SYNTEGRA CONSULTING

13-16 Market Place,
Reading,
RG1 2EG

Energy Strategy Report

March 2023

Ref: 22-9313



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This document must only be treated as a draft unless it has been signed by the originators and approved by a director.

Revision	*Initial*	*Rev A*	*Rev B*	*Rev C*
Date	27/03/2023	29/03/2023	17/04/2023	
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Abbreviations

ASHP:	Air Source Heat Pump
BER:	Building Emission Rate
CO_2:	Carbon Dioxide
CHP:	Combined Heat and Power
CSH:	Code for Sustainable Homes
DHW:	Domestic Hot Water
ESR:	Energy Strategy Report
GHG:	Green House Gas
GSHP:	Ground Source Heat Pump
GLA:	Great London Authority
HVAC:	Heating, Ventilation, and Air Conditioning
IES VE:	Integrated Environmental Solutions Virtual Environment
KWp:	Kilo Watt Power
KWh:	Kilo Watt Hour
LZC:	Low Zero Carbon
MVHR:	Mechanical Ventilation Heat Recovery
MCS:	Microgeneration Certification Scheme
NPPF:	National Planning Policy Framework
NCM:	National Calculation Methodology
OSM:	Open Street Map
PV:	Photovoltaic
SBEM:	Simplified Building Energy Modelling
SFP:	Specific Fan Power
TER:	Target Emission Rate

1. Executive Summary

This Energy Strategy Report demonstrates the predicted energy performance and carbon emissions of the proposed development located at **13-16 Market Place, Reading, RG1 2EG.** The presented figures in this study are based on the most updated information provided by the design team (i.e. **the Architect**). The assessment will comprise of **1 Class E retail/bar restaurant over ground and basement, 11 new-build and 4 conversion dwellings** on the upper floors. The overall analysis took into consideration the national building regulations (i.e. **Part L 1A/L2A**) and the local policy requirements. Based on the study assumptions, the project shall comply with the council local polices and buildings regulations.

1.1 Buildings Policy Requirements

The building regulations require buildings to comply with the energy efficiency requirements. This shall be accomplished through capping the project carbon emissions below the regulated target. In addition to the above, the **Reading Borough Council** requires new developments to incorporate sustainable design and construction measures. The table below summarises the best practice building regulations and local policy requirements the assessment adopted for the development.

Policy:	Requirement	Compliance Check
Part L 1A (Criterion 1)	*The calculated CO_2 emissions rate for the dwellings (i.e. DER) must not be greater than the Target CO_2 Emissions Rate (i.e. TER).*	*The project achieved criterion 1 through the Be-Lean stage, by measures of improving fabric thermal performance and efficient building services.*
Part L 2A (Criterion 1)	*The calculated CO_2 emissions rate for the non-domestic buildings (i.e. BER) must not be greater than the Target CO_2 Emissions Rate (i.e. TER).*	*The project achieved criterion 1 compliance through the Be-Lean stage, by measures of improving fabric thermal performance and efficient building services.*
Reading Council 2019 SPD (for new buildings)	*Policy H5 states that all major new-build residential should achieve zero carbon homes and all other new-build housing must achieve a minimum 19% improvement over the 2013 Building Regulations target*	*The proposed scheme has achieved over **19%** carbon reduction from the Be Lean stage under the 2021 Building Regulation target, while all the converted flats achieve more than 19% carbon reduction from the Be Lean under the 2013 Building Regulations.*
	Monitor, verify and report on energy performance at be Seen Stage.	*The Smart Meters are recommended to be installed to monitor the actual in-use energy consumption to minimize the performance gap.*

Table 01: Building National and Local Policy Requirements

1.2 Assessment Methodology and Strategies

The adopted methodology to mitigate the development CO_2 emissions is in alignment with the best practice Efficient Energy Hierarchy Guidance. Calculations have been completed using standard SAP methodology (using SAP10.1 CO_2 emission factors) for the residential part of the building and NCM methodology for the non-domestic part of building. The development building has been assessed using the best practice energy hierarchy strategies for both residential and non-residential parts of the building.

Table 2 below explains the Energy Hierarchy stages and the suggested taken strategies to help the proposed development achieve the required carbon targets.

Stages	Strategies
BE LEAN Carbon Efficient Design (minimising energy demand)	• Improved fabric U-values beyond Part L 1A 2021/L2A 2021 • Energy efficient lighting fittings (i.e. LED). Further information can be found in the Be Lean Section. • Low air permeability
BE CLEAN (Availability of CHP and communal heating systems)	• Analysis for local CHPs and communal heating systems been considered. Further information could be found in the Be Clean Section.
BE GREEN On-site renewable technologies (i.e. ASHP, PVs, etc)	• Efficient Building services by using ASHP. Further information will be presented in the Be Green section below.
BE SEEN In-use monitoring	• The Smart Meters are recommended to be installed to monitor the actual operational energy use, to manage it effectively and mitigate the performance gap.

Table 02: Best practice Energy Hierarchy to achieve compliance over Part L1A/2A requirement

1.3 Assessment Results

1.1.1. Residential Flats

The new build and converted residential dwellings has been simulated under three conditions to analyse the improvements hierarchy. The first simulation assessed the flats under the same notional building specifications. The function of this first simulation is to generate the regulated carbon target (TER) and the actual Dwelling Emission Rate (DER). The second calculation analysed the carbon reductions achieved after improving the building fabric thermal performance by adopting improved thermal U-value (i.e. Be Lean). The third simulation analysed the carbon reductions on the new build dwellings only after considering renewable technologies as an effective design measure to achieve the **19%** reductions beyond **Part L1A** requirements (i.e. Be Green) and achieve compliance under **Part L2A** requirements. The new build dwellings (extension) meet the 19% CO2 reduction required by the 2019 Reading SPD strategy and also achieve more than 19% CO2 reduction under current Building Regulations. The converted flats achieve more than 19% CO2 reduction under 2013 Building Regulations and therefore are compliant with the 2019 Reading SPD strategy.

Block Compliance report (New Build) - 2021

Block Reference : Market Place Property Number	Block Name Floor Area (m2)	Be Lean DER (kgCO2/m2)	 TER (kgCO2/m2)	 %DER/TER	Be Green DER (kgCO2/m2)	 TER (kgCO2/m2)	 %DER/TER	Overall Reduction
Flat 01	70.7	5.99	9.59	37.5	4.27	9.59	55.47	28.71
Flat 02	50.65	7.01	9.1	22.96	5.11	9.1	43.84	27.1
Flat 03	75.99	5.59	8.87	36.97	3.9	8.87	56.03	30.23
Flat 04	70.7	5.34	6.65	19.69	3.5	6.65	47.36	34.45
Flat 05	61.72	5.57	10.38	46.33	3.54	10.38	65.896	36.44
Flat 06	64.3	5.5	6.04	8.94	3.54	6.04	41.39	35.63
Flat 07	70.7	5.34	6.65	19.69	3.5	6.65	47.36	34.45
Flat 08	61.72	5.57	10.38	46.33	3.54	10.38	65.58	36.45
Flat 09	64.3	6.01	7.75	22.45	4.14	7.75	46.58	31.11
Flat 10	70.7	5.62	8.41	33.17	3.87	8.41	53.98	31.13
Flat 11	52	6.65	7.29	8.77	4.63	7.29	36.48	30.73
Totals	713.48	64.19	91.11		43.54	91.11		
Average Be Green DER = 3.96 kgCO2/m2 Average TER = 8.28 kgCO2/m2		52.29%		PASS				

Block Compliance report (Converted) - 2013

Block Reference : Market Place Property Number	Block Name Floor Area (m2)	Be Lean DER (kgCO2/m2)	 TER (kgCO2/m2)	 %DER/TER	Be Green DER (kgCO2/m2)	 TER (kgCO2/m2)	 %DER/TER	Overall Reduction
Flat 12	56.3	20.83	28.7	73%	15.91	28.7	55%	45%
Flat 13	49.96	22.16	30.56	73%	16.92	30.56	55%	45%
Flat 14	82.19	19.04	25.27	75%	14.83	25.27	59%	31%
Flat 15	84.29	17.81	23.76	75%	13.8	23.76	58%	32%
Totals	272.74	79.84	108.29		61.46	108.29		
Average Be Green DER = 15.365 kgCO2/m2 Average TER = 27.07 kgCO2/m2		43.23%		PASS				

Image 01: Domestic Carbon Emissions reduction

1.1.2. Commercial Non domestic Unit

The new build commercial units on the lower floors has been simulated under three conditions to analyse the improvements hierarchy. The first simulation assessed the unit under the same notional building specifications. The function of this first simulation is to generate the regulated carbon target (TER) and the actual Building Emission Rate (BER). The second calculation analysed the carbon reductions achieved after improving the building fabric thermal performance by adopting improved thermal U-value (i.e. Be Lean). The third stage of simulation analysed the carbon reductions after considering renewable technologies as an effective design measure.

Project name

Market Place - Commercial space (Be Lean) As designed

Date: Tue Apr 11 14:36:11 2023

Administrative information

Building Details

Address: 13-16 MARKET PLACE, READING, RG21 2EG

Certifier details

Name:

Telephone number:

Address: , ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m²]: 272.01

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	2.36	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	1.99	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	25.87	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	21.91	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

Project name

Market Place - Commercial space (Be Green) As designed

Date: Tue Apr 11 14:33:45 2023

Administrative information

Building Details

Address: 13-16 MARKET PLACE, READING, RG21 2EG

Certifier details

Name:

Telephone number:

Address: , ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m²]: 272.01

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	2.36	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	1.91	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	25.87	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	20.99	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

Image 02: Non domestic Carbon Emissions after each stage of the proposed strategy

Results show that by improving the fabric thermal performance (i.e. U-values) and implementing efficient building services are analysed in the following stage of simulation. Further analysis carried out to examine the impact of Implementing **ASHP** as the main heating system improved the project rating and managed to make the project fully comply with Part L requirements.

2. Introduction

This energy strategy statement (ESR) has been prepared by Syntegra on behalf of the client (the Applicant) in support of a full planning application, (the Application), submitted to Reading Borough Council for the residential development of **13-16 Market Place, Reading, RG1 2EG** (the Site), as shown within a red line drawing within the planning statement. Image 3 below display the site plan.

The site is located in a prominent position in Market Place, Reading. The site is within the Town Centre Conservation Area and north of river Kennet on Market Place. The site contains a 4 storey building which will comprise of **1 Class E retail/bar restaurant over ground and basement, 11 new-build and 4 conversion dwellings** on the upper floors.

This ESR provides Reading Borough Council with the energy strategies studied for the proposed scheme. The report presents how the annual energy consumption and related carbon emissions will be minimised to meet the regulated targeted carbon emissions **(i.e. PL1A/L2A TER)**. Furthermore, the report explains how to reach the required energy targets to achieve the required carbon reductions for the development.

The domestic and non-domestic sector plays an important role in the UK economy, both as a direct (and indirect) employer and generator of output, and in providing other sectors, such as retailers and financial and business services, with a critical factor of production – the physical location from which to do business. This ESR report analyses the project using research and policies guidance to make sure this major development is built up to achieve positive economic, social and environmental impacts.



Image 03: Site location

3. Planning Policy

The following planning policies and requirements have been identified as being applicable to the development and as such have informed the assessment methodology and production of the energy strategy for the proposed development.

3.1 National Planning Policy Framework (NPPF, February 2021)

The National Planning Policy Framework (NPPF) was published in 2021.The NPPF sets out the governments planning policies for England.

Section 2/Achieving Sustainable Development.

Sets out the sustainability objectives of the plan and outline the three overarching objectives which must be pursued in mutually supporting ways. The objectives are economic; social and; environmental.

Section 2, paragraph 7 of the NPPF states:

> "The purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs4. At a similarly high level, members of the United Nations – including the United Kingdom – have agreed to pursue the 17 Global Goals for Sustainable Development in the period to 2030. These address social progress, economic well-being and environmental protection."

Section 2, Paragraph 8 of the NPPF states:

> "Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives):
>
> a) an economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;
>
> b) a social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering well-designed, beautiful and safe places, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and
>
> c) an environmental objective – to protect and enhance our natural, built and historic

environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

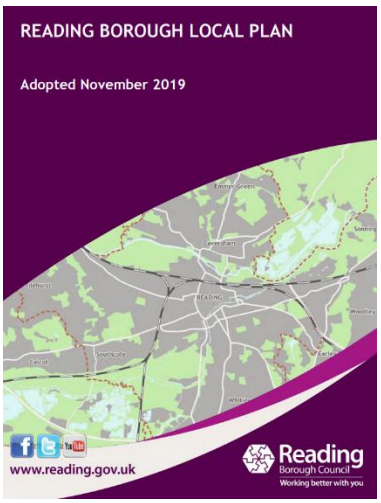
Section 2, paragraph 10 states:

> "So that sustainable development is pursued in a positive way, at the heart of the Framework is a presumption in favour of sustainable development (paragraph 11)."

3.2 Reading Borough Council

The Reading Borough Local Plan was adopted in November 2019, and this responds to the Climate Emergency by setting out ambitious but achievable standards for sustainable design and construction. It is vital that residential and non-residential schemes are built in a way that minimises their use of energy and harmful emissions, reducing and mitigating other environment impacts.

Policy 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. All major new-build residential should achieve zero carbon homes and all other new-build housing must achieve a minimum 19% improvement over the 2013 Building Regulations target. 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.



Local Council Strategy (Adopted in 2019)

Climate Change Local Target: Achieve a carbon neutral Reading by 2030

Reading Borough Local Plan

The Reading Borough Local Plan was adopted on 4th November 2019. One of the main objectives of the new Local Plan is to ensure new development and existing areas are sustainable, including reducing its effects on and adapting to climate change. The Local Plan requires development to both adapt to a changing climate and mitigate the worsening effects of climate change. The following policies are the main policies supplemented by this document

CC2: Sustainable Design and Construction
This policy seeks improved sustainability performance of buildings by setting out BREEAM requirements for non-residential developments conversions to residential. It also sets out the general principles of sustainability in new development that applies to both residential and non-residential uses. Requiring the specified BREEAM levels will significantly contribute to achieving Reading's emissions targets, as well as mitigating the effects of climate change.

CC3: Adaptation to Climate Change
This identifies measures including building orientation, shading, heating, ventilation, green or brown roofs and walls, planting and surface water run-off to deal with the effects of climate change. Where these measures are not appropriately incorporated, planners will consider whether or not this is a reason for refusal. This policy will ensure that development within the Borough is resilient in the face of climate change.

CC4: Decentralised Energy
This policy requires developers to consider inclusion of decentralised energy infrastructure, increasing the amount of decentralised energy provision in the Borough. This will help to achieve a shift to sustainable energy consumption and production and covers a wide range of technologies that reduce dependence on a centralised network or grid.

CC5: Waste Minimisation and Storage
This policy requires developers to identify measures to minimise the generation of waste and to handle waste appropriately during the lifetime of a development. It will help to achieve the aims of the Council's Waste Minimisation Strategy9, as well as to comply with national policy, such as the Landfill Directive.

EN18: Flooding and Sustainable Drainage Systems
This policy directs development away from areas that are liable to flood. In areas of lower risk, development may move forward if it passes the exception test in the NPPF. It also requires major developments to incorporate Sustainable Drainage Systems (SuDS). This policy will help to protect people and property from flooding.

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. All major new-build residential should achieve zero carbon homes and all other new-build housing must achieve a minimum 19% improvement over the 2013 Building Regulations target.

4. Assessment Methodology

4.1 The Energy Hierarchy

The energy hierarchy is a classification of different methods to improve energy performance in a parallel sequence. This includes primarily a focus on reducing energy use by avoiding unnecessary consumption, to then improving the efficiency of energy systems to minimise loss. This is followed by exploiting renewable energy sources and low carbon energy solutions for energy needs. Finally, any remaining demand can be catered for by conventional fuel sources and carbon offsetting solutions.

The Energy Strategy adopts a set of principles to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. The following hierarchy should be used to assess applications:

- **BE LEAN** – By using less energy and considering the further energy efficiency measure in comparison to the baseline building.
    - Improved U values beyond those required for the Building Regulations Part L 2021.
    - BRE accredited thermal bridging details.
    - 100% energy efficient lighting throughout the development.
- **BE CLEAN** – By supplying energy efficiently. Clean energy use looks at further carbon dioxide emission savings over the lean building by taking into consideration the use of decentralise energy (e.g. CHP, District Heat Networks).
- **BE GREEN** – By integrating renewable energy into the scheme which can further reduce the carbon dioxide emission rate.
- **BE SEEN –** By monitoring, verifying, and reporting on energy performance to use energy mode effectively.

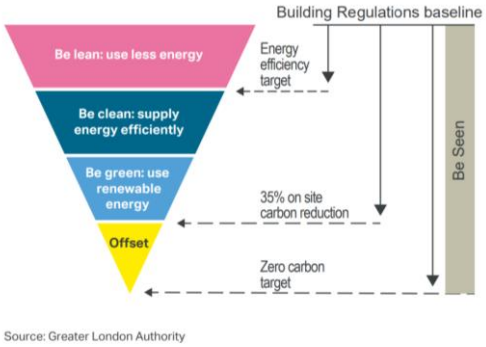


Image 04: GLA Energy Hierarchy

4.2 Modelling strategy

The Government approved software **StromaSAP10** and **IES VE 2022** has been utilised to carry out the project compliance simulations **(i.e., SAP** and **SBEM)** according to the National Calculation Methodology (NCM). Simulated Models are built to assess the actual building BER against the notional building TER. The notional building used to determine carbon dioxide targets (TER) is the same size and shape as the actual buildings, constructed to concurrent regulated specifications (i.e. **Part L1A and L2A**).

The actual building has been modelled entirely to the notional building specifications in order to meet the carbon targets and the limiting fabric and buildings services parameters. However, for differences in fabric design and glazing areas, actual buildings sometimes are expected to exceed the notional TER. Therefore, further improvements to the actual building parameters (e.g. fabric, HVAC, lightings, renewables) are made to meet the required compliance targets.

