302.36	235.02	145.6	78.21	51.58	(83)
--------	-------	-------	--------	--------	--------	--------	-----	--------	--------	-------	-------	-------	------

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

(84)m=	298.54	357.5	428.83	508.32	561.1	556.71	530.71	484.04	423.58	347.41	295.28	280.42	(84)
--------	--------	-------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	------

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.94	0.84	0.67	0.51	0.58	0.83	0.97	1	1	(86)

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

(87)m=	19.51	19.69	20.02	20.44	20.77	20.94	20.99	20.98	20.84	20.38	19.86	19.48	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(88)m=	19.79	19.8	19.8	19.81	19.81	19.82	19.82	19.83	19.82	19.81	19.81	19.8	(88)
--------	-------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	------	------

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

(89)m=	1	0.99	0.98	0.92	0.78	0.57	0.38	0.44	0.75	0.96	0.99	1	(89)
--------	---	------	------	------	------	------	------	------	------	------	------	---	------

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

(90)m=	18.45	18.64	18.96	19.37	19.66	19.8	19.82	19.82	19.73	19.33	18.82	18.43	(90)
--------	-------	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.35 (91)

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

(92)m=	18.82	19	19.33	19.74	20.04	20.19	20.22	20.22	20.11	19.69	19.18	18.79	(92)
--------	-------	----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

TFEE WorkSheet: New dwelling design stage

(93)m=	18.82	19	19.33	19.74	20.04	20.19	20.22	20.22	20.11	19.69	19.18	18.79	(93)
--------	-------	----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ 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, h_m :

(94)m=	1	0.99	0.97	0.92	0.8	0.6	0.43	0.49	0.77	0.96	0.99	1	(94)
--------	---	------	------	------	-----	-----	------	------	------	------	------	---	------

Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	297.26	354.05	417.4	466.99	446.76	335.89	226.52	236.13	327.73	332.52	292.79	279.5	(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, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	946.12	916.97	831.98	695.12	533.94	354.26	229.55	241.51	382.47	581.71	776.29	941.93	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	482.75	378.28	308.44	164.25	64.86	0	0	0	0	185.4	348.12	492.85	
--------	--------	--------	--------	--------	-------	---	---	---	---	-------	--------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 2424.96 (98)

Space heating requirement in $kWh/m^2/year$

50.63 (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 L_m (calculated using $25^\circ C$ internal temperature and external temperature from Table 10)

(100)m=	0	0	0	0	0	595.39	468.71	480.47	0	0	0	0	(100)
---------	---	---	---	---	---	--------	--------	--------	---	---	---	---	-------

Utilisation factor for loss h_m

(101)m=	0	0	0	0	0	0.88	0.93	0.91	0	0	0	0	(101)
---------	---	---	---	---	---	------	------	------	---	---	---	---	-------

Useful loss, $h_m L_m$ (Watts) = $(100)m \times (101)m$

(102)m=	0	0	0	0	0	525.91	437.53	436.57	0	0	0	0	(102)
---------	---	---	---	---	---	--------	--------	--------	---	---	---	---	-------

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

(103)m=	0	0	0	0	0	712.54	681	627.35	0	0	0	0	(103)
---------	---	---	---	---	---	--------	-----	--------	---	---	---	---	-------

Space cooling requirement for month, whole dwelling, continuous (kWh) = $0.024 \times [(103)m - (102)m] \times (41)m$

set $(104)m$ to zero if $(104)m < 3 \times (98)m$

(104)m=	0	0	0	0	0	134.37	181.14	141.94	0	0	0	0	
---------	---	---	---	---	---	--------	--------	--------	---	---	---	---	--

Total = $Sum(104) =$ 457.46 (104)

Cooled fraction

$f_C = \text{cooled area} \div (4) =$ 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 = $(104)m \times (105) \times (106)m$

(107)m=	0	0	0	0	0	33.59	45.29	35.49	0	0	0	0	
---------	---	---	---	---	---	-------	-------	-------	---	---	---	---	--

Total = $Sum(107) =$ 114.36 (107)

Space cooling requirement in $kWh/m^2/year$

$(107) \div (4) =$ 2.39 (108)

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

Fabric Energy Efficiency $(99) + (108) =$ 53.01 (109)

Target Fabric Energy Efficiency (TFEE) 60.96 (109)

DFEE WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.5.12

Property Address: Unit 1

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Basement	47.9 (1a)	2.8 (2a)	134.12 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	134.12 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	0	0	0	0 (6a)
Number of open flues	0	0	0	0	0 (6b)
Number of intermittent fans				2	20 (7a)
Number of passive vents				0	0 (7b)
Number of flueless gas fires				0	0 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.15 (8)
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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)

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 3 (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) 0.3 (18)

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

Number of sides sheltered 2 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.85 (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = 0.25 (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
---------	------	------	------	-----	------	------	------	------	---	------	------	------