Syntegra received architectural drawings and project relevant documents. Received information is used to undertake the ultimate energy assessments and supporting the modelling assumptions. The document references are listed in the table below.

No.	Document Name	Format	Received Date
1	21-16 Proposed plans	PDF/DWG	*February 2023*
2	21-16 Proposed Elevations	PDF	*February 2023*
3	21-16 3D views	PDF	*February 2023*
4	21-28 11-12 MARKET PLACE PLOTS_53A Block Plan	PDF	*February 2023*
5	21-28 11-12 MARKET PLACE PLOTS_50A Planning plans	PDF	*February 2023*
6	Scoping Document - 13-16 Market Place -ref 21.16	PDF	*February 2023*
7	13-16 Market Place Sketches 29 April 22	PDF	*February 2023*

Table 03: Energy assessment document list

5. BE LEAN - Energy Efficient Design

This section outlines the project condition analysis and energy efficient measures taken in order to minimise the building's energy demand. The analysis helps reducing the energy use and CO_2 emissions further than the Baseline results and achieving TER compliance (Building Regulations 2013 **Part L 1A& 2A** compliance).

5.1 Site weather and Microclimate

The local weather microclimate usually influences buildings' energy performance. Urban design has a significant impact on microclimate and outdoor thermal comfort. Several studies in different climate regions have concluded that ventilation and shade are crucial to improve urban thermal comfort. Often the thermal conditions are improved as a consequence of good urban design including exist of proper shade and sufficient ventilation. This in turn leads to decreased occurrence of heat stress and heat-related diseases as well as grown performance of both mental and physical tasks.

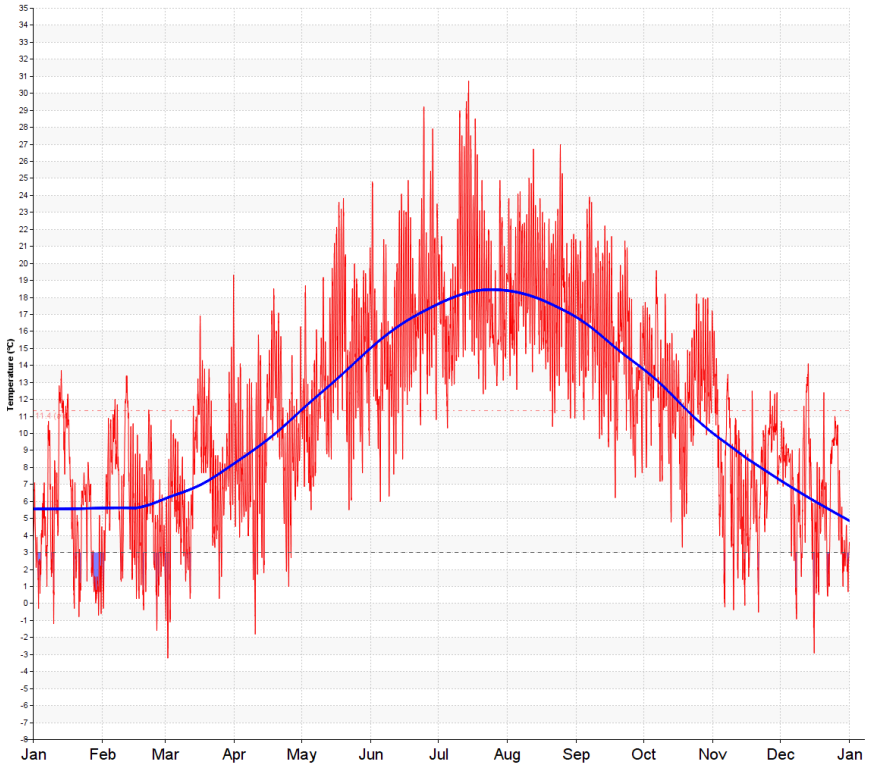


Image 05: Annual Dry Bulb Temperature according to the closet CIBSE weather file to the location (London) along with the regression trend of temperature throughout the year

The nearest weather station is in London, and this will be used for thermal and energy simulations. Figure 4 represents the annual dry bulb temperature in London City. Maximum temperatures can reach up to 30.7°C in late Jun, and minimum temperatures can reach down to -3.2°C in late Feb. The buildings in this location are generally low rise, and the site is not expected to suffer from the Urban Heat Island effects.

The site's landscape also affects the energy demand of a building. Vegetation, landform, and any existing buildings can provide shade to a new development. For instance, if located to the south of the building, deciduous trees can be advantageous, providing shade in the summer but allowing sunshine through in the winter when they lose their leaves. However, any tree used for energy conservation should be considered as part of a much larger landscape.

5.2 Building Orientation, layout, and form

Building layout, orientation and form can influence many key features of the development. The design should provide for an effective use of space and appealing layout, with opportunities to benefit from natural daylight balanced with achieving solar gain without overheating. In general, a higher thermal performance can be achieved by limiting the surface area to volume ratio as this minimises heat loss through the wall area.

It should be noted that where the building footprint is extremely tight, for example in a city centre location, then the building form and orientation may have to be dictated by the available space and not by implementation of best practice measures. Invariably, planning constraints and/or the functional relationships of specific areas will result in some measure of deep planning, thus reducing the opportunity for natural ventilation.

Planning the internal layout of buildings and space to maximise the benefits of solar gain and minimise the disadvantages is essential. Spaces where overheating would be critical can be placed on the north side of the building or overhangs used to protect from excessive solar gain.

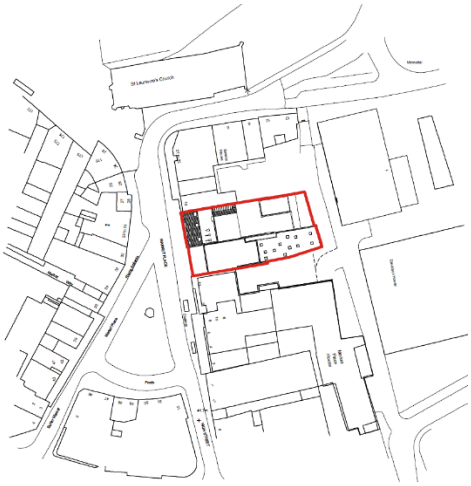


Image 06: Proposed Building site

5.3 Building Design – Energy Efficiency Design Measures

- **Enhancing Building Fabric Thermal Performance**

At the 'BE LEAN' stage of the energy hierarchy, energy efficient building elements have been incorporated into the model. The heat loss of different building element is dependent upon their U-value, air permeability, and thermal bridging Y-values. Therefore, better U-values and air permeability figures than the minimum values set in the **Part L1A 2021** have been suggested in this stage of simulation. Table 4 below presents the different U-values used.

Building Type		**New Build Residential flats**	
Category Specification		**Part L 1A Notional**	**Be-lean Improved values**
U-value *(W/m² K)*	*Wall*	*0.18*	*0.13*
	Window	*1.20*	*1.20*
	Floor	*0.13*	*0.11*
	Roof	*0.11*	*0.11*
	Doors	*1.00*	*1.00*
Air Permeability *(m³/h.m² at 50 Pa)*		*5.00*	*3.00*
		Converted Residential flats	
Category Specification		**Part L 1A Notional**	**Be-lean Improved values**
U-value *(W/m² K)*	*Wall*	*0.18*	*0.18*
	Window	*1.20*	*1.20*
	Floor	*0.13*	*0.13*
	Roof	*0.11*	*0.16*
	Doors	*1.00*	*1.00*
Air Permeability *(m³/h.m² at 50 Pa)*		*5.00*	*3.00*
		Non - Domestic	
Category Specification		**Part L 2A Notional**	**Be-lean Improved values**
U-value *(W/m² K)*	*Wall*	*0.26*	*0.18*
	Window	*1.60*	*1.4*
	Floor	*0.18*	*0.15*

Air Permeability *($m^3/h.m^2$ at 50 Pa)*	*5.00*	*5.00*

Table 04: Domestic and non-domestic Proposed fabric and building Elements

The building is adopting the following measures for the fabric thermal performance:

- Enhanced envelope U-values - to reduce the building's heating losses and demand.
- Providing a well-sealed envelope to minimize the infiltration of cold winter air and warm air in summer - to reduce the building's heating and cooling requirement.
- Minimizing thermal bridging by using accredited construction details to reduce the building's heating and cooling requirement.
- Adopting a window to wall ratio that prioritizes daylight but controls solar gain and glare – to reduce electric lighting energy consumption while mitigating overheating.
- Providing exposed thermal mass to provide passive cooling – suppresses summertime overheating to acceptable levels without the need for high energy consuming and expensive to run and maintain mechanical cooling systems.

5.4 Daylighting and Solar Shading Strategy

The scheme benefits from the usage of solar performance glazing. The glazing specification is carefully selected to ensure the internal environment is pleasant on all orientations and the selected g value is 0.63 for the domestic part of the building and 0.28 for the non-domestic part of the building.

5.5 Ventilation strategy

MVHR will be adopted with extract fans in wet rooms; bathrooms, kitchens and utility rooms (if there is any). A Nuaire MRXBOX70 has been designated.

MVHR will be adopted also on the non-domestic part of the building with a heat recovery of 85% and 1.1 W/l/s SFP (Specific Fan Power)

The following table demonstrates the reduction in CO_2 emissions from the energy efficiency measures mentioned above.

❖ BE LEAN STAGE

Building Type	TER at BE-LEAN *($KgCO_2/m^2.annum$)*	DER at BE-LEAN *($KgCO_2/m^2.annum$)*
Domestic New Build	*8.28*	*5.84*
Domestic Converted	*27.07*	*19.96*
Non domestic	*2.36*	*1.99*

Table 05: Regulated Carbon Emissions (DER) at Be Lean Stage

At the 'BE LEAN' stage of the energy hierarchy, energy efficient building elements have been incorporated into the model. The heat loss of different building element is dependent upon their U-value, air permeability, and thermal bridging Y-values.

6. BE CLEAN – CHP & Decentralised Energy Networks

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

6.1 Decentralised Energy Network

District and community heating systems are favoured because they offer:

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

The feasibility of connecting into an existing heating network or providing the building with its own combined heat and power plant has been assessed alongside the **District Heating Installation Map** as part of this assessment. The map from the Association of Decentralised Energy indicates that there are not existing connection available near the site.

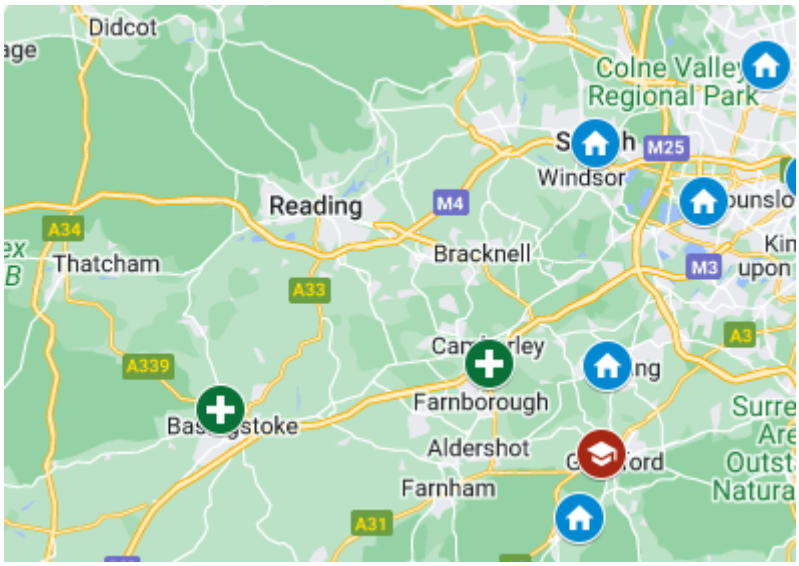


Image 07: District Heating near the site

It is proposed for this development to utilise air source heat pump installations to provide a low temperature heating network within the building to be used for heating and hot water within the residential units.

Cooling Hierarchy

Policy SI 4 of the London Plan outlines a hierarchy of measures which should be followed in order to reduce the demand for cooling within the development. These have been included as follows:

Multiple strategies have been considered for this development to reduce the cooling demand and the overheating risks.

- ✓ Firstly, **internal heat losses shall be reduced through energy efficient design** during design development. It will include minimizing duct lengths and adopting pipe configurations which minimize heat loss (e.g., twin pipes).
- ✓ Minimizing Internal Heat Gains – DHW circulation pipe recommended to been eliminated in the communal areas of the development.
- ✓ Reducing Solar Gains – As stated previously, low G-Values have been targeted.
- ✓ Thermal Mass – Thermal mass is being incorporated though the floor slabs, external walls and roof however further investigation will be undertaken as to the design of these finishes to try to capitalise on the thermal massing wherever possible, so as to help regulate the internal temperature.
- ✓ Lastly, a **mix of passive ventilation and mechanical extraction strategies will be adopted with extract fans in wet rooms** (e.g., toilets, and food preparation) to remove the hot humid air and help free cooling.

7. BE GREEN – Renewable Energy Appraisal

In this section the viable renewable energy technologies that could reduce the development's CO_2 emissions are examined. In determining the appropriate renewable technology for the site, the following factors are considered.

- Renewable energy resources or fuel availability of the LZC technology on the site.
- Implementation with regards the overall M&E design strategy for building type.
- Capital, operating and maintenance cost available for the project.
- Planning Permission form the local council.
- Available Grants.

The table below summarises the various low zero carbon technologies considered for the projects, and we have identified that **Air Source Heat Pumps (ASHP) and Photovoltaic Panels (PV)** would be the most appropriate option in this development, however only Air Source Heat Pumps (ASHP) are required to meet the relevant carbon and energy target.

The Government has outlined its ambitions for residential and non-domestic developments to be delivered to a zero-carbon standard. It is anticipated that zero carbon development will be realised predominantly through energy efficiency measures and the use of on-site low or zero carbon energy and connected heat. However, it is recognised that it will be difficult to deliver all the carbon savings necessary to meet zero carbon standards on site through these measures alone.

Technology Name:	Carbon Payback	Feasibility
Photovoltaic (PV)	High	LOW
Air Source Heat Pumps (ASHP)	High	HIGH
Biomass	High	LOW
Wind Power	Low	LOW
Hydro Power	None	LOW
Solar Thermal	Low	LOW
Ground Source Heat Pumps (GSHP)	Medium	LOW

Table 06: Feasibility Study of LZC Technologies

7.1 Non-feasible Technology

- **Ground Source Heat Pumps (GSHP)**

Ground source heat pump would be a feasible option to meet the space heating requirements, however, it requires ground space for bore holes to extract the ground heat in order to be utilized for space heating requirements. However, this has not been accounted for due to unknown ground conditions/ contamination statues and expensive CAPEX cost for investigating.

- **Solar Thermal**

The use of solar thermal for this development would be limited to domestic hot water only. The use of solar thermal for space heating would not be practical as it is not required when solar thermal is at its most effective during the summer months. Area coverage on the roof is an issue as well. Moreover, according to the scheme scale the expected carbon offset from the system is generally lower compared to other LZC technologies.

- **Hydro power**

Small-scale hydroelectric will not be studied any further because of the location and the spatial limitations of the development.

- **Wind Power**

Wind turbines need extensive planning requirements, and they are only feasible at consistent wind speed. Moreover, there is no available wind grid located near the project location (http://www.renew-reuse-recycle.com/noabl.pl?n=503). Hence this option has been discounted.

Squares surrounding the central square correspond to wind speeds for surrounding grid squares. Power generated is related to windspeed by a cubic ratio. That means if you halve the windspeed, the power goes down by a factor of 8 (which is 2 x 2 x 2). A quarter of the windspeed gives you a 64th of the power (4 x 4 x 4). As a rough guide, if your turbine is rated at producing 1KW at 12m/s then it will produce 125W at 6m/s and 15W at 3m/s.

Please note that bear in mind that the NOABL windspeed dataset used here is a model of windspeeds across the country, assuming completely flat terrain. It isn't a database of measured windspeeds. Other factors such as hills, houses, trees and other obstructions in your vicinity need to be considered as well as they can have a significant effect. If you're thinking about installing a wind turbine, you should perform your own windspeed measurements using an anemometer to determine what the actual figures are.

- **Biomass**

A biomass system designed for this development would be fueled by wood pellets which have a high energy content. However, a biomass system would not be an appropriate technology for the site for the following reasons:

A. The burning of wood pellets releases substantially more NOx emissions when compared to similar gas boilers. As the development is situated within an urban area, the installation of a biomass boiler would further impact on the air quality in this area.
B. Pellets would need to be transported from local pellet suppliers, which causes carbon emissions into the air.
C. The site doesn't have an adequate storage space impacting layout and logistics arrangements.

7.2 Proposed Technology

- **Air Source Heat Pumps**

An ASHP, specified **BS EN 14511-3,** can meet the space heating demands on site efficiently in comparison with gas boilers. Although this low carbon technology consumes electricity to operate, due to higher efficiency the heat output is much greater. Therefore, it has been suggested for the space heating, and hot water demand. The design stage specifications used for energy calculations are in the table below. However, the ASHP was proposed only for simulation, detailed ASHP specifications will be provided by a mechanical engineer during the design development. The system must be certified under the Microgeneration Certification Scheme (MCS).

Given the proposed LZC technologies on the site (i.e., **ASHP**), the overall CO2 reduction at BE GREEN stage can be calculated as shown below.

Building	TER ($KgCO_2/m^2.annum$)	DER at BE-GREEN ($KgCO_2/m^2.annum$)	Carbon Savings at Be-Green
Domestic New Build	*8.28*	*3.95*	***52.29%***
Domestic Converted	*27.07*	*15.365*	***43.23%***
Non domestic	*2.36*	*1.91*	***19.06%***

Table 07: Regulated Carbon Reduction at Be-Green Stage

8. BE SEEN

The new development will be required to monitor, verify and report on energy performance for a period of at least five years in accordance with Policy SI 2 of the London Plan.
Developments are required to review the predicted operational energy demand of a development and compare this to the actual energy consumption of the building once it is occupied.
The Be Seen Energy Monitoring Guidance (September 2021) sets out the requirements for developers to take a number of actions within four weeks of a successful planning approval:

- Upload the necessary contextual and performance data to the 'be seen' portal
- Confirm the target dates for all subsequent 'be seen' stages
- Confirm that metering plans that will enable the in-use energy performance reporting are in place

In line with the Be Seen guidance document, this Energy Strategy outlines the majority of the information required at this stage of the development, with estimates provided for the entire development as a whole, as opposed to listing estimates for each home.
The Be Seen Energy Monitoring Guidance (September 2021) sets out further requirements to be undertaken by the developer at as-built stage:

- Update the contextual data and upload energy performance predictions onto the 'be seen' portal.
- Confirm that the metering installation is complete and correctly calibrated.

At in-use stage it is likely that ownership of the building will revert to a management company to operate the building on behalf of leaseholders. The client will appropriately secure these responsibilities (to be confirmed by the developer) between the Local Authority, the client and the management company.

The Be Seen Energy Monitoring Guidance (September 2021) sets out the requirements to be undertaken by the management company at in-use stage:

- Submit energy performance data annually for at least five years.
- Where actual performance differs from estimated performance, identify the causes and the potential mitigation measures.

9. Conclusion

This report assesses the predicted energy performance and carbon dioxide emissions of the proposed development at **13-16 Market Place, Reading, RG1 2EG.**

The study results showed that efficient thermal performance building fabric and heating systems are keys to achieve building regulations compliance. Moreover, ASHP technology proved to be a major measure to achieve over the required **19%** reduction beyond Part L requirements. The carbon savings from each stage are shown in the chart below. Given the total cumulative carbon savings, the proposed development shall meet the planning requirements on the site and the designed excellent ratings.

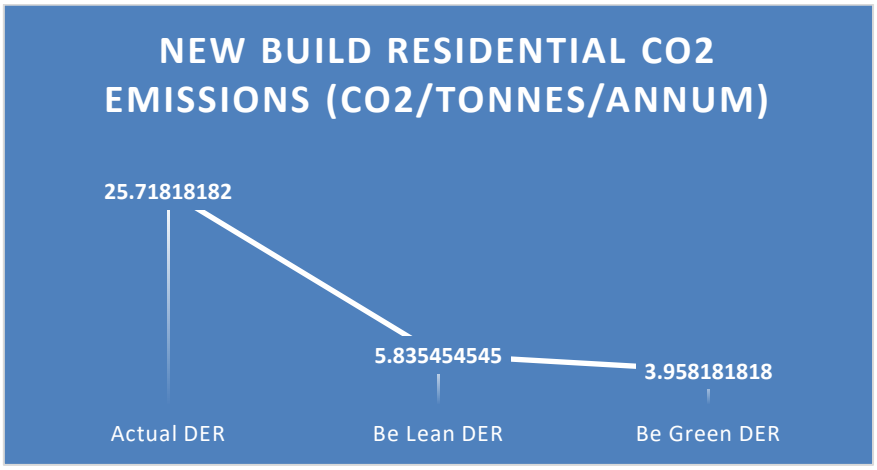


Chart 1: New Build Domestic Carbon Emissions Reductions after each stage of the Energy Hierarchy

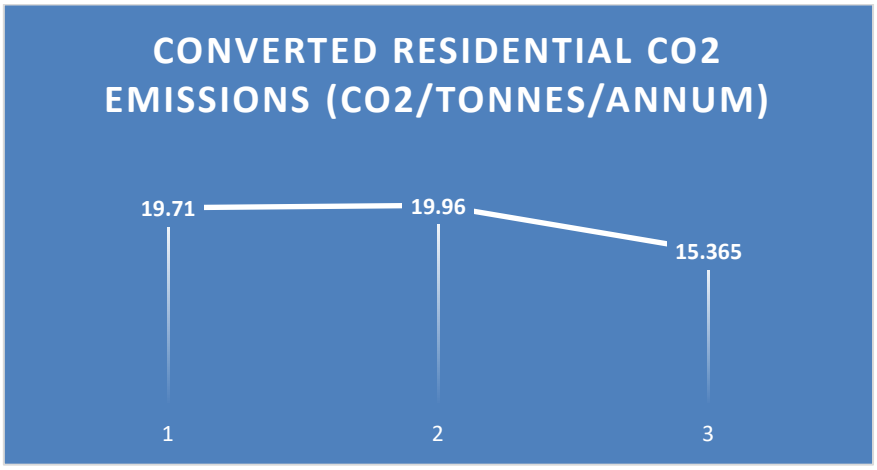


Chart 2: Converted Domestic Carbon Emissions Reductions after each stage of the Energy Hierarchy

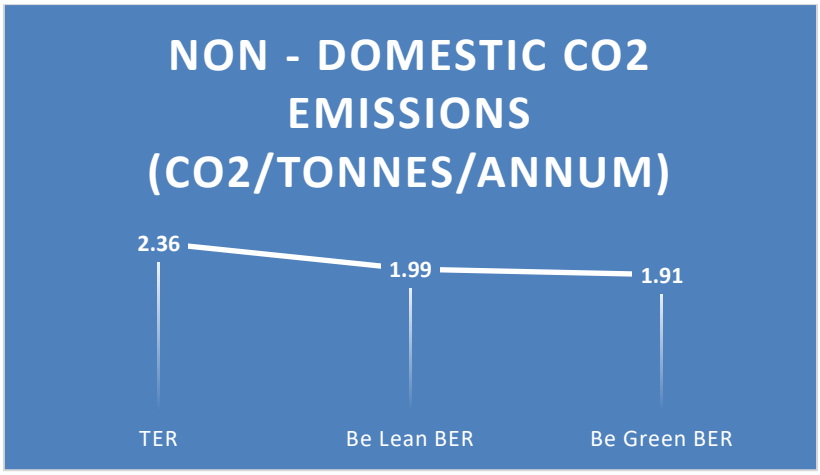


Chart 3: Non - Domestic Carbon Emissions Reductions after each stage of the Energy Hierarchy

The table outlines the savings from the baseline to Be Green stage as being 46% meaning that a saving of 1.766 tonnes of CO_2 will be saved per year throughout the life of the building.

❖ Development Overall Carbon Savings

Building	Be Lean DER (tCO_2/m^2.annum)	DER at BE-GREEN (tCO_2/m^2.annum)	Carbon Savings at Be-Green
Domestic New Build	*5.83*	*3.95*	***32.24%***
Domestic Converted	*19.96*	*15.365*	***23.02%***
Non - domestic	*2.99*	*2.91*	***2.67%***

Table 08: Overall Regulated Carbon Reduction

Appendix – SAP Calculations

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.49	10018.7	(29a)
Roof	7.07	578.7	(30)
Total area of external elements ∑A, m²		129.29	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	30.32	(33)
Heat capacity Cm = ∑(A x k)	14260.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	30.56	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	30.56	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	60.88	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

86.57	86.39	86.22	85.34	85.16	84.28	84.28	84.1	84.63	85.16	85.51	85.86	(39)

Heat loss parameter (HLP), W/m²K

1.35	1.34	1.34	1.33	1.32	1.31	1.31	1.31	1.32	1.32	1.33	1.34	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.1	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

81.72	80.49	78.7	75.28	72.75	69.93	68.33	70.11	72.06	75.08	78.58	81.41	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	132.22	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

143.54	140.62	136.98	131.25	126.67	121.71	119.67	123.29	127.13	132.35	138.17	143.14	1584.52	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

227.34	200.24	210.53	179.67	170.52	149.66	144.73	152.66	156.77	179.6	196.85	224.13	2192.68	(45)

Distribution loss (46) = 0.15 x (45)

34.1	30.04	31.58	26.95	25.58	22.45	21.71	22.9	23.51	26.94	29.53	33.62	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96	46.03	50.96	49.32	50.96	49.32	50.96	50.96	49.32	50.96	49.32	50.96	(61)

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

278.29	246.27	261.49	228.99	221.48	198.97	195.68	203.62	206.08	230.56	246.17	275.08	2792.68	(62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0	0	0	0	0	0	0	0	0	0	0	0	(63b)

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

0	0	0	0	0	0	0	0	0	0	0	0	(63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

278.29	246.27	261.49	228.99	221.48	198.97	195.68	203.62	206.08	230.56	246.17	275.08	2792.68	(64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0	0	0	0	0	0	0	0	0	0	0	0	(64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

88.33	78.09	82.74	72.07	69.44	62.09	60.86	63.5	64.45	72.46	77.78	87.26	(65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	(66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

26.13	23.21	18.88	14.29	10.68	9.02	9.74	12.67	17	21.59	25.19	26.86	(67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1	276.94	269.78	254.52	235.26	217.15	205.06	202.21	209.38	224.64	243.9	262.01	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

	118.72	116.2	111.21	100.1	93.33	86.24	81.8	85.35	89.52	97.39	108.03	117.29	(72)

Total internal gains

	513.66	511.06	494.57	463.61	433.97	404.11	388.31	391.94	407.61	438.32	471.83	500.86	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31	(83)

Total gains – internal and solar (watts)

	629.7	708.73	765.03	798.72	809.32	776.75	747.57	721.17	700.46	656.79	610.83	600.17	(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, ⍰1,m (see Table 9a)

	0.99	0.97	0.95	0.91	0.81	0.65	0.49	0.52	0.74	0.92	0.97	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.67	19.87	20.16	20.5	20.78	20.94	20.99	20.98	20.89	20.54	20.04	19.63	(87)

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

	19.8	19.81	19.81	19.82	19.82	19.83	19.83	19.83	19.83	19.82	19.82	19.81	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.98	0.97	0.94	0.87	0.75	0.55	0.36	0.4	0.65	0.88	0.97	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	18.31	18.56	18.92	19.34	19.64	19.8	19.83	19.83	19.76	19.4	18.79	18.26	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	18.76	19	19.33	19.72	20.02	20.18	20.21	20.21	20.14	19.78	19.2	18.72	(92)

Adjusted mean internal temperature:

	18.61	18.85	19.18	19.57	19.87	20.03	20.06	20.06	19.99	19.63	19.05	18.57	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.96	0.93	0.87	0.75	0.57	0.39	0.42	0.66	0.88	0.96	0.98	(94)

Useful gains, mGm , W

613.95	679.54	710.41	692.58	608.14	439.56	289.42	304.28	461.76	575.36	584.82	587.59	(95)

Monthly average external temperature from Table U1

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

1239.03	1205.03	1093.54	910.83	695.85	457.62	291.94	308.02	498.17	768.72	1022.23	1233.62	(97)

Space heating requirement for each month

465.05	353.13	285.05	157.14	65.25	0	0	0	0	143.86	314.93	480.65	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

465.05	353.13	285.05	157.14	65.25	0	0	0	0	143.86	314.93	480.65	(98c)

Space heating requirement in kWh/m²/year 35.23 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
553.64	420.4	339.34	187.07	77.68	0	0	0	0	171.26	374.92	572.2		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
331.3	293.17	311.3	272.6	263.66	236.87	232.96	242.4	245.33	274.47	293.06	327.48	3324.62	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		2696.51	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3324.62	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	185.92	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		271.92	(231)
Electricity for lighting		184.59	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			6477.64	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		98.15	(240a)
Low-rate fraction	0		98.15	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		98.15	(241a)
Low-rate fraction	0		98.15	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		98.15	(242a)

Low-rate fraction	0		98.15	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		121.02	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		44.84	(249)
Energy For lighting	0		30.44	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		386.45	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.27	(257)
SAP rating		79.37	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			566.27	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			698.17	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1264.44	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		37.72	(267)
Electricity for lighting		26.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1328.8	(272)
Dwelling CO2 Emission Rate		20.67	(273)
EI rating		84	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3047.06	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3756.82	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6803.88	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			411.36	(281)
Electricity for lighting			283.14	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7498.37	(286)
Dwelling PE Rate			116.62	(287)

SAP WORKSHEET

Dwelling Reference: Flat 10
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7	(1a) x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.71	10252.4	(29a)
Roof	7.78	636.3	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	33.69	(33)
Heat capacity Cm = ∑(A x k)	13900.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	479.23	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	479.23	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	512.92	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

541.16	540.97	540.77	539.8	539.61	538.64	538.64	538.44	539.03	539.61	540	540.39	(39)

Heat loss parameter (HLP), W/m²K

7.65	7.65	7.65	7.64	7.63	7.62	7.62	7.62	7.62	7.63	7.64	7.64	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.26	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

85.47	84.19	82.32	78.74	76.09	73.15	71.47	73.33	75.36	78.53	82.19	85.15	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	138.3	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

150.13	147.08	143.27	137.28	132.48	127.3	125.16	128.95	132.97	138.43	144.52	149.72	1657.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

237.78	209.43	220.2	187.92	178.35	156.53	151.37	159.67	163.97	187.85	205.89	234.42	2293.38	(45)

Distribution loss (46) = 0.15 x (45)

35.67	31.42	33.03	28.19	26.75	23.48	22.71	23.95	24.59	28.18	30.88	35.16	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

91.8 81.14 85.96 74.81 72.04 64.38 63.07 65.83 66.85 75.2 80.79 90.68 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

28.48 25.3 20.57 15.57 11.64 9.83 10.62 13.8 18.53 23.53 27.46 29.27 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	123.39	120.75	115.53	103.91	96.83	89.41	84.77	88.48	92.84	101.07	112.21	121.89	(72)

Total internal gains

	547.87	545.13	527.42	494.28	462.4	430.56	413.61	417.42	434.27	467.03	502.96	534.06	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	629.63	692.95	752.4	811.12	852.06	832.7	794.95	742.1	690.7	636.53	602.44	603.02	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.99	0.98	0.98	0.97	0.95	0.92	0.88	0.89	0.94	0.97	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	15.34	15.6	16.22	17.13	18.17	19.19	19.87	19.78	18.93	17.64	16.34	15.29	(87)

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

	18	18	18	18	18	18	18	18	18	18	18	18	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.98	0.98	0.97	0.95	0.92	0.82	0.6	0.66	0.88	0.96	0.98	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	12.39	12.7	13.46	14.57	15.83	17.05	17.77	17.69	16.76	15.2	13.62	12.32	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	13.51	13.8	14.51	15.54	16.72	17.86	18.57	18.48	17.58	16.12	14.65	13.45	(92)

Adjusted mean internal temperature:

	13.36	13.65	14.36	15.39	16.57	17.71	18.42	18.33	17.43	15.97	14.5	13.3	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.96	0.95	0.93	0.88	0.81	0.68	0.72	0.86	0.93	0.96	0.97	(94)

Useful gains, mGm , W

609.15	665.7	713.52	750.37	752.38	670.43	539.66	531.1	591.03	592.18	577.76	584.74	(95)

Monthly average external temperature from Table U1

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

4900.48	4734.18	4249.1	3504.44	2625.58	1676.01	978.55	1040.45	1797.32	2898.34	3995.74	4915.83	(97)

Space heating requirement for each month

3192.75	2734.02	2630.47	1982.93	1393.66	0	0	0	0	1715.79	2460.95	3222.33	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

3192.75	2734.02	2630.47	1982.93	1393.66	0	0	0	0	1715.79	2460.95	3222.33	(98c)

Space heating requirement in kWh/m²/year 273.45 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
3800.9	3254.79	3131.51	2360.63	1659.12	0	0	0	0	2042.6	2929.7	3836.11		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
343.73	304.12	322.81	282.43	272.98	245.06	240.87	250.75	253.91	284.29	303.82	339.74	3444.5	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		23015.35	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3444.5	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	204.42	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		290.42	(231)
Electricity for lighting		201.18	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year	
energy saved		0	(236a)
energy used		0	(237a)
Total delivered energy for all uses		26951.46	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		837.76	(240a)
Low-rate fraction	0		837.76	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		837.76	(241a)
Low-rate fraction	0		837.76	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		837.76	(242a)

Low-rate fraction	0		837.76	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		125.38	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		47.89	(249)
Energy For lighting	0		33.18	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		1136.2	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		3.54	(257)
SAP rating		42.71	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			4833.22	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			723.35	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		5556.57	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		40.29	(267)
Electricity for lighting		29.04	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		5625.89	(272)
Dwelling CO2 Emission Rate		79.57	(273)
EI rating		40	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			26007.35	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3892.29	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			29899.63	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			439.35	(281)
Electricity for lighting			308.58	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			30647.57	(286)
Dwelling PE Rate			433.49	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	52	(1a) x	2.4	(2a) =	124.8	(3a)
Total floor area TFA					52	(4)
Dwelling volume					124.8	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.13	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	1.67	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

Effective air change rate from PCDB:

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.11	9617.8	(29a)
Roof	5.72	468	(30)
Total area of external elements ∑A, m²		111.44	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	24.65	(33)
Heat capacity Cm = ∑(A x k)	13097.2	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	25.91	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	25.91	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	50.56	(37)

Ventilation heat loss calculated monthly

20.18	20.05	19.92	19.26	19.13	18.48	18.48	18.34	18.74	19.13	19.4	19.66	(38)

Heat transfer coefficient, W/K

70.74	70.61	70.48	69.82	69.69	69.04	69.04	68.91	69.3	69.69	69.96	70.22	(39)

Heat loss parameter (HLP), W/m²K

1.36	1.36	1.36	1.34	1.34	1.33	1.33	1.33	1.33	1.34	1.35	1.35	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.75 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

73.63	72.52	70.91	67.82	65.55	63.01	61.56	63.16	64.92	67.64	70.79	73.34	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

23.15	22.81	22.32	21.43	20.76	20.02	19.62	20.1	20.62	21.42	22.33	23.07	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.54	31.36	30.18	28.99	27.81	26.63	26.63	27.81	28.99	30.18	31.36	32.54	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 119.12 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