DFEE WorkSheet: New dwelling design stage

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

0.32	0.32	0.31	0.28	0.27	0.24	0.24	0.24	0.25	0.27	0.29	0.3
------	------	------	------	------	------	------	------	------	------	------	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x 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) x [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 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			1.53	1.8	2.754		
Windows Type 1			7.7	$\times 1/[1/(1.3) + 0.04]$	9.52		
Windows Type 2			2.75	$\times 1/[1/(1.3) + 0.04]$	3.4		
Floor			47.9	0.1	4.79		
Walls Type1	43.4	10.45	32.95	0.15	4.94		
Walls Type2	25.8	1.53	24.27	0.27	6.5		
Total area of elements, m²			117.1				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ 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) = 31.9 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 11.2 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 43.1 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	24.46	24.37	24.28	23.86	23.78	23.42	23.42	23.35	23.56	23.78	23.94	24.1

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

(39)m=	67.56	67.47	67.38	66.96	66.88	66.52	66.52	66.45	66.66	66.88	67.04	67.21
Average = Sum(39) _{1...12} /12=												66.96

DFEE WorkSheet: New dwelling design stage

Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

(40)m=	1.41	1.41	1.41	1.4	1.4	1.39	1.39	1.39	1.39	1.4	1.4	1.4		
Average = Sum(40) _{1...12} /12=													1.4	(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

1.63

(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

72.88

(43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 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=	80.16	77.25	74.33	71.42	68.5	65.59	65.59	68.5	71.42	74.33	77.25	80.16		
Total = Sum(44) _{1...12} =													874.52	(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=	118.88	103.97	107.29	93.54	89.75	77.45	71.77	82.36	83.34	97.12	106.02	115.13		
Total = Sum(45) _{1...12} =													1146.63	(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

80

(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

$$(48) \times (49) =$$

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

$$(47) \times (51) \times (52) \times (53) =$$

0

(54)

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

0

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

(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 x (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)
--------	---	---	---	---	---	---	---	---	---	---	---	---	--	------

DFEE WorkSheet: New dwelling design stage

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	(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=	101.05	88.38	91.2	79.51	76.29	65.83	61	70	70.84	82.56	90.12	97.86	(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	(63)
--------	---	---	---	---	---	---	---	---	---	---	---	------

Output from water heater

(64)m=	101.05	88.38	91.2	79.51	76.29	65.83	61	70	70.84	82.56	90.12	97.86	
Output from water heater (annual) _{1...12}												974.64	(64)

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

(65)m=	25.26	22.09	22.8	19.88	19.07	16.46	15.25	17.5	17.71	20.64	22.53	24.47	(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=	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	(66)

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

(67)m=	12.65	11.23	9.14	6.92	5.17	4.36	4.72	6.13	8.23	10.45	12.19	13	(67)
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Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	141.78	143.25	139.55	131.65	121.69	112.33	106.07	104.6	108.31	116.2	126.16	135.53	(68)
--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	-------	--------	--------	------

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

(69)m=	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	(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=	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	33.95	32.88	30.64	27.61	25.64	22.86	20.5	23.52	24.6	27.74	31.29	32.88	(72)
--------	-------	-------	-------	-------	-------	-------	------	-------	------	-------	-------	-------	------

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

(73)m=	235.81	234.79	226.75	213.6	199.92	186.98	178.71	181.68	188.56	201.81	217.07	228.84	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
West	0.9x	0.77	x	7.7	x	19.64	x	0.63	x	0.7	=	46.22 (80)
West	0.9x	0.77	x	2.75	x	19.64	x	0.63	x	0.7	=	16.51 (80)
West	0.9x	0.77	x	7.7	x	38.42	x	0.63	x	0.7	=	90.41 (80)
West	0.9x	0.77	x	2.75	x	38.42	x	0.63	x	0.7	=	32.29 (80)
West	0.9x	0.77	x	7.7	x	63.27	x	0.63	x	0.7	=	148.9 (80)