129.32	126.68	123.4	118.24	114.11	109.65	107.81	111.07	114.53	119.24	124.48	128.96	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

204.81	180.4	189.67	161.87	153.62	134.83	130.38	137.53	141.23	161.8	177.35	201.92	(45)

Distribution loss (46) = 0.15 x (45)

30.72	27.06	28.45	24.28	23.04	20.22	19.56	20.63	21.18	24.27	26.6	30.29	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

255.77 226.42 240.63 211.18 204.58 184.14 181.34 188.49 190.55 212.76 226.66 252.87 2575.39 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

255.77 226.42 240.63 211.18 204.58 184.14 181.34 188.49 190.55 212.76 226.66 252.87 2575.39 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

80.84 71.49 75.8 66.15 63.82 57.16 56.09 58.47 59.29 66.54 71.3 79.88 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

21.21 18.84 15.32 11.6 8.67 7.32 7.91 10.28 13.8 17.52 20.45 21.8 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

227.5 229.86 223.91 211.25 195.26 180.24 170.2 167.84 173.79 186.45 202.44 217.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	(71)

Water heating gains (Table 5)

108.65	106.38	101.89	91.88	85.78	79.39	75.39	78.59	82.34	89.43	99.02	107.36	(72)

Total internal gains

442.59	440.31	426.35	399.95	374.93	349.17	335.73	338.93	352.15	378.63	407.13	431.85	(73)

6. Solar gains

Solar gains in watts, calculated for each month

77.36	131.78	180.3	223.41	250.23	248.42	239.51	219.49	195.23	145.64	92.66	66.21	(83)

Total gains – internal and solar (watts)

519.95	572.09	606.65	623.35	625.17	597.59	575.23	558.42	547.39	524.27	499.8	498.06	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

0.98	0.98	0.96	0.92	0.83	0.68	0.51	0.55	0.76	0.92	0.97	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

19.67	19.85	20.12	20.45	20.74	20.93	20.98	20.98	20.87	20.52	20.03	19.63	(87)

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

19.79	19.8	19.8	19.81	19.81	19.82	19.82	19.82	19.82	19.81	19.81	19.8	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.97	0.94	0.89	0.77	0.58	0.38	0.42	0.67	0.89	0.96	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

18.3	18.53	18.87	19.28	19.6	19.78	19.81	19.81	19.74	19.36	18.77	18.26	(90)

Living area fraction 0.46 (91)

Mean internal temperature (for the whole dwelling)

18.93	19.14	19.45	19.82	20.13	20.31	20.36	20.35	20.26	19.9	19.35	18.89	(92)

Adjusted mean internal temperature:

18.78	18.99	19.3	19.67	19.98	20.16	20.21	20.2	20.11	19.75	19.2	18.74	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.96	0.94	0.88	0.78	0.61	0.43	0.46	0.69	0.89	0.96	0.98	(94)

Useful gains, mGm , W

506.7	549.77	567.64	551.08	489.22	363.21	245.59	257.32	378.83	464.83	478.91	487.22	(95)

Monthly average external temperature from Table U1

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

1024.69	994.87	902.03	752.13	577.05	383.87	248.92	262.03	416.69	637.43	846.69	1021.17	(97)

Space heating requirement for each month

385.39	299.11	248.79	144.76	65.35	0	0	0	0	128.41	264.8	397.26	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

385.39	299.11	248.79	144.76	65.35	0	0	0	0	128.41	264.8	397.26	(98c)

Space heating requirement in kWh/m²/year 37.19 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
458.8	356.08	296.18	172.33	77.8	0	0	0	0	152.87	315.24	472.92			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
304.48	269.55	286.46	251.41	243.55	219.22	215.88	224.39	226.84	253.29	269.83	301.04		3065.94	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													2302.22	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													3065.94	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			150.35	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													45	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													236.35	(231)
Electricity for lighting													149.83	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			5754.35	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		83.8	(240a)
Low-rate fraction	0		83.8	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		83.8	(241a)
Low-rate fraction	0		83.8	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		83.8	(242a)

Low-rate fraction	0		83.8	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		111.6	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		38.97	(249)
Energy For lighting	0		24.71	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		351.08	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.3	(257)
SAP rating		78.88	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			483.47	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			643.85	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1127.31	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		32.79	(267)
Electricity for lighting		21.63	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1181.73	(272)
Dwelling CO2 Emission Rate		22.73	(273)
EI rating		84	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			2601.51	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3464.52	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6066.03	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			357.55	(281)
Electricity for lighting			229.82	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			6653.4	(286)
Dwelling PE Rate			127.95	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	56.3	(1a) x	2.4	(2a) =	135.12	(3a)
Total floor area TFA					56.3	(4)
Dwelling volume					135.12	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80	=	0 (6a)
Open chimneys	0	x	20	=	0 (6b)
Chimneys / flues attached to closed fire	0	x	10	=	0 (6c)
Flues attached to solid fuel boiler	0	x	20	=	0 (6d)
Flues attached to other heater	0	x	35	=	0 (6e)
Number of blocked chimneys	0	x	20	=	0 (6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	9.57		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.32	4222.5	(28b)
Basement wall	0	0	(29)
External wall	4.85	5114.8	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		93.52	(31)
Party Wall	0	10929.6	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.68	(33)
Heat capacity Cm = ∑(A x k)	20266.9	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	31.04	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	31.04	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.72	(37)

Ventilation heat loss calculated monthly

25.62	25.4	25.19	24.11	23.89	22.81	22.81	22.59	23.24	23.89	24.32	24.75	(38)

Heat transfer coefficient, W/K

80.34	80.12	79.9	78.82	78.61	77.53	77.53	77.31	77.96	78.61	79.04	79.47	(39)

Heat loss parameter (HLP), W/m²K

1.43	1.42	1.42	1.4	1.4	1.38	1.38	1.37	1.38	1.4	1.4	1.41	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	1.88	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

76.54	75.39	73.71	70.5	68.14	65.5	64	65.66	67.48	70.32	73.59	76.24	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

24.06	23.7	23.2	22.27	21.58	20.81	20.39	20.89	21.43	22.26	23.21	23.98	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

33.84	32.6	31.37	30.14	28.91	27.68	27.68	28.91	30.14	31.37	32.6	33.84	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	123.83	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

134.43	131.69	128.28	122.92	118.63	113.99	112.07	115.46	119.06	123.95	129.4	134.06	1483.95	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

212.91	187.53	197.17	168.27	159.7	140.16	135.54	142.97	146.82	168.2	184.36	209.9	2053.52	(45)

Distribution loss (46) = 0.15 x (45)

31.94	28.13	29.58	25.24	23.95	21.02	20.33	21.45	22.02	25.23	27.65	31.49	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a	0	(52)
Temperature factor from Table 2b	0	(53)
Energy lost from water storage, kWh/day	0	(54)
Enter (50) or (54) in (55)	0	(55)

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

0	0	0	0	0	0	0	0	0	0	0	0	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96	46.03	50.96	49.32	50.96	49.32	50.96	50.96	49.32	50.96	49.32	50.96	(61)

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

263.87	233.56	248.13	217.59	210.65	189.48	186.5	193.93	196.13	219.16	233.67	260.86	2653.52	(62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0	0	0	0	0	0	0	0	0	0	0	0	(63b)

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

0	0	0	0	0	0	0	0	0	0	0	0	(63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

263.87	233.56	248.13	217.59	210.65	189.48	186.5	193.93	196.13	219.16	233.67	260.86	2653.52	(64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0	0	0	0	0	0	0	0	0	0	0	0	(64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

83.53	73.86	78.3	68.28	65.84	58.93	57.81	60.28	61.15	68.67	73.63	82.53	(65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

112.52	112.52	112.52	112.52	112.52	112.52	112.52	112.52	112.52	112.52	112.52	112.52	(66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

22.77	20.23	16.45	12.45	9.31	7.86	8.49	11.04	14.81	18.81	21.95	23.4	(67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

244.07	246.61	240.22	226.64	209.48	193.36	182.6	180.06	186.45	200.03	217.18	233.3	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	(71)

Water heating gains (Table 5)

112.27	109.91	105.24	94.83	88.49	81.85	77.7	81.02	84.92	92.29	102.26	110.93	(72)

Total internal gains

467.75	465.38	450.55	422.55	395.92	368.71	354.42	357.75	371.82	399.77	430.03	456.27	(73)

6. Solar gains

Solar gains in watts, calculated for each month

61.57	109.64	162.68	222.78	268.89	275.46	262.03	226.33	183.28	124.59	74.62	52.13	(83)

Total gains – internal and solar (watts)

529.32	575.02	613.22	645.33	664.81	644.17	616.45	584.08	555.1	524.36	504.65	508.4	(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, 1,m (see Table 9a)

0.99	0.98	0.97	0.93	0.85	0.7	0.53	0.58	0.8	0.94	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

19.52	19.68	19.97	20.36	20.7	20.91	20.98	20.97	20.83	20.41	19.9	19.49	(87)

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

19.74	19.75	19.75	19.76	19.77	19.78	19.78	19.78	19.78	19.77	19.76	19.75	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.98	0.98	0.96	0.91	0.79	0.59	0.4	0.44	0.71	0.92	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.07	18.28	18.65	19.13	19.52	19.73	19.77	19.77	19.66	19.2	18.57	18.04	(90)

Living area fraction 0.48 (91)

Mean internal temperature (for the whole dwelling)

18.76	18.95	19.28	19.71	20.08	20.29	20.35	20.34	20.22	19.78	19.21	18.73	(92)

Adjusted mean internal temperature:

18.61	18.8	19.13	19.56	19.93	20.14	20.2	20.19	20.07	19.63	19.06	18.58	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.95	0.9	0.8	0.62	0.44	0.49	0.74	0.91	0.97	0.98	(94)

Useful gains, mGm , W

518.52	557.77	582.19	581.67	532.22	402.19	274.1	285.92	408.03	478.01	488.19	499.47	(95)

Monthly average external temperature from Table U1

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

1149.54	1113.79	1009.26	840.64	646.78	429.84	278.98	293.29	465.34	709.75	944.92	1142.92	(97)

Space heating requirement for each month

469.48	373.64	317.74	186.46	85.24	0	0	0	0	172.42	328.85	478.73	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

469.48	373.64	317.74	186.46	85.24	0	0	0	0	172.42	328.85	478.73	(98c)

Space heating requirement in kWh/m²/year 42.85 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
558.91	444.81	378.26	221.98	101.47	0	0	0	0	205.26	391.48	569.91			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
314.13	278.04	295.39	259.03	250.78	225.57	222.02	230.87	233.49	260.9	278.18	310.55		3158.95	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		2872.09	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3158.95	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	162.79	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		248.79	(231)
Electricity for lighting		160.86	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			6440.68	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		104.54	(240a)
Low-rate fraction	0		104.54	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		104.54	(241a)
Low-rate fraction	0		104.54	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		104.54	(242a)

Low-rate fraction	0		104.54	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		114.99	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		41.02	(249)
Energy For lighting	0		26.53	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		379.08	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.35	(257)
SAP rating		78.16	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			603.14	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			663.38	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1266.52	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		34.51	(267)
Electricity for lighting		23.22	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1324.24	(272)
Dwelling CO2 Emission Rate		23.52	(273)
EI rating		82	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3245.46	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3569.61	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6815.07	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			376.36	(281)
Electricity for lighting			246.73	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7438.17	(286)
Dwelling PE Rate			132.12	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	49.96 (1a)	x	2.4	(2a) =	119.9	(3a)
Total floor area TFA					49.96	(4)
Dwelling volume					119.9	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	10.09		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.49	3747	(28b)
Basement wall	0	0	(29)
External wall	4.76	5029.3	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		87.18	(31)
Party Wall	0	10929.6	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.29	(33)
Heat capacity Cm = ∑(A x k)	19705.9	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	31.04	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	31.04	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.33	(37)

Ventilation heat loss calculated monthly

22.73	22.54	22.35	21.39	21.2	20.24	20.24	20.05	20.62	21.2	21.58	21.97	(38)

Heat transfer coefficient, W/K

77.06	76.87	76.68	75.72	75.53	74.57	74.57	74.38	74.95	75.53	75.91	76.29	(39)

Heat loss parameter (HLP), W/m²K

1.54	1.54	1.53	1.52	1.51	1.49	1.49	1.49	1.5	1.51	1.52	1.53	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.69 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

72.24	71.15	69.57	66.54	64.31	61.82	60.4	61.97	63.69	66.37	69.46	71.96	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

22.72	22.38	21.9	21.03	20.37	19.64	19.25	19.72	20.24	21.02	21.91	22.64	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

31.93	30.77	29.6	28.44	27.28	26.12	26.12	27.28	28.44	29.6	30.77	31.93	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.88 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.88	124.3	121.08	116.02	111.96	107.59	105.78	108.98	112.38	116.99	122.14	126.53	1400.6	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.95	177	186.09	158.82	150.73	132.29	127.93	134.94	138.57	158.75	174	198.11	1938.18	(45)

Distribution loss (46) = 0.15 x (45)

30.14	26.55	27.91	23.82	22.61	19.84	19.19	20.24	20.79	23.81	26.1	29.72	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

251.91 223.02 237.05 208.13 201.68 181.6 178.89 185.9 187.88 209.71 223.32 249.07 2538.18 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

251.91 223.02 237.05 208.13 201.68 181.6 178.89 185.9 187.88 209.71 223.32 249.07 2538.18 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

79.56 70.36 74.62 65.14 62.86 56.31 55.28 57.61 58.4 65.52 70.19 78.61 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

19.05 16.92 13.76 10.42 7.79 6.57 7.1 9.23 12.39 15.73 18.36 19.58 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

219.6 221.88 216.13 203.91 188.48 173.97 164.28 162.01 167.75 179.97 195.4 209.91 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	(71)

Water heating gains (Table 5)

106.93	104.7	100.29	90.47	84.48	78.22	74.3	77.43	81.12	88.07	97.48	105.66	(72)

Total internal gains

429.17	427.09	413.78	388.39	364.35	339.36	326.28	329.27	341.86	367.38	394.85	418.75	(73)

6. Solar gains

Solar gains in watts, calculated for each month

52.88	103.45	170.36	248.46	304.5	311.71	296.76	254.91	198.14	122.75	65.94	43.49	(83)

Total gains – internal and solar (watts)

482.05	530.54	584.14	636.85	668.84	651.07	623.04	584.18	539.99	490.13	460.78	462.23	(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, 1,m (see Table 9a)

0.99	0.98	0.96	0.92	0.82	0.66	0.51	0.56	0.79	0.94	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

19.38	19.56	19.9	20.33	20.69	20.91	20.98	20.97	20.81	20.35	19.79	19.34	(87)

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

19.66	19.66	19.66	19.68	19.68	19.69	19.69	19.7	19.69	19.68	19.67	19.67	(88)

Roof Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.98	0.97	0.95	0.89	0.76	0.55	0.37	0.41	0.69	0.91	0.97	0.99	(89)

Roof Mean internal temperature in the rest of dwelling T2

17.83	18.07	18.49	19.03	19.43	19.65	19.69	19.69	19.57	19.06	18.37	17.8	(90)

Living area fraction 0.44 (91)

Mean internal temperature (for the whole dwelling)

18.52	18.73	19.11	19.6	19.99	20.2	20.26	20.25	20.12	19.63	18.99	18.48	(92)

Adjusted mean internal temperature:

18.37	18.58	18.96	19.45	19.84	20.05	20.11	20.1	19.97	19.48	18.84	18.33	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.94	0.88	0.77	0.59	0.41	0.46	0.71	0.91	0.97	0.98	(94)

Useful gains, mGm , W

471.41	513.04	549.8	561.38	513.18	382.34	257.15	268.56	385.39	443.72	444.81	453.43	(95)

Monthly average external temperature from Table U1

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

1083.9	1051.58	955.71	799.19	614.76	406.71	261.51	275.32	439.87	670.58	891.52	1078.31	(97)

Space heating requirement for each month

455.69	361.9	302	171.22	75.57	0	0	0	0	168.78	321.63	464.92	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

455.69	361.9	302	171.22	75.57	0	0	0	0	168.78	321.63	464.92	(98c)

Space heating requirement in kWh/m²/year 46.47 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
542.49	430.83	359.53	203.84	89.97	0	0	0	0	200.93	382.89	553.47			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
299.89	265.51	282.21	247.78	240.1	216.2	212.96	221.31	223.67	249.66	265.86	296.51		3021.64	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		2763.94	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3021.64	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	144.45	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		230.45	(231)
Electricity for lighting		134.55	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			6150.59	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		100.61	(240a)
Low-rate fraction	0		100.61	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		100.61	(241a)
Low-rate fraction	0		100.61	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		100.61	(242a)

Low-rate fraction	0		100.61	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		109.99	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		38	(249)
Energy For lighting	0		22.19	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		362.78	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.38	(257)
SAP rating		77.71	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			580.43	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			634.54	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1214.97	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		31.97	(267)
Electricity for lighting		19.42	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1266.36	(272)
Dwelling CO2 Emission Rate		25.35	(273)
EI rating		82	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3123.26	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3414.45	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6537.71	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			348.63	(281)
Electricity for lighting			206.38	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7092.72	(286)
Dwelling PE Rate			141.97	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	54.15 (1a)	x	3	(2a) =	162.45	(3a)
First Floor	28.04 (1b)	x	2.4	(2b) =	67.3	(3b)
Total floor area TFA					82.19	(4)
Dwelling volume					229.75	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Monthly average wind speed from Table U2													
5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)
Wind Factor													
1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)
Adjusted infiltration rate (allowing for shelter and wind speed)													
0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	13.65		(27)
Roof window	6.8		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	12.72	13421.79	(29a)
Roof	5.3	433.89	(30)
Total area of external elements ∑A, m²		138.65	(31)

Party Wall	0	14785.2	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)
Internal wall **		0	(33c)
Internal floor		0	(32d)
Internal ceiling floor		0	(32e)
Fabric heat loss, W/K = ∑ (A x U)		40.41	(33)
Heat capacity Cm = ∑(A x k)		28640.88	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K		250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K		46.09	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available		46.09	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ		86.5	(37)

Ventilation heat loss calculated monthly

43.56	43.19	42.82	40.99	40.62	38.78	38.78	38.42	39.52	40.62	41.36	42.09	(38)

Heat transfer coefficient, W/K

130.06	129.69	129.32	127.49	127.12	125.28	125.28	124.92	126.02	127.12	127.85	128.59	(39)

Heat loss parameter (HLP), W/m²K

1.58	1.58	1.57	1.55	1.55	1.52	1.52	1.52	1.53	1.55	1.56	1.56	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.5	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

91.01	89.64	87.65	83.84	81.02	77.88	76.1	78.08	80.25	83.61	87.51	90.66	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

28.59	28.16	27.56	26.46	25.64	24.72	24.23	24.82	25.47	26.45	27.57	28.49	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

40.26	38.8	37.34	35.87	34.41	32.94	32.94	34.41	35.87	37.34	38.8	40.26	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	147.26	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

159.86	156.6	152.55	146.17	141.07	135.55	133.27	137.31	141.58	147.4	153.88	159.41	1764.64 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

253.18	223	234.46	200.1	189.9	166.67	161.18	170.01	174.59	200.02	219.23	249.6	2441.94 (45)

Distribution loss (46) = 0.15 x (45)

37.98	33.45	35.17	30.01	28.49	25	24.18	25.5	26.19	30	32.88	37.44	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

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

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

304.14 269.03 285.42 249.41 240.86 215.99 212.14 220.97 223.9 250.98 268.55 300.56 3041.94 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

304.14 269.03 285.42 249.41 240.86 215.99 212.14 220.97 223.9 250.98 268.55 300.56 3041.94 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

96.92 85.65 90.7 78.86 75.88 67.75 66.33 69.27 70.38 79.25 85.22 95.73 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

32.29 28.68 23.32 17.66 13.2 11.14 12.04 15.65 21 26.67 31.13 33.18 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

	334.26	337.73	328.99	310.38	286.89	264.82	250.07	246.6	255.34	273.95	297.44	319.52	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	(71)

Water heating gains (Table 5)

	130.27	127.46	121.91	109.53	101.99	94.09	89.16	93.1	97.75	106.51	118.37	128.67	(72)

Total internal gains

	602.41	599.46	579.8	543.15	507.67	472.64	453.85	457.94	476.68	512.72	552.52	586.96	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	134.28	266.78	449.63	671.98	838.03	864.31	820.22	694.83	528.21	319.25	168.16	109.95	(83)

Total gains – internal and solar (watts)

	736.68	866.24	1029.43	1215.14	1345.7	1336.95	1274.06	1152.77	1004.88	831.97	720.68	696.91	(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, ⍰1,m (see Table 9a)

	0.99	0.98	0.96	0.88	0.74	0.57	0.42	0.48	0.74	0.94	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.26	19.5	19.92	20.43	20.78	20.95	20.99	20.98	20.85	20.34	19.7	19.22	(87)

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

	19.63	19.63	19.63	19.65	19.65	19.67	19.67	19.67	19.66	19.65	19.65	19.64	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.99	0.98	0.94	0.84	0.67	0.46	0.3	0.35	0.64	0.91	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	17.66	17.98	18.5	19.11	19.49	19.64	19.67	19.67	19.57	19.03	18.24	17.62	(90)

Living area fraction 0.24 (91)

Mean internal temperature (for the whole dwelling)

	18.05	18.35	18.84	19.43	19.8	19.96	19.99	19.99	19.88	19.35	18.6	18.01	(92)

Adjusted mean internal temperature:

	17.9	18.2	18.69	19.28	19.65	19.81	19.84	19.84	19.73	19.2	18.45	17.86	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.93	0.83	0.67	0.47	0.32	0.37	0.64	0.89	0.97	0.98	(94)

Useful gains, mGm , W

722.69	836.52	953.71	1011.04	905.4	633.75	402.88	424.2	647.14	742.21	697.52	685.98	(95)

Monthly average external temperature from Table U1

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

1768.81	1724.48	1576.98	1323.63	1010.96	652.74	405.61	429.18	709.48	1093.26	1450.93	1756.74	(97)

Space heating requirement for each month

778.31	596.71	463.71	225.07	78.54	0	0	0	0	261.18	542.46	796.64	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

778.31	596.71	463.71	225.07	78.54	0	0	0	0	261.18	542.46	796.64	(98c)

Space heating requirement in kWh/m²/year 45.54 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
926.56	710.37	552.04	267.94	93.5	0	0	0	0	310.93	645.79	948.38		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
362.07	320.27	339.79	296.92	286.74	257.13	252.54	263.06	266.55	298.78	319.7	357.81	3621.36	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1			4455.5 (211)
Space heating fuel used, main system 2			0 (213)
Space heating fuel used, secondary			0 (215)
Water heating fuel used			3621.36 (219)
Electricity for instantaneous electric shower(s)			0 (64a)
Space cooling fuel used			0 (221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	0	311.82 (230a)
warm air heating system fans			0 (230b)
Heating circulation pump or water pump within warm air heating unit			41 (230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)			0 (230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)			45 (230e)
Maintaining electric keep-hot facility for gas combi boiler			0 (230f)
Pump for solar water heating			0 (230g)
Pump for storage WWHRS			0 (230h)
Total electricity for the above			397.82 (231)
Electricity for lighting			228.08 (232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			8702.75	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		162.18	(240a)
Low-rate fraction	0		162.18	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		162.18	(241a)
Low-rate fraction	0		162.18	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		162.18	(242a)

Low-rate fraction	0		162.18	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		131.82	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		65.6	(249)
Energy For lighting	0		37.61	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		489.21	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.38	(257)
SAP rating		77.55	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			935.65	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			760.49	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1696.14	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		55.18	(267)
Electricity for lighting		32.92	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1784.24	(272)
Dwelling CO2 Emission Rate		21.71	(273)
EI rating		81	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			5034.71	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			4092.14	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			9126.85	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			601.83	(281)
Electricity for lighting			349.83	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			10078.5	(286)
Dwelling PE Rate			122.62	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	52.93 (1a)	x	3	(2a) =	158.79	(3a)
First Floor	31.36 (1b)	x	2.4	(2b) =	75.26	(3b)
Total floor area TFA					84.29	(4)
Dwelling volume					234.05	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Monthly average wind speed from Table U2													
5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)
Wind Factor													
1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)
Adjusted infiltration rate (allowing for shelter and wind speed)													
0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	12.57		(27)
Roof window	6.8		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0.12	72	(28b)
Basement wall	0	0	(29)
External wall	13.69	14445.7	(29a)
Roof	5.27	431.55	(30)
Total area of external elements ∑A, m²		143.8	(31)

Party Wall	0	12925.8	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)
Internal wall **		0	(33c)
Internal floor		0	(32d)
Internal ceiling floor		0	(32e)
Fabric heat loss, W/K = ∑ (A x U)		40.4	(33)
Heat capacity Cm = ∑(A x k)		27875.05	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K		250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K		36.12	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available		36.12	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ		76.51	(37)

Ventilation heat loss calculated monthly

	44.38	44	43.63	41.76	41.38	39.51	39.51	39.14	40.26	41.38	42.13	42.88	(38)

Heat transfer coefficient, W/K

	120.89	120.52	120.14	118.27	117.9	116.03	116.03	115.65	116.77	117.9	118.65	119.39	(39)

Heat loss parameter (HLP), W/m²K

	1.43	1.43	1.43	1.4	1.4	1.38	1.38	1.37	1.39	1.4	1.41	1.42	(40)

Number of days in month (Table 1a)

	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.54	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

	91.84	90.46	88.45	84.6	81.76	78.6	76.8	78.79	80.98	84.38	88.31	91.49	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

	28.85	28.42	27.82	26.7	25.87	24.95	24.45	25.05	25.7	26.69	27.82	28.75	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

	40.63	39.16	37.68	36.2	34.72	33.25	33.25	34.72	36.2	37.68	39.16	40.63	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	148.6	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

	161.32	158.04	153.95	147.51	142.36	136.79	134.49	138.56	142.88	148.75	155.29	160.87	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

	255.5	225.04	236.61	201.93	191.64	168.2	162.65	171.57	176.19	201.85	221.24	251.89	(45)

Distribution loss (46) = 0.15 x (45)

	38.32	33.76	35.49	30.29	28.75	25.23	24.4	25.74	26.43	30.28	33.19	37.78	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

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

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96	46.03	50.96	49.32	50.96	49.32	50.96	50.96	49.32	50.96	49.32	50.96	(61)

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

306.46	271.07	287.57	251.25	242.6	217.51	213.61	222.53	225.5	252.81	270.55	302.85	3064.3	(62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0	0	0	0	0	0	0	0	0	0	0	0	(63b)

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

0	0	0	0	0	0	0	0	0	0	0	0	(63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

306.46	271.07	287.57	251.25	242.6	217.51	213.61	222.53	225.5	252.81	270.55	302.85	3064.3	(64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0	0	0	0	0	0	0	0	0	0	0	0	(64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

97.69	86.33	91.41	79.47	76.46	68.25	66.82	69.79	70.91	79.85	85.89	96.49	(65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

152.35	152.35	152.35	152.35	152.35	152.35	152.35	152.35	152.35	152.35	152.35	152.35	(66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

33.09	29.39	23.9	18.1	13.53	11.42	12.34	16.04	21.53	27.34	31.91	34.01	(67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

340.56	344.09	335.18	316.23	292.29	269.8	254.78	251.24	260.15	279.11	303.04	325.53	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	(71)

Water heating gains (Table 5)

131.31	128.47	122.87	110.38	102.77	94.8	89.81	93.8	98.49	107.33	119.29	129.7	(72)

Total internal gains

611.52	608.52	588.51	551.26	515.15	479.58	460.49	464.64	483.72	520.33	560.8	595.8	(73)

6. Solar gains

Solar gains in watts, calculated for each month

170.19	317.01	494.98	698.31	846.98	865.96	824.69	712.18	566.33	367.92	209.05	142.14	(83)

Total gains – internal and solar (watts)

781.71	925.53	1083.5	1249.57	1362.14	1345.54	1285.18	1176.82	1050.06	888.25	769.84	737.94	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

0.99	0.98	0.95	0.86	0.71	0.53	0.39	0.44	0.69	0.92	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

19.49	19.75	20.13	20.57	20.85	20.97	20.99	20.99	20.9	20.5	19.91	19.45	(87)

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

19.74	19.74	19.74	19.76	19.76	19.78	19.78	19.78	19.77	19.76	19.76	19.75	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.99	0.97	0.93	0.82	0.65	0.44	0.29	0.33	0.6	0.88	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.04	18.36	18.83	19.36	19.65	19.77	19.78	19.78	19.72	19.3	18.58	18	(90)

Living area fraction 0.25 (91)

Mean internal temperature (for the whole dwelling)

18.4	18.71	19.16	19.66	19.95	20.07	20.08	20.09	20.02	19.6	18.92	18.36	(92)

Adjusted mean internal temperature:

18.25	18.56	19.01	19.51	19.8	19.92	19.93	19.94	19.87	19.45	18.77	18.21	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.92	0.81	0.65	0.45	0.3	0.35	0.6	0.87	0.96	0.98	(94)

Useful gains, mGm , W

765.17	888.38	991.72	1016.11	882.47	605.74	385.49	406.22	634.66	773.46	740.96	725.24	(95)

Monthly average external temperature from Table U1

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

1686.77	1645.77	1502.98	1255.36	955.43	617.05	386.93	408.85	673.35	1043.58	1384.22	1673.03	(97)

Space heating requirement for each month

685.67	508.97	380.38	172.26	54.28	0	0	0	0	200.97	463.15	705.16	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

685.67	508.97	380.38	172.26	54.28	0	0	0	0	200.97	463.15	705.16	(98c)

Space heating requirement in kWh/m²/year 37.62 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
816.27	605.91	452.83	205.07	64.62	0	0	0	0	239.25	551.37	839.48			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
364.83	322.7	342.34	299.1	288.81	258.94	254.3	264.91	268.45	300.96	322.09	360.53		3647.98	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													3774.8	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													3647.98	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			317.67	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													45	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													403.67	(231)
Electricity for lighting													233.78	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			8060.22	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		137.4	(240a)
Low-rate fraction	0		137.4	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		137.4	(241a)
Low-rate fraction	0		137.4	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		137.4	(242a)

Low-rate fraction	0		137.4	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		132.79	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		66.57	(249)
Energy For lighting	0		38.55	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		467.3	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.3	(257)
SAP rating		78.91	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			792.71	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			766.08	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1558.78	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		55.99	(267)
Electricity for lighting		33.74	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1648.52	(272)
Dwelling CO2 Emission Rate		19.56	(273)
EI rating		83	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			4265.52	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			4122.21	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			8387.74	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			610.67	(281)
Electricity for lighting			358.58	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			9356.98	(286)
Dwelling PE Rate			111.01	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	9.19	5302.5	(28b)
Basement wall	0	0	(29)
External wall	9.71	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	35.1	(33)
Heat capacity Cm = ∑(A x k)	18566.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	32.67	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	32.67	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	67.77	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

96.01	95.82	95.62	94.65	94.46	93.49	93.49	93.29	93.87	94.46	94.85	95.23	(39)

Heat loss parameter (HLP), W/m²K

1.36	1.36	1.35	1.34	1.34	1.32	1.32	1.32	1.33	1.34	1.34	1.35	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

85.47	84.19	82.32	78.74	76.09	73.15	71.47	73.33	75.36	78.53	82.19	85.15	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 138.3 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

150.13	147.08	143.27	137.28	132.48	127.3	125.16	128.95	132.97	138.43	144.52	149.72	1657.29 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

237.78	209.43	220.2	187.92	178.35	156.53	151.37	159.67	163.97	187.85	205.89	234.42	2293.38 (45)

Distribution loss (46) = 0.15 x (45)

35.67	31.42	33.03	28.19	26.75	23.48	22.71	23.95	24.59	28.18	30.88	35.16	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

91.8 81.14 85.96 74.81 72.04 64.38 63.07 65.83 66.85 75.2 80.79 90.68 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

28.48 25.3 20.57 15.57 11.64 9.83 10.62 13.8 18.53 23.53 27.46 29.27 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	123.39	120.75	115.53	103.91	96.83	89.41	84.77	88.48	92.84	101.07	112.21	121.89	(72)

Total internal gains

	547.87	545.13	527.42	494.28	462.4	430.56	413.61	417.42	434.27	467.03	502.96	534.06	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	629.63	692.95	752.4	811.12	852.06	832.7	794.95	742.1	690.7	636.53	602.44	603.02	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.99	0.98	0.97	0.93	0.83	0.66	0.5	0.56	0.79	0.94	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.57	19.74	20.04	20.42	20.75	20.93	20.98	20.98	20.85	20.44	19.94	19.53	(87)

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

	19.8	19.8	19.8	19.81	19.81	19.82	19.82	19.83	19.82	19.81	19.81	19.8	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.99	0.98	0.96	0.9	0.77	0.56	0.38	0.43	0.7	0.92	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.17	18.39	18.77	19.24	19.61	19.79	19.82	19.82	19.72	19.28	18.65	18.13	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	18.7	18.9	19.25	19.69	20.04	20.22	20.26	20.26	20.15	19.72	19.14	18.66	(92)

Adjusted mean internal temperature:

	18.55	18.75	19.1	19.54	19.89	20.07	20.11	20.11	20	19.57	18.99	18.51	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.95	0.89	0.78	0.59	0.41	0.46	0.72	0.91	0.97	0.98	(94)

Useful gains, mGm , W

618.36	673.61	714.2	724.31	660.76	487.87	324.57	339.82	495.81	580.63	584.62	593.9	(95)

Monthly average external temperature from Table U1

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

1368.23	1327.39	1204.6	1006.99	773.56	511.49	328.19	345.81	553.82	847.01	1127.38	1363.16	(97)

Space heating requirement for each month

557.9	439.35	364.86	203.52	83.92	0	0	0	0	198.19	390.79	572.34	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

557.9	439.35	364.86	203.52	83.92	0	0	0	0	198.19	390.79	572.34	(98c)

Space heating requirement in kWh/m²/year 39.76 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
664.17	523.03	434.36	242.29	99.9	0	0	0	0	235.94	465.22	681.35			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
343.73	304.12	322.81	282.43	272.98	245.06	240.87	250.75	253.91	284.29	303.82	339.74	3444.5		(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													3346.26	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													3444.5	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			204.42	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													45	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													290.42	(231)
Electricity for lighting													201.18	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			7282.37	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		121.8	(240a)
Low-rate fraction	0		121.8	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		121.8	(241a)
Low-rate fraction	0		121.8	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		121.8	(242a)

Low-rate fraction	0		121.8	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		125.38	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		47.89	(249)
Energy For lighting	0		33.18	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		420.25	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.31	(257)
SAP rating		78.8	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			702.72	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			723.35	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1426.06	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		40.29	(267)
Electricity for lighting		29.04	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1495.38	(272)
Dwelling CO2 Emission Rate		21.15	(273)
EI rating		83	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3781.28	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3892.29	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			7673.56	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			439.35	(281)
Electricity for lighting			308.58	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			8421.5	(286)
Dwelling PE Rate			119.12	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	50.65 (1a)	x	2.4	(2a) =	121.56	(3a)
Total floor area TFA					50.65	(4)
Dwelling volume					121.56	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.12	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	1.53	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

Effective air change rate from PCDB:

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.58	3798.75	(28b)
Basement wall	0	0	(29)
External wall	6.33	6676.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		94.61	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	22.73	(33)
Heat capacity Cm = ∑(A x k)	15673.75	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	26.57	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	26.57	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	49.29	(37)