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West	0.9x	0.77	x	2.75	x	63.27	x	0.63	x	0.7	=	53.18	(80)
West	0.9x	0.77	x	7.7	x	92.28	x	0.63	x	0.7	=	217.16	(80)
West	0.9x	0.77	x	2.75	x	92.28	x	0.63	x	0.7	=	77.56	(80)
West	0.9x	0.77	x	7.7	x	113.09	x	0.63	x	0.7	=	266.13	(80)
West	0.9x	0.77	x	2.75	x	113.09	x	0.63	x	0.7	=	95.05	(80)
West	0.9x	0.77	x	7.7	x	115.77	x	0.63	x	0.7	=	272.43	(80)
West	0.9x	0.77	x	2.75	x	115.77	x	0.63	x	0.7	=	97.3	(80)
West	0.9x	0.77	x	7.7	x	110.22	x	0.63	x	0.7	=	259.37	(80)
West	0.9x	0.77	x	2.75	x	110.22	x	0.63	x	0.7	=	92.63	(80)
West	0.9x	0.77	x	7.7	x	94.68	x	0.63	x	0.7	=	222.79	(80)
West	0.9x	0.77	x	2.75	x	94.68	x	0.63	x	0.7	=	79.57	(80)
West	0.9x	0.77	x	7.7	x	73.59	x	0.63	x	0.7	=	173.17	(80)
West	0.9x	0.77	x	2.75	x	73.59	x	0.63	x	0.7	=	61.85	(80)
West	0.9x	0.77	x	7.7	x	45.59	x	0.63	x	0.7	=	107.28	(80)
West	0.9x	0.77	x	2.75	x	45.59	x	0.63	x	0.7	=	38.31	(80)
West	0.9x	0.77	x	7.7	x	24.49	x	0.63	x	0.7	=	57.63	(80)
West	0.9x	0.77	x	2.75	x	24.49	x	0.63	x	0.7	=	20.58	(80)
West	0.9x	0.77	x	7.7	x	16.15	x	0.63	x	0.7	=	38.01	(80)
West	0.9x	0.77	x	2.75	x	16.15	x	0.63	x	0.7	=	13.57	(80)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	62.72	122.7	202.07	294.71	361.18	369.73	352	302.36	235.02	145.6	78.21	51.58	(83)
--------	-------	-------	--------	--------	--------	--------	-----	--------	--------	-------	-------	-------	------

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

(84)m=	298.54	357.5	428.83	508.32	561.1	556.71	530.71	484.04	423.58	347.41	295.28	280.42	(84)
--------	--------	-------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	------

7. Mean internal temperature (heating season)

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

21 (85)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.95	0.85	0.69	0.53	0.6	0.84	0.97	1	1	(86)

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

(87)m=	19.45	19.63	19.96	20.38	20.73	20.92	20.98	20.97	20.81	20.33	19.8	19.41	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	------

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

(88)m=	19.76	19.76	19.76	19.76	19.77	19.77	19.77	19.77	19.77	19.77	19.76	19.76	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	1	0.99	0.98	0.92	0.8	0.59	0.39	0.45	0.76	0.96	0.99	1	(89)
--------	---	------	------	------	-----	------	------	------	------	------	------	---	------

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

(90)m=	18.36	18.54	18.87	19.28	19.59	19.74	19.77	19.76	19.67	19.24	18.72	18.33	(90)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.35 (91)

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

(92)m=	18.73	18.92	19.25	19.66	19.99	20.15	20.19	20.18	20.06	19.62	19.1	18.7	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

DFEE WorkSheet: New dwelling design stage

(93)m=	18.73	18.92	19.25	19.66	19.99	20.15	20.19	20.18	20.06	19.62	19.1	18.7	(93)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ 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, h_m :

(94)m=	1	0.99	0.97	0.92	0.81	0.62	0.44	0.5	0.79	0.96	0.99	1	(94)
--------	---	------	------	------	------	------	------	-----	------	------	------	---	------

Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	297.23	354.04	417.65	468.9	452.7	345.53	234.5	244.07	332.74	333.03	292.78	279.47	(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, L_m , $W = [(39)m \times [(93)m - (96)m]$

(97)m=	975.16	945.94	858.91	720.7	554.18	369.13	238.67	251.33	397.46	603.23	804.25	974.52	(97)
--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	504.38	397.76	328.3	181.3	75.5	0	0	0	0	201.03	368.26	517.11	(98)
--------	--------	--------	-------	-------	------	---	---	---	---	--------	--------	--------	------

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 2573.64

Space heating requirement in $kWh/m^2/year$

53.73 (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
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Heat loss rate L_m (calculated using $25^\circ C$ internal temperature and external temperature from Table 10)

(100)m=	0	0	0	0	0	625.3	492.26	505.06	0	0	0	0	(100)
---------	---	---	---	---	---	-------	--------	--------	---	---	---	---	-------

Utilisation factor for loss h_m

(101)m=	0	0	0	0	0	0.86	0.92	0.89	0	0	0	0	(101)
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Useful loss, $h_m L_m$ (Watts) = $(100)m \times (101)m$

(102)m=	0	0	0	0	0	538.66	451.64	448.99	0	0	0	0	(102)
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Gains (solar gains calculated for applicable weather region, see Table 10)

(103)m=	0	0	0	0	0	712.54	681	627.35	0	0	0	0	(103)
---------	---	---	---	---	---	--------	-----	--------	---	---	---	---	-------

Space cooling requirement for month, whole dwelling, continuous (kWh) = $0.024 \times [(103)m - (102)m] \times (41)m$

set $(104)m$ to zero if $(104)m < 3 \times (98)m$

(104)m=	0	0	0	0	0	125.19	170.64	132.7	0	0	0	0	(104)
---------	---	---	---	---	---	--------	--------	-------	---	---	---	---	-------

Total = $Sum(104) =$ 428.54

Cooled fraction

$f_C = \text{cooled area} \div (4) =$ 1

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0	(106)
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Total = $Sum(104) =$ 0

Space cooling requirement for month = $(104)m \times (105) \times (106)m$

(107)m=	0	0	0	0	0	31.3	42.66	33.17	0	0	0	0	(107)
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Total = $Sum(107) =$ 107.13

Space cooling requirement in $kWh/m^2/year$

$(107) \div (4) =$ 2.24

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

Fabric Energy Efficiency $(99) + (108) =$ 55.97

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.5.12

Property Address: Unit 1

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Basement	47.9 (1a) x	2.8 (2a) =	134.12 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	134.12 (5)

2. Ventilation rate:

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

	Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0 ÷ (5) = 0 (8)

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

Number of storeys in the dwelling (ns) (9)

Additional infiltration [(9)-1]x0.1 = (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction (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 (12)

If no draught lobby, enter 0.05, else enter 0 (13)

Percentage of windows and doors draught stripped (14)

Window infiltration 0.25 - [0.2 x (14) ÷ 100] = (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) (18)

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

Number of sides sheltered (19)

Shelter factor (20) = 1 - [0.075 x (19)] = (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = (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
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DER WorkSheet: New dwelling design stage

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

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15
------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

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

0.5 (23b)

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

75.65 (23c)

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

(24a)m= 0.28 0.28 0.28 0.26 0.26 0.24 0.24 0.24 0.25 0.26 0.27 0.27 (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 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (23b)

(24c)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24c)

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

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

(24d)m= 0 0 0 0 0 0 0 0 0 0 0 0 (24d)

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

(25)m= 0.28 0.28 0.28 0.26 0.26 0.24 0.24 0.24 0.25 0.26 0.27 0.27 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			1.53	1.8	2.754		
Windows Type 1			7.7	$\times 1/[1/(1.3) + 0.04]$	9.52		
Windows Type 2			2.75	$\times 1/[1/(1.3) + 0.04]$	3.4		
Floor			47.9	0.1	4.79		
Walls Type1	43.4	10.45	32.95	0.15	4.94		
Walls Type2	25.8	1.53	24.27	0.27	6.5		
Total area of elements, m²			117.1				

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ 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) = 31.9 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 11.2 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 43.1 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	12.58	12.44	12.3	11.6	11.45	10.75	10.75	10.61	11.03	11.45	11.74	12.02

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

(39)m=	55.68	55.54	55.4	54.7	54.56	53.85	53.85	53.71	54.13	54.56	54.84	55.12
Average = Sum(39) _{1...12} /12=												54.66 (39)

DER WorkSheet: New dwelling design stage

Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

(40)m=	1.16	1.16	1.16	1.14	1.14	1.12	1.12	1.12	1.13	1.14	1.14	1.15		
Average = Sum(40) _{1...12} /12=													1.14	(40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

1.63

(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

72.88

(43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 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=	80.16	77.25	74.33	71.42	68.5	65.59	65.59	68.5	71.42	74.33	77.25	80.16		
Total = Sum(44) _{1...12} =													874.52	(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=	118.88	103.97	107.29	93.54	89.75	77.45	71.77	82.36	83.34	97.12	106.02	115.13		
Total = Sum(45) _{1...12} =													1146.63	(45)

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

(46)m=	17.83	15.6	16.09	14.03	13.46	11.62	10.77	12.35	12.5	14.57	15.9	17.27		(46)
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Water storage loss:

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

80

(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

$$(48) \times (49) =$$

80

(50)

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

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

0.03

(51)

If community heating see section 4.3

Volume factor from Table 2a

1.14

(52)

Temperature factor from Table 2b

0.54

(53)

Energy lost from water storage, kWh/year

$$(47) \times (51) \times (52) \times (53) =$$

1.24

(54)

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

1.24

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

(56)m=	38.39	34.68	38.39	37.16	38.39	37.16	38.39	38.39	37.16	38.39	37.16	38.39		(56)
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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=	38.39	34.68	38.39	37.16	38.39	37.16	38.39	38.39	37.16	38.39	37.16	38.39		(57)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

Primary circuit loss (annual) from Table 3

0

(58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (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)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

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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	(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=	180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79	(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	(63)
--------	---	---	---	---	---	---	---	---	---	---	---	------

Output from water heater

(64)m=	180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79	
Output from water heater (annual) _{1...12}												1872.6	(64)

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

(65)m=	88.85	79.12	85	78.84	79.17	73.49	73.19	76.71	75.45	81.62	82.99	87.61	(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=	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	(66)

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

(67)m=	12.65	11.23	9.14	6.92	5.17	4.36	4.72	6.13	8.23	10.45	12.19	13	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	----	------

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

(68)m=	141.78	143.25	139.55	131.65	121.69	112.33	106.07	104.6	108.31	116.2	126.16	135.53	(68)
--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	-------	--------	--------	------

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

(69)m=	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	(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=	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	119.43	117.74	114.25	109.5	106.41	102.07	98.37	103.1	104.79	109.7	115.26	117.75	(72)
--------	--------	--------	--------	-------	--------	--------	-------	-------	--------	-------	--------	--------	------