Ventilation heat loss calculated monthly

19.08	18.97	18.85	18.27	18.15	17.57	17.57	17.45	17.8	18.15	18.38	18.62	(38)

Heat transfer coefficient, W/K

68.38	68.26	68.14	67.56	67.45	66.86	66.86	66.75	67.1	67.45	67.68	67.91	(39)

Heat loss parameter (HLP), W/m²K

1.35	1.35	1.35	1.33	1.33	1.32	1.32	1.32	1.32	1.33	1.34	1.34	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.71 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

72.71	71.61	70.02	66.98	64.73	62.22	60.8	62.38	64.11	66.8	69.91	72.43	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

22.86	22.52	22.04	21.16	20.5	19.77	19.38	19.85	20.37	21.15	22.05	22.79	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.13	30.97	29.8	28.63	27.46	26.29	26.29	27.46	28.63	29.8	30.97	32.13	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 117.64 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

127.7	125.1	121.86	116.77	112.69	108.28	106.46	109.69	113.1	117.75	122.93	127.35	1409.69 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

202.25	178.15	187.3	159.85	151.7	133.15	128.76	135.81	139.47	159.78	175.13	199.4	1950.76 (45)

Distribution loss (46) = 0.15 x (45)

30.34	26.72	28.1	23.98	22.76	19.97	19.31	20.37	20.92	23.97	26.27	29.91	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

253.21 224.17 238.26 209.16 202.66 182.46 179.72 186.77 188.78 210.74 224.45 250.36 2550.76 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

253.21 224.17 238.26 209.16 202.66 182.46 179.72 186.77 188.78 210.74 224.45 250.36 2550.76 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

79.99 70.74 75.02 65.48 63.18 56.6 55.55 57.9 58.7 65.87 70.56 79.04 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

20.42 18.13 14.75 11.16 8.35 7.05 7.61 9.9 13.28 16.86 19.68 20.98 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

222.27 224.58 218.77 206.39 190.77 176.09 166.29 163.98 169.79 182.16 197.78 212.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	(71)

Water heating gains (Table 5)

	107.51	105.27	100.83	90.94	84.92	78.61	74.67	77.82	81.53	88.53	98	106.24	(72)

Total internal gains

	434.35	432.13	418.49	392.65	368.19	342.9	329.71	332.84	345.75	371.71	399.62	423.83	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	23.72	48.29	87	142.89	192.07	204.76	191.55	152.71	106.02	59.01	29.85	19.37	(83)

Total gains – internal and solar (watts)

	458.07	480.42	505.5	535.53	560.25	547.66	521.27	485.55	451.77	430.73	429.47	443.21	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.99	0.99	0.97	0.94	0.86	0.71	0.54	0.6	0.83	0.95	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.59	19.72	19.99	20.36	20.7	20.91	20.98	20.97	20.82	20.4	19.94	19.56	(87)

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

	19.8	19.8	19.81	19.81	19.82	19.83	19.83	19.83	19.82	19.82	19.81	19.81	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.99	0.98	0.97	0.92	0.81	0.6	0.41	0.46	0.75	0.93	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.21	18.37	18.71	19.17	19.57	19.78	19.82	19.82	19.7	19.24	18.65	18.18	(90)

Living area fraction 0.49 (91)

Mean internal temperature (for the whole dwelling)

	18.88	19.03	19.33	19.75	20.12	20.33	20.38	20.38	20.24	19.81	19.28	18.85	(92)

Adjusted mean internal temperature:

	18.73	18.88	19.18	19.6	19.97	20.18	20.23	20.23	20.09	19.66	19.13	18.7	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.98	0.96	0.92	0.82	0.64	0.46	0.51	0.77	0.93	0.97	0.98	(94)

Useful gains, mGm , W

449.75	468.77	485	490.53	456.95	349.2	238.78	248.61	346.72	399.53	417.44	436.15	(95)

Monthly average external temperature from Table U1

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

986.93	954.3	864.17	722.98	557.8	373.21	243.01	255.48	402.15	610.77	814.22	984.92	(97)

Space heating requirement for each month

399.66	326.27	282.11	167.36	75.03	0	0	0	0	157.16	285.69	408.28	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

399.66	326.27	282.11	167.36	75.03	0	0	0	0	157.16	285.69	408.28	(98c)

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

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0 (107)

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
475.79	388.42	335.84	199.24	89.33	0	0	0	0	187.1	340.1	486.05		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
301.44	266.87	283.64	249.01	241.27	217.22	213.95	222.35	224.74	250.88	267.2	298.04	3036.61	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												2501.87	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												3036.61	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		146.45	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												45	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												232.45	(231)
Electricity for lighting												144.22	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year	
energy saved		0	(236a)
energy used		0	(237a)
Total delivered energy for all uses		5915.16	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		91.07	(240a)
Low-rate fraction	0		91.07	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		91.07	(241a)
Low-rate fraction	0		91.07	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		91.07	(242a)

Low-rate fraction	0		91.07	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		110.53	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		38.33	(249)
Energy For lighting	0		23.78	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		355.71	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.34	(257)
SAP rating		78.3	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			525.39	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			637.69	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1163.08	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		32.24	(267)
Electricity for lighting		20.82	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1216.14	(272)
Dwelling CO2 Emission Rate		24.01	(273)
EI rating		83	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			2827.12	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3431.37	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6258.49	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			351.65	(281)
Electricity for lighting			221.21	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			6831.35	(286)
Dwelling PE Rate			134.87	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	75.99 (1a)	x	2.4	(2a) =	182.38	(3a)
Total floor area TFA					75.99	(4)
Dwelling volume					182.38	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	15.25		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	9.88	5699.25	(28b)
Basement wall	0	0	(29)
External wall	10.43	11008.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		149.19	(31)
Party Wall	0	2187	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	37.5	(33)
Heat capacity Cm = ∑(A x k)	18894.85	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	33.55	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	33.55	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	71.05	(37)

Ventilation heat loss calculated monthly

30.36	30.15	29.94	28.9	28.69	27.64	27.64	27.43	28.06	28.69	29.1	29.52	(38)

Heat transfer coefficient, W/K

101.41	101.2	100.99	99.95	99.74	98.7	98.7	98.49	99.11	99.74	100.16	100.58	(39)

Heat loss parameter (HLP), W/m²K

1.33	1.33	1.33	1.32	1.31	1.3	1.3	1.3	1.3	1.31	1.32	1.32	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.38	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

88.23	86.9	84.97	81.27	78.54	75.5	73.77	75.69	77.79	81.06	84.83	87.89	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

27.72	27.3	26.72	25.66	24.86	23.97	23.49	24.06	24.69	25.64	26.73	27.62	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

39.03	37.61	36.19	34.77	33.35	31.93	31.93	33.35	34.77	36.19	37.61	39.03	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	142.75	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

154.97	151.81	147.88	141.7	136.75	131.4	129.19	133.1	137.25	142.89	149.17	154.54	1710.66	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

245.43	216.18	227.29	193.98	184.09	161.57	156.25	164.81	169.25	193.9	212.53	241.97	2367.24	(45)

Distribution loss (46) = 0.15 x (45)

36.82	32.43	34.09	29.1	27.61	24.24	23.44	24.72	25.39	29.08	31.88	36.3	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

296.39 262.21 278.25 243.29 235.05 210.89 207.21 215.77 218.56 244.86 261.84 292.93 2967.24 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

296.39 262.21 278.25 243.29 235.05 210.89 207.21 215.77 218.56 244.86 261.84 292.93 2967.24 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

94.35 83.39 88.31 76.83 73.95 66.05 64.69 67.54 68.6 77.21 82.99 93.19 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

30.7 27.26 22.17 16.79 12.55 10.59 11.45 14.88 19.97 25.36 29.59 31.55 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

314.71 317.98 309.75 292.23 270.11 249.33 235.44 232.18 240.4 257.92 280.04 300.83 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	(71)

Water heating gains (Table 5)

126.81	124.09	118.7	106.7	99.4	91.74	86.95	90.78	95.28	103.78	115.27	125.26	(72)

Total internal gains

574.54	571.65	552.94	518.04	484.38	450.98	433.16	437.16	454.98	489.38	527.23	559.96	(73)

6. Solar gains

Solar gains in watts, calculated for each month

149.78	255.13	349.08	432.53	484.46	480.96	463.7	424.95	377.98	281.97	179.4	128.18	(83)

Total gains – internal and solar (watts)

724.32	826.78	902.02	950.57	968.84	931.94	896.86	862.11	832.96	771.35	706.63	688.14	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

0.99	0.98	0.95	0.9	0.8	0.64	0.47	0.51	0.73	0.92	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

19.66	19.88	20.17	20.52	20.79	20.95	20.99	20.98	20.9	20.55	20.04	19.62	(87)

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

19.81	19.82	19.82	19.83	19.83	19.84	19.84	19.84	19.84	19.83	19.83	19.82	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.97	0.94	0.87	0.74	0.54	0.35	0.39	0.64	0.88	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.31	18.57	18.94	19.36	19.67	19.81	19.84	19.84	19.77	19.41	18.79	18.26	(90)

Living area fraction 0.28 (91)

Mean internal temperature (for the whole dwelling)

18.69	18.94	19.29	19.69	19.98	20.13	20.16	20.16	20.09	19.73	19.14	18.64	(92)

Adjusted mean internal temperature:

18.54	18.79	19.14	19.54	19.83	19.98	20.01	20.01	19.94	19.58	18.99	18.49	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.93	0.86	0.74	0.55	0.37	0.41	0.65	0.87	0.96	0.98	(94)

Useful gains, mGm , W

707.39	793.31	836.48	818.94	716.68	512.84	334.36	351.98	539.96	674.54	677.75	674.85	(95)

Monthly average external temperature from Table U1

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

1443.88	1405.75	1276.55	1063.33	811.12	531.19	336.77	355.65	578.83	895.71	1190.94	1437.25	(97)

Space heating requirement for each month

547.95	411.56	327.41	175.96	70.26	0	0	0	0	164.55	369.5	567.23	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

547.95	411.56	327.41	175.96	70.26	0	0	0	0	164.55	369.5	567.23	(98c)

Space heating requirement in kWh/m²/year 34.67 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0 (107)

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
652.32	489.95	389.77	209.48	83.65	0	0	0	0	195.89	439.88	675.27		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
352.85	312.15	331.25	289.63	279.82	251.06	246.67	256.87	260.19	291.5	311.72	348.72	3532.43	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		3136.22	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3532.43	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	0	219.72 (230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		305.72	(231)
Electricity for lighting		216.84	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			7191.2	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		114.16	(240a)
Low-rate fraction	0		114.16	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		114.16	(241a)
Low-rate fraction	0		114.16	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		114.16	(242a)

Low-rate fraction	0		114.16	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		128.58	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		50.41	(249)
Energy For lighting	0		35.76	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		420.91	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.25	(257)
SAP rating		79.7	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			658.61	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			741.81	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1400.42	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		42.41	(267)
Electricity for lighting		31.3	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1474.12	(272)
Dwelling CO2 Emission Rate		19.4	(273)
EI rating		84	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3543.93	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3991.65	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			7535.58	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			462.49	(281)
Electricity for lighting			332.59	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			8330.66	(286)
Dwelling PE Rate			109.63	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.71	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	25.91	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	28.18	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	28.18	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.09	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

82.34	82.14	81.95	80.98	80.78	79.81	79.81	79.62	80.2	80.78	81.17	81.56	(39)

Heat loss parameter (HLP), W/m²K

1.16	1.16	1.16	1.15	1.14	1.13	1.13	1.13	1.13	1.14	1.15	1.15	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.26	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

85.47	84.19	82.32	78.74	76.09	73.15	71.47	73.33	75.36	78.53	82.19	85.15	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	138.3	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

150.13	147.08	143.27	137.28	132.48	127.3	125.16	128.95	132.97	138.43	144.52	149.72	1657.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

237.78	209.43	220.2	187.92	178.35	156.53	151.37	159.67	163.97	187.85	205.89	234.42	2293.38	(45)

Distribution loss (46) = 0.15 x (45)

35.67	31.42	33.03	28.19	26.75	23.48	22.71	23.95	24.59	28.18	30.88	35.16	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

91.8 81.14 85.96 74.81 72.04 64.38 63.07 65.83 66.85 75.2 80.79 90.68 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

28.48 25.3 20.57 15.57 11.64 9.83 10.62 13.8 18.53 23.53 27.46 29.27 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	123.39	120.75	115.53	103.91	96.83	89.41	84.77	88.48	92.84	101.07	112.21	121.89	(72)

Total internal gains

	547.87	545.13	527.42	494.28	462.4	430.56	413.61	417.42	434.27	467.03	502.96	534.06	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	629.63	692.95	752.4	811.12	852.06	832.7	794.95	742.1	690.7	636.53	602.44	603.02	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.99	0.98	0.96	0.9	0.78	0.59	0.44	0.49	0.73	0.93	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.86	20.03	20.29	20.62	20.87	20.97	21	20.99	20.93	20.62	20.18	19.83	(87)

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

	19.95	19.95	19.95	19.96	19.97	19.98	19.98	19.98	19.97	19.97	19.96	19.96	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.99	0.97	0.95	0.87	0.72	0.51	0.34	0.38	0.65	0.9	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.65	18.86	19.2	19.6	19.86	19.96	19.98	19.98	19.93	19.61	19.07	18.62	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	19.11	19.3	19.61	19.99	20.24	20.35	20.36	20.36	20.31	19.99	19.49	19.08	(92)

Adjusted mean internal temperature:

	18.96	19.15	19.46	19.84	20.09	20.2	20.21	20.21	20.16	19.84	19.34	18.93	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.94	0.87	0.73	0.53	0.36	0.41	0.66	0.89	0.97	0.98	(94)

Useful gains, mGm , W

617.56	671.3	707.51	704.78	619.61	437.81	287.25	301.61	458.37	568.76	582.35	593.38	(95)

Monthly average external temperature from Table U1

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

1207.09	1170.79	1062.24	885.63	677.84	446.63	288.29	303.47	485.65	746.42	993.69	1201.05	(97)

Space heating requirement for each month

438.61	335.65	263.92	130.21	43.32	0	0	0	0	132.17	296.17	452.11	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

438.61	335.65	263.92	130.21	43.32	0	0	0	0	132.17	296.17	452.11	(98c)

Space heating requirement in kWh/m²/year 29.59 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
522.15	399.59	314.19	155.02	51.57	0	0	0	0	157.35	352.58	538.22			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
343.73	304.12	322.81	282.43	272.98	245.06	240.87	250.75	253.91	284.29	303.82	339.74	3444.5		(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		2490.66	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3444.5	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	204.42	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		290.42	(231)
Electricity for lighting		201.18	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling													
Electricity generated by PVs (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)
Electricity generated by hydro-electric generators													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)
Electricity used or net electricity generated by micro-CHP													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)
Energy saving/generation technologies (Appendices M, N) - Energy exported													
Electricity generated by PVs (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)
Electricity generated by hydro-electric generators													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)
Electricity used or net electricity generated by micro-CHP													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)
Appendix Q items: annual energy													
Appendix Q, <item 1 description>								Fuel		kWh/year			
energy saved												0	(236a)
energy used												0	(237a)
Total delivered energy for all uses												6426.77	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(240a)
Low-rate fraction	0		90.66	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(241a)
Low-rate fraction	0		90.66	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(242a)

Low-rate fraction	0		90.66	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		125.38	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		47.89	(249)
Energy For lighting	0		33.18	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		389.11	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.21	(257)
SAP rating		80.37	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			523.04	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			723.35	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1246.38	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		40.29	(267)
Electricity for lighting		29.04	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1315.71	(272)
Dwelling CO2 Emission Rate		18.61	(273)
EI rating		85	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			2814.45	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3892.29	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6706.74	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			439.35	(281)
Electricity for lighting			308.58	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7454.67	(286)
Dwelling PE Rate			105.44	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.03	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	20.28	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	23.48	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	23.48	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	43.76	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

68.41	68.24	68.07	67.23	67.06	66.21	66.21	66.04	66.55	67.06	67.4	67.74	(39)

Heat loss parameter (HLP), W/m²K

1.11	1.11	1.1	1.09	1.09	1.07	1.07	1.07	1.08	1.09	1.09	1.1	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

80.1	78.89	77.14	73.78	71.31	68.55	66.98	68.72	70.62	73.59	77.02	79.79	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 129.6 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

140.69	137.82	134.26	128.64	124.15	119.29	117.29	120.84	124.6	129.72	135.43	140.3	1553.03 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

222.82	196.26	206.35	176.1	167.13	146.69	141.85	149.62	153.65	176.03	192.94	219.67	2149.11 (45)

Distribution loss (46) = 0.15 x (45)

33.42	29.44	30.95	26.42	25.07	22	21.28	22.44	23.05	26.4	28.94	32.95	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

273.78 242.29 257.3 225.42 218.09 196 192.81 200.58 202.97 226.99 242.26 270.63 2749.11 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

273.78 242.29 257.3 225.42 218.09 196 192.81 200.58 202.97 226.99 242.26 270.63 2749.11 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

86.83 76.76 81.35 70.88 68.31 61.1 59.9 62.49 63.42 71.27 76.48 85.78 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

24.96 22.17 18.03 13.65 10.2 8.61 9.31 12.1 16.24 20.62 24.07 25.66 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

116.7	114.23	109.34	98.45	91.81	84.86	80.52	83.99	88.08	95.79	106.22	115.3	(72)

Total internal gains

499.04	496.52	480.58	450.57	421.9	392.89	377.56	381.08	396.23	426.05	458.52	486.66	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

610.14	685.76	739.5	771.4	781.25	749.64	721.51	696.28	676.59	635.2	591.59	581.73	(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, ⍰1,m (see Table 9a)

0.98	0.97	0.93	0.86	0.73	0.55	0.4	0.43	0.65	0.88	0.96	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.05	20.24	20.48	20.74	20.91	20.98	21	21	20.96	20.75	20.36	20.01	(87)