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

(73)m=	324.28	322.66	313.36	298.49	283.7	269.18	259.59	264.26	271.75	286.78	304.04	316.7	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)		
West	0.9x	0.77	x	7.7	x	19.64	x	0.63	x	0.7	=	46.22	(80)
West	0.9x	0.77	x	2.75	x	19.64	x	0.63	x	0.7	=	16.51	(80)
West	0.9x	0.77	x	7.7	x	38.42	x	0.63	x	0.7	=	90.41	(80)
West	0.9x	0.77	x	2.75	x	38.42	x	0.63	x	0.7	=	32.29	(80)
West	0.9x	0.77	x	7.7	x	63.27	x	0.63	x	0.7	=	148.9	(80)

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West	0.9x	0.77	x	2.75	x	63.27	x	0.63	x	0.7	=	53.18	(80)
West	0.9x	0.77	x	7.7	x	92.28	x	0.63	x	0.7	=	217.16	(80)
West	0.9x	0.77	x	2.75	x	92.28	x	0.63	x	0.7	=	77.56	(80)
West	0.9x	0.77	x	7.7	x	113.09	x	0.63	x	0.7	=	266.13	(80)
West	0.9x	0.77	x	2.75	x	113.09	x	0.63	x	0.7	=	95.05	(80)
West	0.9x	0.77	x	7.7	x	115.77	x	0.63	x	0.7	=	272.43	(80)
West	0.9x	0.77	x	2.75	x	115.77	x	0.63	x	0.7	=	97.3	(80)
West	0.9x	0.77	x	7.7	x	110.22	x	0.63	x	0.7	=	259.37	(80)
West	0.9x	0.77	x	2.75	x	110.22	x	0.63	x	0.7	=	92.63	(80)
West	0.9x	0.77	x	7.7	x	94.68	x	0.63	x	0.7	=	222.79	(80)
West	0.9x	0.77	x	2.75	x	94.68	x	0.63	x	0.7	=	79.57	(80)
West	0.9x	0.77	x	7.7	x	73.59	x	0.63	x	0.7	=	173.17	(80)
West	0.9x	0.77	x	2.75	x	73.59	x	0.63	x	0.7	=	61.85	(80)
West	0.9x	0.77	x	7.7	x	45.59	x	0.63	x	0.7	=	107.28	(80)
West	0.9x	0.77	x	2.75	x	45.59	x	0.63	x	0.7	=	38.31	(80)
West	0.9x	0.77	x	7.7	x	24.49	x	0.63	x	0.7	=	57.63	(80)
West	0.9x	0.77	x	2.75	x	24.49	x	0.63	x	0.7	=	20.58	(80)
West	0.9x	0.77	x	7.7	x	16.15	x	0.63	x	0.7	=	38.01	(80)
West	0.9x	0.77	x	2.75	x	16.15	x	0.63	x	0.7	=	13.57	(80)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	62.72	122.7	202.07	294.71	361.18	369.73	352	302.36	235.02	145.6	78.21	51.58	(83)
--------	-------	-------	--------	--------	--------	--------	-----	--------	--------	-------	-------	-------	------

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

(84)m=	387.01	445.36	515.43	593.2	644.88	638.91	611.59	566.62	506.77	432.37	382.25	368.29	(84)
--------	--------	--------	--------	-------	--------	--------	--------	--------	--------	--------	--------	--------	------

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
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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	0.72	0.53	0.39	0.43	0.69	0.93	0.98	0.99	(86)

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

(87)m=	20.14	20.28	20.49	20.74	20.88	20.94	20.95	20.94	20.91	20.7	20.38	20.12	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	-------	------

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

(88)m=	19.95	19.95	19.95	19.97	19.97	19.98	19.98	19.98	19.98	19.97	19.96	19.96	(88)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(89)m=	0.99	0.98	0.95	0.84	0.66	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=	18.82	19.01	19.32	19.66	19.84	19.9	19.9	19.9	19.87	19.62	19.17	18.8	(90)
--------	-------	-------	-------	-------	-------	------	------	------	-------	-------	-------	------	------

fLA = Living area ÷ (4) =

0.35 (91)

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

(92)m=	19.28	19.45	19.73	20.03	20.2	20.26	20.26	20.27	20.23	20	19.59	19.26	(92)
--------	-------	-------	-------	-------	------	-------	-------	-------	-------	----	-------	-------	------

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

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(93)m=	19.28	19.45	19.73	20.03	20.2	20.26	20.26	20.27	20.23	20	19.59	19.26	(93)
--------	-------	-------	-------	-------	------	-------	-------	-------	-------	----	-------	-------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ 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, h_m :

(94)m=	0.99	0.98	0.94	0.85	0.68	0.47	0.32	0.37	0.63	0.9	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	------	-----	------	------	------

Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	382.44	434.86	485.51	501.62	435.36	301.02	196.9	206.82	317.62	388	373.07	364.8	(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, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	834.14	808.21	732.74	609.01	463.71	304.66	197.31	207.59	331.97	512.66	684.9	829.9	(97)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------	-------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	336.07	250.89	183.94	77.32	21.09	0	0	0	0	92.74	224.52	346.04	
Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$												1532.62	(98)

Space heating requirement in $kWh/m^2/year$

32	(99)
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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

$$(204) = (202) \times [1 - (203)] =$$

1	(204)
---	-------

Efficiency of main space heating system 1

170	(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)

336.07	250.89	183.94	77.32	21.09	0	0	0	0	92.74	224.52	346.04
--------	--------	--------	-------	-------	---	---	---	---	-------	--------	--------

$$(211)m = \{[(98)m \times (204)]\} \times 100 \div (206)$$

197.69	147.58	108.2	45.48	12.41	0	0	0	0	54.56	132.07	203.55
--------	--------	-------	-------	-------	---	---	---	---	-------	--------	--------

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

901.54	(211)
--------	-------

Space heating fuel (secondary), $kWh/month$

$$= \{[(98)m \times (201)]\} \times 100 \div (208)$$

(215)m=	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)

180.54	159.66	168.95	153.21	151.41	137.12	133.43	144.01	143.01	158.78	165.69	176.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

170	(216)
-----	-------

(217)m=	170	170	170	170	170	170	170	170	170	170	170	(217)
---------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-------

Fuel for water heating, $kWh/month$

$$(219)m = (64)m \times 100 \div (217)m$$

(219)m=	106.2	93.92	99.38	90.12	89.07	80.66	78.49	84.71	84.12	93.4	97.46	103.99
---------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------	--------

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

1101.53	(219)
---------	-------

Annual totals

Space heating fuel used, main system 1

$kWh/year$

$kWh/year$

901.54

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Water heating fuel used		1101.53	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	229.08		(230a)
central heating pump:	30		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		259.08 (231)
Electricity for lighting		223.37	(232)

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	0.519	=	467.9 (261)
Space heating (secondary)	(215) x	0.519	=	0 (263)
Water heating	(219) x	0.216	=	237.93 (264)
Space and water heating	(261) + (262) + (263) + (264) =			705.83 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	134.46 (267)
Electricity for lighting	(232) x	0.519	=	115.93 (268)
Total CO2, kg/year	sum of (265)...(271) =			956.22 (272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =			19.96 (273)
EI rating (section 14)				86 (274)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version:

Version: 1.0.5.12

Property Address: Unit 1

Address :

1. Overall dwelling dimensions:

	Area(m ²)	Av. Height(m)	Volume(m ³)
Basement	47.9 (1a) x	2.8 (2a) =	134.12 (3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	47.9 (4)		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	134.12 (5)

2. Ventilation rate:

	main heating	secondary heating	other	total	m ³ 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)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20 ÷ (5) =	0.15 (8)
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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)

Additional infiltration

[(9)-1]x0.1 =

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0

If no draught lobby, enter 0.05, else enter 0

Percentage of windows and doors draught stripped

Window infiltration

0.25 - [0.2 x (14) ÷ 100] =

Infiltration rate

(8) + (10) + (11) + (12) + (13) + (15) =

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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

Number of sides sheltered

Shelter factor

(20) = 1 - [0.075 x (19)] =

Infiltration rate incorporating shelter factor

(21) = (18) x (20) =

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

0.43	0.42	0.42	0.37	0.36	0.32	0.32	0.31	0.34	0.36	0.38	0.4
------	------	------	------	------	------	------	------	------	------	------	-----

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x 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) x [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 x (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 x (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= 0.59 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (24d)

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

(25)m= 0.59 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			1.53	x 1	= 1.53		(26)
Windows Type 1			7.7	x 1/[1/(1.4)+0.04]	= 10.21		(27)
Windows Type 2			2.75	x 1/[1/(1.4)+0.04]	= 3.65		(27)
Floor			47.9	x 0.13	= 6.227		(28)
Walls Type1	43.4	10.45	32.95	x 0.18	= 5.93		(29)
Walls Type2	25.8	1.53	24.27	x 0.18	= 4.37		(29)
Total area of elements, m²			117.1				(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) = 31.91 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 7 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 38.91 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m=	26.27	26.11	25.95	25.21	25.07	24.43	24.43	24.31	24.68	25.07	25.35	25.65

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

(39)m=	65.18	65.02	64.86	64.12	63.98	63.34	63.34	63.22	63.59	63.98	64.26	64.56
Average = Sum(39) _{1...12} /12=												64.12 (39)

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Heat loss parameter (HLP), W/m²K

$$(40)m = (39)m \div (4)$$

(40)m=	1.36	1.36	1.35	1.34	1.34	1.32	1.32	1.32	1.33	1.34	1.34	1.35		
Average = Sum(40) _{1...12} /12=													1.34	(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