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

19.99	20	20	20.01	20.01	20.02	20.02	20.03	20.02	20.01	20.01	20	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.96	0.91	0.83	0.67	0.47	0.31	0.34	0.57	0.84	0.95	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

18.92	19.15	19.45	19.76	19.94	20.01	20.02	20.02	20	19.79	19.32	18.88	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

19.37	19.59	19.86	20.15	20.33	20.4	20.41	20.41	20.38	20.17	19.73	19.33	(92)

Adjusted mean internal temperature:

19.22	19.44	19.71	20	20.18	20.25	20.26	20.26	20.23	20.02	19.58	19.18	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.95	0.91	0.83	0.68	0.49	0.34	0.37	0.59	0.84	0.95	0.98	(94)

Useful gains, mGm , W

592.3	651.04	671.89	637.07	534.93	369.51	242	254.35	396.53	532.38	560.39	567.68	(95)

Monthly average external temperature from Table U1

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

1020.84	992.06	899.52	746.42	568.63	374.24	242.49	255.12	408.17	631.97	841.38	1014.71	(97)

Space heating requirement for each month

318.83	229.16	169.35	78.73	25.08	0	0	0	0	74.09	202.31	332.59	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

318.83	229.16	169.35	78.73	25.08	0	0	0	0	74.09	202.31	332.59	(98c)

Space heating requirement in kWh/m²/year 23.17 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
379.56	272.81	201.61	93.72	29.86	0	0	0	0	88.21	240.85	395.94		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
325.92	288.44	306.31	268.35	259.63	233.33	229.53	238.79	241.63	270.22	288.4	322.18	3272.75	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		1702.57	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3272.75	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	178.46	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		264.46	(231)
Electricity for lighting		176.34	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			5416.11	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		61.97	(240a)
Low-rate fraction	0		61.97	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		61.97	(241a)
Low-rate fraction	0		61.97	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		61.97	(242a)

Low-rate fraction	0		61.97	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		119.13	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		43.61	(249)
Energy For lighting	0		29.08	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		345.79	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.17	(257)
SAP rating		81.09	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			357.54	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			687.28	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1044.82	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		36.68	(267)
Electricity for lighting		25.45	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1106.95	(272)
Dwelling CO2 Emission Rate		17.94	(273)
EI rating		86	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			1923.9	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3698.2	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			5622.1	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			400.07	(281)
Electricity for lighting			270.47	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			6292.65	(286)
Dwelling PE Rate			101.95	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.49	10018.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		64.99	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.25	(33)
Heat capacity Cm = ∑(A x k)	13681.7	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	25.6	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	25.6	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	48.85	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

74.54	74.36	74.18	73.3	73.12	72.24	72.24	72.06	72.59	73.12	73.48	73.83	(39)

Heat loss parameter (HLP), W/m²K

1.16	1.16	1.15	1.14	1.14	1.12	1.12	1.12	1.13	1.14	1.14	1.15	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.1 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

81.72	80.49	78.7	75.28	72.75	69.93	68.33	70.11	72.06	75.08	78.58	81.41	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 132.22 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

143.54	140.62	136.98	131.25	126.67	121.71	119.67	123.29	127.13	132.35	138.17	143.14	1584.52 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

227.34	200.24	210.53	179.67	170.52	149.66	144.73	152.66	156.77	179.6	196.85	224.13	2192.68 (45)

Distribution loss (46) = 0.15 x (45)

34.1	30.04	31.58	26.95	25.58	22.45	21.71	22.9	23.51	26.94	29.53	33.62	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96	46.03	50.96	49.32	50.96	49.32	50.96	50.96	49.32	50.96	49.32	50.96	(61)

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

278.29	246.27	261.49	228.99	221.48	198.97	195.68	203.62	206.08	230.56	246.17	275.08	2792.68	(62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0	0	0	0	0	0	0	0	0	0	0	0	(63b)

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

0	0	0	0	0	0	0	0	0	0	0	0	(63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0	0	0	0	0	0	0	0	0	0	0	0	(63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

278.29	246.27	261.49	228.99	221.48	198.97	195.68	203.62	206.08	230.56	246.17	275.08	2792.68	(64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0	0	0	0	0	0	0	0	0	0	0	0	(64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

88.33	78.09	82.74	72.07	69.44	62.09	60.86	63.5	64.45	72.46	77.78	87.26	(65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	126.01	(66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

26.13	23.21	18.88	14.29	10.68	9.02	9.74	12.67	17	21.59	25.19	26.86	(67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1	276.94	269.78	254.52	235.26	217.15	205.06	202.21	209.38	224.64	243.9	262.01	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

	118.72	116.2	111.21	100.1	93.33	86.24	81.8	85.35	89.52	97.39	108.03	117.29	(72)

Total internal gains

	513.66	511.06	494.57	463.61	433.97	404.11	388.31	391.94	407.61	438.32	471.83	500.86	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31	(83)

Total gains – internal and solar (watts)

	629.7	708.73	765.03	798.72	809.32	776.75	747.57	721.17	700.46	656.79	610.83	600.17	(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, ⍰1,m (see Table 9a)

	0.98	0.97	0.94	0.88	0.76	0.58	0.42	0.46	0.67	0.89	0.97	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.96	20.15	20.41	20.69	20.88	20.98	21	20.99	20.95	20.71	20.28	19.92	(87)

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

	19.95	19.96	19.96	19.97	19.97	19.98	19.98	19.98	19.98	19.97	19.97	19.96	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.98	0.96	0.92	0.84	0.7	0.49	0.33	0.36	0.59	0.85	0.96	0.98	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.78	19.02	19.33	19.67	19.88	19.97	19.98	19.98	19.95	19.7	19.19	18.73	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	19.17	19.39	19.69	20.01	20.21	20.3	20.32	20.32	20.28	20.04	19.56	19.13	(92)

Adjusted mean internal temperature:

	19.02	19.24	19.54	19.86	20.06	20.15	20.17	20.17	20.13	19.89	19.41	18.98	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.95	0.91	0.84	0.7	0.51	0.34	0.38	0.6	0.85	0.95	0.98	(94)

Useful gains, mGm , W

612.32	675.07	699.75	668.81	567.46	394.56	257.05	270.46	421.97	557.52	580.7	586.45	(95)

Monthly average external temperature from Table U1

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

1097.16	1066.6	967.3	803.22	611.63	401.26	257.78	271.59	437.8	679	904.24	1091.01	(97)

Space heating requirement for each month

360.73	263.11	199.06	96.77	32.86	0	0	0	0	90.39	232.95	375.39	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

360.73	263.11	199.06	96.77	32.86	0	0	0	0	90.39	232.95	375.39	(98c)

Space heating requirement in kWh/m²/year 25.68 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
429.44	313.22	236.98	115.21	39.12	0	0	0	0	107.6	277.32	446.9		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
331.3	293.17	311.3	272.6	263.66	236.87	232.96	242.4	245.33	274.47	293.06	327.48	3324.62	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												1965.78	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												3324.62	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		185.92	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												45	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												271.92	(231)
Electricity for lighting												184.59	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			5746.91	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		71.55	(240a)
Low-rate fraction	0		71.55	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		71.55	(241a)
Low-rate fraction	0		71.55	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		71.55	(242a)

Low-rate fraction	0		71.55	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		121.02	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		44.84	(249)
Energy For lighting	0		30.44	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		359.85	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.19	(257)
SAP rating		80.79	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			412.81	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			698.17	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1110.98	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		37.72	(267)
Electricity for lighting		26.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1175.34	(272)
Dwelling CO2 Emission Rate		18.28	(273)
EI rating		86	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			2221.33	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3756.82	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			5978.15	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			411.36	(281)
Electricity for lighting			283.14	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			6672.64	(286)
Dwelling PE Rate			103.77	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	9.71	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	25.91	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	28.18	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	28.18	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.09	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

82.34	82.14	81.95	80.98	80.78	79.81	79.81	79.62	80.2	80.78	81.17	81.56	(39)

Heat loss parameter (HLP), W/m²K

1.16	1.16	1.16	1.15	1.14	1.13	1.13	1.13	1.13	1.14	1.15	1.15	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.26	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

85.47	84.19	82.32	78.74	76.09	73.15	71.47	73.33	75.36	78.53	82.19	85.15	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	138.3	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

150.13	147.08	143.27	137.28	132.48	127.3	125.16	128.95	132.97	138.43	144.52	149.72	1657.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

237.78	209.43	220.2	187.92	178.35	156.53	151.37	159.67	163.97	187.85	205.89	234.42	2293.38	(45)

Distribution loss (46) = 0.15 x (45)

35.67	31.42	33.03	28.19	26.75	23.48	22.71	23.95	24.59	28.18	30.88	35.16	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

288.73 255.46 271.16 237.24 229.31 205.85 202.33 210.63 213.28 238.81 255.21 285.38 2893.38 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

91.8 81.14 85.96 74.81 72.04 64.38 63.07 65.83 66.85 75.2 80.79 90.68 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

28.48 25.3 20.57 15.57 11.64 9.83 10.62 13.8 18.53 23.53 27.46 29.27 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	123.39	120.75	115.53	103.91	96.83	89.41	84.77	88.48	92.84	101.07	112.21	121.89	(72)

Total internal gains

	547.87	545.13	527.42	494.28	462.4	430.56	413.61	417.42	434.27	467.03	502.96	534.06	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	629.63	692.95	752.4	811.12	852.06	832.7	794.95	742.1	690.7	636.53	602.44	603.02	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.99	0.98	0.96	0.9	0.78	0.59	0.44	0.49	0.73	0.93	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	19.86	20.03	20.29	20.62	20.87	20.97	21	20.99	20.93	20.62	20.18	19.83	(87)

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

	19.95	19.95	19.95	19.96	19.97	19.98	19.98	19.98	19.97	19.97	19.96	19.96	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.99	0.97	0.95	0.87	0.72	0.51	0.34	0.38	0.65	0.9	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.65	18.86	19.2	19.6	19.86	19.96	19.98	19.98	19.93	19.61	19.07	18.62	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	19.11	19.3	19.61	19.99	20.24	20.35	20.36	20.36	20.31	19.99	19.49	19.08	(92)

Adjusted mean internal temperature:

	18.96	19.15	19.46	19.84	20.09	20.2	20.21	20.21	20.16	19.84	19.34	18.93	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.94	0.87	0.73	0.53	0.36	0.41	0.66	0.89	0.97	0.98	(94)

Useful gains, mGm , W

617.56	671.3	707.51	704.78	619.61	437.81	287.25	301.61	458.37	568.76	582.35	593.38	(95)

Monthly average external temperature from Table U1

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

1207.09	1170.79	1062.24	885.63	677.84	446.63	288.29	303.47	485.65	746.42	993.69	1201.05	(97)

Space heating requirement for each month

438.61	335.65	263.92	130.21	43.32	0	0	0	0	132.17	296.17	452.11	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

438.61	335.65	263.92	130.21	43.32	0	0	0	0	132.17	296.17	452.11	(98c)

Space heating requirement in kWh/m²/year 29.59 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
522.15	399.59	314.19	155.02	51.57	0	0	0	0	157.35	352.58	538.22			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
343.73	304.12	322.81	282.43	272.98	245.06	240.87	250.75	253.91	284.29	303.82	339.74	3444.5		(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		2490.66	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3444.5	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	204.42	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		290.42	(231)
Electricity for lighting		201.18	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling													
Electricity generated by PVs (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)
Electricity generated by hydro-electric generators													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)
Electricity used or net electricity generated by micro-CHP													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)
Energy saving/generation technologies (Appendices M, N) - Energy exported													
Electricity generated by PVs (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)
Electricity generated by hydro-electric generators													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)
Electricity used or net electricity generated by micro-CHP													
0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)
Appendix Q items: annual energy													
Appendix Q, <item 1 description>								Fuel		kWh/year			
energy saved												0	(236a)
energy used												0	(237a)
Total delivered energy for all uses												6426.77	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(240a)
Low-rate fraction	0		90.66	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(241a)
Low-rate fraction	0		90.66	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		90.66	(242a)

Low-rate fraction	0		90.66	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		125.38	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		47.89	(249)
Energy For lighting	0		33.18	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		389.11	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.21	(257)
SAP rating		80.37	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			523.04	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			723.35	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1246.38	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		40.29	(267)
Electricity for lighting		29.04	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1315.71	(272)
Dwelling CO2 Emission Rate		18.61	(273)
EI rating		85	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			2814.45	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3892.29	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			6706.74	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			439.35	(281)
Electricity for lighting			308.58	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7454.67	(286)
Dwelling PE Rate			105.44	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.03	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	20.28	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	10.16	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	10.16	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	30.44	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

55.1	54.93	54.76	53.91	53.74	52.89	52.89	52.72	53.23	53.74	54.08	54.42	(39)

Heat loss parameter (HLP), W/m²K

0.89	0.89	0.89	0.87	0.87	0.86	0.86	0.85	0.86	0.87	0.88	0.88	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

80.1	78.89	77.14	73.78	71.31	68.55	66.98	68.72	70.62	73.59	77.02	79.79	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 129.6 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

140.69	137.82	134.26	128.64	124.15	119.29	117.29	120.84	124.6	129.72	135.43	140.3	1553.03 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

222.82	196.26	206.35	176.1	167.13	146.69	141.85	149.62	153.65	176.03	192.94	219.67	2149.11 (45)

Distribution loss (46) = 0.15 x (45)

33.42	29.44	30.95	26.42	25.07	22	21.28	22.44	23.05	26.4	28.94	32.95	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

50.96 46.03 50.96 49.32 50.96 49.32 50.96 50.96 49.32 50.96 49.32 50.96 (61)

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

273.78 242.29 257.3 225.42 218.09 196 192.81 200.58 202.97 226.99 242.26 270.63 2749.11 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

273.78 242.29 257.3 225.42 218.09 196 192.81 200.58 202.97 226.99 242.26 270.63 2749.11 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

86.83 76.76 81.35 70.88 68.31 61.1 59.9 62.49 63.42 71.27 76.48 85.78 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

24.96 22.17 18.03 13.65 10.2 8.61 9.31 12.1 16.24 20.62 24.07 25.66 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

116.7	114.23	109.34	98.45	91.81	84.86	80.52	83.99	88.08	95.79	106.22	115.3	(72)

Total internal gains

499.04	496.52	480.58	450.57	421.9	392.89	377.56	381.08	396.23	426.05	458.52	486.66	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

610.14	685.76	739.5	771.4	781.25	749.64	721.51	696.28	676.59	635.2	591.59	581.73	(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, 1,m (see Table 9a)

0.97	0.94	0.89	0.78	0.63	0.45	0.32	0.35	0.54	0.8	0.94	0.98	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.4	20.57	20.75	20.91	20.98	21	21	21	20.99	20.91	20.65	20.37	(87)

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

20.17	20.18	20.18	20.19	20.19	20.2	20.2	20.21	20.2	20.19	20.19	20.18	(88)

Roof Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.96	0.93	0.87	0.74	0.58	0.39	0.26	0.29	0.48	0.76	0.93	0.97	(89)

Roof Mean internal temperature in the rest of dwelling T2

19.51	19.71	19.93	20.11	20.18	20.2	20.2	20.21	20.2	20.11	19.81	19.47	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

19.86	20.05	20.26	20.43	20.5	20.52	20.52	20.52	20.51	20.43	20.15	19.83	(92)

Adjusted mean internal temperature:

19.71	19.9	20.11	20.28	20.35	20.37	20.37	20.37	20.36	20.28	20	19.68	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.93	0.86	0.75	0.59	0.41	0.28	0.3	0.49	0.76	0.92	0.97	(94)

Useful gains, mGm , W

585.66	635.56	639.42	576.9	457.51	304.67	199.49	209.44	331.61	485.58	545.9	562.63	(95)

Monthly average external temperature from Table U1

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

849.29	824.03	745.05	613.4	464.75	305.24	199.53	209.51	333.49	520.35	697.43	842.36	(97)

Space heating requirement for each month

196.15	126.65	78.59	26.28	5.39	0	0	0	0	25.87	109.11	208.11	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

196.15	126.65	78.59	26.28	5.39	0	0	0	0	25.87	109.11	208.11	(98c)

Space heating requirement in kWh/m²/year 12.58 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												84	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
233.51	150.78	93.56	31.29	6.41	0	0	0	0	30.8	129.89	247.75		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				84	(216)
Efficiency of water heater													
84	84	84	84	84	84	84	84	84	84	84	84		(217)
Fuel for water heating													
325.92	288.44	306.31	268.35	259.63	233.33	229.53	238.79	241.63	270.22	288.4	322.18	3272.75	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)

Annual totals	kWh/year	kWh/year	
Space heating fuel used, main system 1		923.98	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		3272.75	(219)
Electricity for instantaneous electric shower(s)		0	(64a)
Space cooling fuel used		0	(221)
Electricity for pumps, fans and electric keep-hot			
Mechanical vent fans - balanced, extract or positive input from outside	0	178.46	(230a)
warm air heating system fans		0	(230b)
Heating circulation pump or water pump within warm air heating unit		41	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)		0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)		45	(230e)
Maintaining electric keep-hot facility for gas combi boiler		0	(230f)
Pump for solar water heating		0	(230g)
Pump for storage WWHRS		0	(230h)
Total electricity for the above		264.46	(231)
Electricity for lighting		176.34	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			4637.52	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.63	(240a)
Low-rate fraction	0		33.63	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.63	(241a)
Low-rate fraction	0		33.63	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.63	(242a)

Low-rate fraction	0		33.63	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		119.13	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		43.61	(249)
Energy For lighting	0		29.08	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		317.45	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.07	(257)
SAP rating		82.64	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			194.04	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			687.28	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		881.31	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		36.68	(267)
Electricity for lighting		25.45	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		943.45	(272)
Dwelling CO2 Emission Rate		15.29	(273)
EI rating		88	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			1044.09	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3698.2	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			4742.3	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			400.07	(281)
Electricity for lighting			270.47	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			5412.84	(286)
Dwelling PE Rate			87.7	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.85	10018.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		64.99	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	20.61	(33)
Heat capacity Cm = ∑(A x k)	13681.7	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.93	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.93	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	24.54	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