1.63

(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

72.88

(43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 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=	80.16	77.25	74.33	71.42	68.5	65.59	65.59	68.5	71.42	74.33	77.25	80.16		
Total = Sum(44) _{1...12} =													874.52	(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=	118.88	103.97	107.29	93.54	89.75	77.45	71.77	82.36	83.34	97.12	106.02	115.13		
Total = Sum(45) _{1...12} =													1146.63	(45)

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

(46)m=	17.83	15.6	16.09	14.03	13.46	11.62	10.77	12.35	12.5	14.57	15.9	17.27		(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):

0.97

(48)

Temperature factor from Table 2b

0.54

(49)

Energy lost from water storage, kWh/year

$$(48) \times (49) =$$

0.53

(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

$$(47) \times (51) \times (52) \times (53) =$$

0

(54)

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

0.53

(55)

Water storage loss calculated for each month

$$((56)m = (55) \times (41)m$$

(56)m=	16.32	14.74	16.32	15.79	16.32	15.79	16.32	16.32	15.79	16.32	15.79	16.32		(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=	16.32	14.74	16.32	15.79	16.32	15.79	16.32	16.32	15.79	16.32	15.79	16.32		(57)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

Primary circuit loss (annual) from Table 3

0

(58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (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)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--	------

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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	(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=	158.46	139.73	146.87	131.84	129.34	115.76	111.35	121.94	121.64	136.71	144.32	154.71	(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	(63)
--------	---	---	---	---	---	---	---	---	---	---	---	------

Output from water heater

(64)m=	158.46	139.73	146.87	131.84	129.34	115.76	111.35	121.94	121.64	136.71	144.32	154.71	
Output from water heater (annual) _{1...12}												1612.67	(64)

Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

(65)m=	71.19	63.17	67.34	61.75	61.51	56.4	55.53	59.05	58.35	63.96	65.9	69.95	(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=	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	81.42	(66)

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

(67)m=	12.65	11.23	9.14	6.92	5.17	4.36	4.72	6.13	8.23	10.45	12.19	13	(67)
--------	-------	-------	------	------	------	------	------	------	------	-------	-------	----	------

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

(68)m=	141.78	143.25	139.55	131.65	121.69	112.33	106.07	104.6	108.31	116.2	126.16	135.53	(68)
--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	-------	--------	--------	------

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

(69)m=	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	(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=	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	-65.14	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

(72)m=	95.69	94.01	90.51	85.76	82.67	78.33	74.64	79.37	81.05	85.97	91.52	94.01	(72)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

(73)m=	300.55	298.92	289.62	274.75	259.96	245.45	235.85	240.52	248.01	263.04	280.3	292.97	(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 m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
West	0.9x	0.77	x	7.7	x	19.64	x	0.63	x	0.7	=	46.22 (80)
West	0.9x	0.77	x	2.75	x	19.64	x	0.63	x	0.7	=	16.51 (80)
West	0.9x	0.77	x	7.7	x	38.42	x	0.63	x	0.7	=	90.41 (80)
West	0.9x	0.77	x	2.75	x	38.42	x	0.63	x	0.7	=	32.29 (80)
West	0.9x	0.77	x	7.7	x	63.27	x	0.63	x	0.7	=	148.9 (80)

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West	0.9x	0.77	x	2.75	x	63.27	x	0.63	x	0.7	=	53.18	(80)
West	0.9x	0.77	x	7.7	x	92.28	x	0.63	x	0.7	=	217.16	(80)
West	0.9x	0.77	x	2.75	x	92.28	x	0.63	x	0.7	=	77.56	(80)
West	0.9x	0.77	x	7.7	x	113.09	x	0.63	x	0.7	=	266.13	(80)
West	0.9x	0.77	x	2.75	x	113.09	x	0.63	x	0.7	=	95.05	(80)
West	0.9x	0.77	x	7.7	x	115.77	x	0.63	x	0.7	=	272.43	(80)
West	0.9x	0.77	x	2.75	x	115.77	x	0.63	x	0.7	=	97.3	(80)
West	0.9x	0.77	x	7.7	x	110.22	x	0.63	x	0.7	=	259.37	(80)
West	0.9x	0.77	x	2.75	x	110.22	x	0.63	x	0.7	=	92.63	(80)
West	0.9x	0.77	x	7.7	x	94.68	x	0.63	x	0.7	=	222.79	(80)
West	0.9x	0.77	x	2.75	x	94.68	x	0.63	x	0.7	=	79.57	(80)
West	0.9x	0.77	x	7.7	x	73.59	x	0.63	x	0.7	=	173.17	(80)
West	0.9x	0.77	x	2.75	x	73.59	x	0.63	x	0.7	=	61.85	(80)
West	0.9x	0.77	x	7.7	x	45.59	x	0.63	x	0.7	=	107.28	(80)
West	0.9x	0.77	x	2.75	x	45.59	x	0.63	x	0.7	=	38.31	(80)
West	0.9x	0.77	x	7.7	x	24.49	x	0.63	x	0.7	=	57.63	(80)
West	0.9x	0.77	x	2.75	x	24.49	x	0.63	x	0.7	=	20.58	(80)
West	0.9x	0.77	x	7.7	x	16.15	x	0.63	x	0.7	=	38.01	(80)
West	0.9x	0.77	x	2.75	x	16.15	x	0.63	x	0.7	=	13.57	(80)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	62.72	122.7	202.07	294.71	361.18	369.73	352	302.36	235.02	145.6	78.21	51.58	(83)
--------	-------	-------	--------	--------	--------	--------	-----	--------	--------	-------	-------	-------	------

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

(84)m=	363.27	421.62	491.69	569.47	621.14	615.18	587.85	542.89	483.03	408.64	358.51	344.55	(84)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
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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	0.8	0.62	0.47	0.52	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=	19.63	19.81	20.13	20.52	20.81	20.96	20.99	20.98	20.88	20.48	19.98	19.6	(87)
--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------	------

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

(88)m=	19.79	19.8	19.8	19.81	19.81	19.82	19.82	19.83	19.82	19.81	19.81	19.8	(88)
--------	-------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	------	------

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

(89)m=	0.99	0.99	0.96	0.89	0.74	0.52	0.35	0.4	0.69	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	18.27	18.72	19.28	19.64	19.8	19.82	19.82	19.73	19.23	18.52	17.96	(90)
--------	----	-------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

fLA = Living area ÷ (4) =

0.35 (91)

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

(92)m=	18.56	18.8	19.21	19.71	20.05	20.2	20.23	20.22	20.13	19.66	19.03	18.53	(92)
--------	-------	------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

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

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(93)m=	18.56	18.8	19.21	19.71	20.05	20.2	20.23	20.22	20.13	19.66	19.03	18.53	(93)
--------	-------	------	-------	-------	-------	------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Set T_i to the mean internal temperature obtained at step 11 of Table 9b, so that $T_{i,m}=(76)m$ 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, h_m :

(94)m=	0.99	0.98	0.96	0.89	0.75	0.55	0.39	0.44	0.71	0.93	0.98	0.99	(94)
--------	------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, $h_m G_m$, $W = (94)m \times (84)m$

(95)m=	359.71	413.71	470.15	505.12	466.26	341.36	227.6	238.16	344.33	378.98	351.93	341.83	(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, L_m , $W = [(39)m \times [(93)m - (96)m]]$

(97)m=	929.65	903.84	824.24	692.95	534.16	354.57	229.65	241.7	383.35	579.92	766.51	924.97	(97)
--------	--------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	------

Space heating requirement for each month, $kWh/month = 0.024 \times [(97)m - (95)m] \times (41)m$

(98)m=	424.03	329.37	263.44	135.24	50.52	0	0	0	0	149.49	298.5	433.86	
--------	--------	--------	--------	--------	-------	---	---	---	---	--------	-------	--------	--

Total per year ($kWh/year$) = $Sum(98)_{1..5,9..12} =$ 2084.46 (98)

Space heating requirement in $kWh/m^2/year$

43.52 (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) = $(202) \times [1 - (203)] =$

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)

424.03	329.37	263.44	135.24	50.52	0	0	0	0	149.49	298.5	433.86
--------	--------	--------	--------	-------	---	---	---	---	--------	-------	--------

(211)m = $\{[(98)m \times (204)]\} \times 100 \div (206)$

453.51	352.27	281.76	144.64	54.03	0	0	0	0	159.89	319.26	464.02
--------	--------	--------	--------	-------	---	---	---	---	--------	--------	--------

Total ($kWh/year$) = $Sum(211)_{1..5,10..12} =$ 2229.37 (211)

Space heating fuel (secondary), $kWh/month$

= $\{[(98)m \times (201)]\} \times 100 \div (208)$

(215)m=	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)

158.46	139.73	146.87	131.84	129.34	115.76	111.35	121.94	121.64	136.71	144.32	154.71
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater

79.8 (216)

(217)m=	87.32	87.02	86.36	84.88	82.54	79.8	79.8	79.8	79.8	85.05	86.71	87.42	(217)
---------	-------	-------	-------	-------	-------	------	------	------	------	-------	-------	-------	-------

Fuel for water heating, $kWh/month$

(219)m = $(64)m \times 100 \div (217)m$

(219)m=	181.48	160.56	170.08	155.33	156.69	145.06	139.54	152.8	152.44	160.73	166.44	176.98
---------	--------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------

Total = $Sum(219a)_{1..12} =$ 1918.13 (219)

Annual totals

$kWh/year$

$kWh/year$

Space heating fuel used, main system 1

2229.37

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Water heating fuel used		1918.13	
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		223.37	(232)

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	=	481.54	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	414.32	(264)
Space and water heating	(261) + (262) + (263) + (264) =				895.86	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	115.93	(268)
Total CO2, kg/year	sum of (265)...(271) =				1050.71	(272)
TER =					21.94	(273)

XCO2
56 Kingsway Place, Sans Walk
London EC1R 0LU

+44 (0)20 7700 1000
mail@xco2.com
xco2.com