50.23	50.05	49.87	48.99	48.81	47.93	47.93	47.75	48.28	48.81	49.17	49.52	(39)

Heat loss parameter (HLP), W/m²K

0.78	0.78	0.78	0.76	0.76	0.75	0.75	0.74	0.75	0.76	0.76	0.77	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.1 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

59.43	58.54	57.24	54.75	52.91	50.86	49.7	50.99	52.4	54.6	57.15	59.21	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 111.62 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

121.25	118.67	115.51	110.72	106.82	102.64	101.03	104.17	107.48	111.87	116.74	120.94	1337.85 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

192.04	168.98	177.54	151.57	143.81	126.21	122.19	128.98	132.53	151.81	166.32	189.36	1851.33 (45)

Distribution loss (46) = 0.15 x (45)

28.81	25.35	26.63	22.74	21.57	18.93	18.33	19.35	19.88	22.77	24.95	28.4	(46)

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

Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.14 (51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

320.41 284.93 305.92 275.8 272.18 168.12 165.5 172.3 174.45 280.19 290.56 317.74 3028.1 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

320.41 284.93 305.92 275.8 272.18 168.12 165.5 172.3 174.45 280.19 290.56 317.74 3028.1 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

166.55 148.95 161.73 149.78 150.52 75.5 75.28 77.54 77.6 153.18 154.69 165.66 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

22.85 20.29 16.5 12.49 9.34 7.88 8.52 11.07 14.86 18.87 22.03 23.48 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1 276.94 269.78 254.52 235.26 217.15 205.06 202.21 209.38 224.64 243.9 262.01 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

	223.86	221.65	217.38	208.03	202.31	104.86	101.18	104.22	107.78	205.89	214.85	222.67	(72)

Total internal gains

	615.52	613.59	598.37	569.75	541.61	421.6	406.46	409.21	423.73	544.11	575.48	602.86	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31	(83)

Total gains – internal and solar (watts)

	731.56	811.26	868.83	904.86	916.96	794.24	765.73	738.45	716.58	762.57	714.48	702.17	(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, ⍰1,m (see Table 9a)

	0.93	0.87	0.78	0.64	0.49	0.39	0.28	0.3	0.46	0.65	0.86	0.94	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.74	20.82	20.9	20.94	20.95	20.96	20.96	20.96	20.96	20.94	20.86	20.72	(87)

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

	20.27	20.27	20.27	20.29	20.29	20.3	20.3	20.3	20.3	20.29	20.28	20.28	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.91	0.85	0.75	0.61	0.46	0.34	0.23	0.25	0.42	0.61	0.83	0.92	(89)

Roof Mean internal temperature in the rest of dwelling T2

	19.98	20.08	20.16	20.22	20.23	20.25	20.25	20.25	20.24	20.22	20.13	19.97	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	20.23	20.33	20.41	20.46	20.47	20.48	20.48	20.48	20.48	20.46	20.37	20.22	(92)

Adjusted mean internal temperature:

	20.23	20.33	20.41	20.46	20.47	20.48	20.48	20.48	20.48	20.46	20.37	20.22	(93)

8. Space heating requirement

Utilisation factor for gains,

0.91	0.85	0.76	0.62	0.47	0.35	0.24	0.26	0.43	0.62	0.83	0.92	(94)

Useful gains, mGm , W

665.27	690.77	658.61	558.39	427.14	281.82	186.07	195.01	307.53	474.44	595.01	647.18	(95)

Monthly average external temperature from Table U1

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

800.14	772.01	693.49	566.25	428.17	281.92	186.07	195.02	307.94	481.38	652.6	793.19	(97)

Space heating requirement for each month

100.34	54.6	25.95	5.66	0.76	0	0	0	0	5.17	41.47	108.63	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

100.34	54.6	25.95	5.66	0.76	0	0	0	0	5.17	41.47	108.63	(98c)

Space heating requirement in kWh/m²/year 5.33 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													319.7	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0		0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
31.38	17.08	8.12	1.77	0.24	0	0	0		0	1.62	12.97	33.98		(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(215)
Output from water heater),								0					224.4	(216)
Efficiency of water heater														
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		224.4	224.4	224.4	224.4		(217)
Fuel for water heating														
142.79	126.97	136.33	122.91	121.29	74.92	73.75	76.78		77.74	124.86	129.48	141.6	1349.42	(219)
Space Cooling														
0	0	0	0	0	0	0	0		0	0	0	0		(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													107.16	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1349.42	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			185.92	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													185.92	(231)
Electricity for lighting													161.39	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1803.88	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		17.67	(240a)
Low-rate fraction	0		17.67	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		17.67	(241a)
Low-rate fraction	0		17.67	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		17.67	(242a)

Low-rate fraction	0		17.67	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		222.52	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		30.66	(249)
Energy For lighting	0		26.61	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		389.46	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator	0.36	(256)
Energy cost factor (ECF)	1.28	(257)
SAP rating	79.21	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			17.09	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			283.38	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		300.47	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		25.79	(267)
Electricity for lighting		23.29	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		349.55	(272)
Dwelling CO2 Emission Rate		5.44	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			170.42	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1524.85	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1695.26	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			281.26	(281)
Electricity for lighting			247.54	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2224.06	(286)
Dwelling PE Rate			34.59	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.21	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	4.27	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	4.27	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	27.48	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

55.72	55.53	55.33	54.36	54.17	53.2	53.2	53	53.58	54.17	54.56	54.94	(39)

Heat loss parameter (HLP), W/m²K

0.79	0.79	0.78	0.77	0.77	0.75	0.75	0.75	0.76	0.77	0.77	0.78	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36 (45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

169.49 151.53 164.44 152.1 152.71 77.42 77.14 79.51 79.62 155.5 157.23 168.56 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

227.8	225.49	221.03	211.25	205.26	107.53	103.69	106.86	110.59	209	218.38	226.55	(72)

Total internal gains

648.95	646.91	630.51	599.79	569.47	447.53	431.28	434.19	449.85	572.2	605.91	635.3	(73)

6. Solar gains

Solar gains in watts, calculated for each month

81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

730.71	794.72	855.49	916.64	959.13	849.67	812.63	758.87	706.27	741.7	705.4	704.26	(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, 1,m (see Table 9a)

0.95	0.92	0.84	0.7	0.52	0.4	0.29	0.32	0.52	0.73	0.9	0.96	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.67	20.76	20.86	20.93	20.95	20.96	20.96	20.96	20.95	20.93	20.81	20.65	(87)

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

20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.94	0.9	0.82	0.66	0.48	0.36	0.24	0.27	0.47	0.69	0.88	0.95	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.89	20	20.11	20.2	20.22	20.24	20.24	20.24	20.23	20.2	20.07	19.88	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

20.19	20.28	20.4	20.48	20.5	20.51	20.51	20.51	20.51	20.48	20.35	20.17	(92)

Adjusted mean internal temperature:

20.19	20.28	20.4	20.48	20.5	20.51	20.51	20.51	20.51	20.48	20.35	20.17	(93)

8. Space heating requirement

Utilisation factor for gains,

0.94	0.9	0.82	0.67	0.5	0.37	0.26	0.29	0.48	0.7	0.89	0.95	(94)

Useful gains, mGm , W

686.91	717.26	703.63	614.64	474.92	314.26	208.03	217.95	342.21	518.98	624.58	667.85	(95)

Monthly average external temperature from Table U1

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

885.16	854.17	768.85	629.45	476.67	314.42	208.04	217.97	343.26	535.09	722.87	877.64	(97)

Space heating requirement for each month

147.5	92.01	48.53	10.67	1.3	0	0	0	0	11.99	70.77	156.08	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

147.5	92.01	48.53	10.67	1.3	0	0	0	0	11.99	70.77	156.08	(98c)

Space heating requirement in kWh/m²/year 7.62 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
46.14	28.78	15.18	3.34	0.41	0	0	0	0	3.75	22.14	48.82		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
146.72	130.43	139.96	126.01	124.24	77.5	76.25	79.42	80.45	127.97	132.89	145.47	1387.31	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												168.54	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1387.31	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		204.42	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												204.42	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1937.9	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(240a)
Low-rate fraction	0		27.79	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(241a)
Low-rate fraction	0		27.79	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(242a)

Low-rate fraction	0		27.79	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		228.77	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		33.71	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		411.56	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.28	(257)
SAP rating		79.24	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			26.79	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			291.34	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		318.12	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		28.36	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		372.12	(272)
Dwelling CO2 Emission Rate		5.26	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			267.7	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1567.66	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1835.37	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			309.25	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2417.06	(286)
Dwelling PE Rate			34.19	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	5.07	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	18.33	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.73	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.73	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	22.06	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

46.71	46.54	46.38	45.53	45.36	44.51	44.51	44.34	44.85	45.36	45.7	46.04	(39)

Heat loss parameter (HLP), W/m²K

0.76	0.75	0.75	0.74	0.73	0.72	0.72	0.72	0.73	0.73	0.74	0.75	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

58.25	57.38	56.1	53.66	51.86	49.85	48.71	49.98	51.36	53.52	56.01	58.03	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 109.4 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

118.84	116.31	113.22	108.52	104.7	100.6	99.02	102.1	105.34	109.65	114.42	118.54	1311.26	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

188.22	165.62	174.01	148.56	140.95	123.7	119.76	126.42	129.9	148.8	163.02	185.6	1814.54	(45)

Distribution loss (46) = 0.15 x (45)

28.23	24.84	26.1	22.28	21.14	18.55	17.96	18.96	19.48	22.32	24.45	27.84	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

316.6 281.57 302.39 272.79 269.33 165.61 163.07 169.73 171.82 277.17 287.25 313.98 2991.31 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

316.6 281.57 302.39 272.79 269.33 165.61 163.07 169.73 171.82 277.17 287.25 313.98 2991.31 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

165.29 147.83 160.56 148.78 149.57 74.66 74.47 76.69 76.72 152.18 153.59 164.41 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

21.72 19.29 15.69 11.88 8.88 7.5 8.1 10.53 14.13 17.94 20.94 22.33 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

222.16	219.99	215.81	206.64	201.03	103.7	100.09	103.07	106.56	204.54	213.32	220.99	(72)

Total internal gains

601.26	599.4	584.7	557	529.79	410.6	395.93	398.59	412.6	532.12	562.49	589.01	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

712.35	788.64	843.63	877.82	889.14	767.35	739.87	713.79	692.96	741.27	695.56	684.09	(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, ⍰1,m (see Table 9a)

0.91	0.85	0.76	0.62	0.47	0.37	0.26	0.29	0.45	0.63	0.84	0.92	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.77	20.85	20.91	20.95	20.96	20.96	20.96	20.96	20.96	20.95	20.88	20.76	(87)

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

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.9	0.83	0.73	0.59	0.44	0.33	0.22	0.24	0.4	0.59	0.81	0.91	(89)

Roof Mean internal temperature in the rest of dwelling T2

20.04	20.13	20.2	20.24	20.25	20.27	20.27	20.27	20.26	20.25	20.18	20.03	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

20.33	20.42	20.48	20.53	20.54	20.54	20.54	20.55	20.54	20.53	20.46	20.32	(92)

Adjusted mean internal temperature:

20.33	20.42	20.48	20.53	20.54	20.54	20.54	20.55	20.54	20.53	20.46	20.32	(93)

8. Space heating requirement

Utilisation factor for gains,

0.9	0.84	0.74	0.6	0.45	0.34	0.24	0.26	0.42	0.6	0.81	0.91	(94)

Useful gains, mGm , W

639.43	658.74	622.65	523.9	400.09	264.51	175.56	183.82	288.59	445.6	566.47	623.09	(95)

Monthly average external temperature from Table U1

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

748.99	722.21	648.46	529.28	400.74	264.57	175.56	183.83	288.85	450.32	610.41	742.21	(97)

Space heating requirement for each month

81.51	42.65	19.2	3.87	0.49	0	0	0	0	3.51	31.63	88.63	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

81.51	42.65	19.2	3.87	0.49	0	0	0	0	3.51	31.63	88.63	(98c)

Space heating requirement in kWh/m²/year 4.4 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
25.5	13.34	6.01	1.21	0.15	0	0	0	0	1.1	9.9	27.72		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
141.09	125.48	134.75	121.56	120.02	73.8	72.67	75.64	76.57	123.52	128.01	139.92	1333.03	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												84.92	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1333.03	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		178.46	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												178.46	(231)
Electricity for lighting												153.44	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1749.85	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(240a)
Low-rate fraction	0		14	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(241a)
Low-rate fraction	0		14	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(242a)

Low-rate fraction	0		14	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		219.82	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		29.43	(249)
Energy For lighting	0		25.3	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		380.55	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.28	(257)
SAP rating		79.19	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			13.57	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			279.94	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		293.5	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		24.75	(267)
Electricity for lighting		22.15	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		340.4	(272)
Dwelling CO2 Emission Rate		5.52	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			135.13	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1506.32	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1641.45	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			269.97	(281)
Electricity for lighting			235.36	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2146.78	(286)
Dwelling PE Rate			34.78	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.85	10018.7	(29a)
Roof	7.07	578.7	(30)
Total area of external elements ∑A, m²		129.29	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	27.68	(33)
Heat capacity Cm = ∑(A x k)	14260.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	12.25	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	12.25	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	39.94	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

65.62	65.45	65.27	64.39	64.21	63.33	63.33	63.15	63.68	64.21	64.56	64.92	(39)

Heat loss parameter (HLP), W/m²K

1.02	1.02	1.02	1	1	0.98	0.98	0.98	0.99	1	1	1.01	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.1 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

59.43	58.54	57.24	54.75	52.91	50.86	49.7	50.99	52.4	54.6	57.15	59.21	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 111.62 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

121.25	118.67	115.51	110.72	106.82	102.64	101.03	104.17	107.48	111.87	116.74	120.94	1337.85 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

192.04	168.98	177.54	151.57	143.81	126.21	122.19	128.98	132.53	151.81	166.32	189.36	1851.33 (45)

Distribution loss (46) = 0.15 x (45)

28.81	25.35	26.63	22.74	21.57	18.93	18.33	19.35	19.88	22.77	24.95	28.4	(46)

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

Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.14 (51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

320.41 284.93 305.92 275.8 272.18 168.12 165.5 172.3 174.45 280.19 290.56 317.74 3028.1 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

320.41 284.93 305.92 275.8 272.18 168.12 165.5 172.3 174.45 280.19 290.56 317.74 3028.1 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

166.55 148.95 161.73 149.78 150.52 75.5 75.28 77.54 77.6 153.18 154.69 165.66 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

22.85 20.29 16.5 12.49 9.34 7.88 8.52 11.07 14.86 18.87 22.03 23.48 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1 276.94 269.78 254.52 235.26 217.15 205.06 202.21 209.38 224.64 243.9 262.01 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

	223.86	221.65	217.38	208.03	202.31	104.86	101.18	104.22	107.78	205.89	214.85	222.67	(72)

Total internal gains

	615.52	613.59	598.37	569.75	541.61	421.6	406.46	409.21	423.73	544.11	575.48	602.86	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31	(83)

Total gains – internal and solar (watts)

	731.56	811.26	868.83	904.86	916.96	794.24	765.73	738.45	716.58	762.57	714.48	702.17	(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, ⍰1,m (see Table 9a)

	0.96	0.93	0.88	0.78	0.63	0.5	0.36	0.39	0.6	0.79	0.93	0.97	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.44	20.57	20.71	20.85	20.92	20.94	20.94	20.94	20.93	20.86	20.64	20.42	(87)

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

	20.07	20.07	20.07	20.08	20.08	20.1	20.1	20.1	20.09	20.08	20.08	20.08	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.95	0.92	0.86	0.74	0.57	0.44	0.29	0.32	0.53	0.74	0.91	0.96	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	19.44	19.59	19.77	19.93	20	20.02	20.03	20.03	20.01	19.94	19.7	19.42	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	19.77	19.91	20.08	20.23	20.3	20.33	20.33	20.33	20.32	20.25	20.01	19.75	(92)

Adjusted mean internal temperature:

	19.77	19.91	20.08	20.23	20.3	20.33	20.33	20.33	20.32	20.25	20.01	19.75	(93)

8. Space heating requirement

Utilisation factor for gains,

0.95	0.92	0.86	0.75	0.59	0.45	0.31	0.34	0.54	0.75	0.91	0.96	(94)

Useful gains, mGm , W

693.83	742.93	743.66	674.23	539.31	360.48	236.11	248.05	389.75	571.25	647.24	671.19	(95)

Monthly average external temperature from Table U1

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

1015.36	982.66	886.4	729.69	552.39	362.75	236.31	248.38	395.99	619.37	833.61	1009.42	(97)

Space heating requirement for each month

239.22	161.1	106.2	39.94	9.73	0	0	0	0	35.8	134.19	251.65	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

239.22	161.1	106.2	39.94	9.73	0	0	0	0	35.8	134.19	251.65	(98c)

Space heating requirement in kWh/m²/year 15.21 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
74.83	50.39	33.22	12.49	3.04	0	0	0	0	11.2	41.97	78.71		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
142.79	126.97	136.33	122.91	121.29	74.92	73.75	76.78	77.74	124.86	129.48	141.6	1349.42	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												305.86	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1349.42	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		185.92	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												185.92	(231)
Electricity for lighting												161.39	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			2002.58	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		50.44	(240a)
Low-rate fraction	0		50.44	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		50.44	(241a)
Low-rate fraction	0		50.44	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		50.44	(242a)

Low-rate fraction	0		50.44	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		222.52	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		30.66	(249)
Energy For lighting	0		26.61	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		422.23	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.39	(257)
SAP rating		77.46	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			48.22	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			283.38	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		331.6	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		25.79	(267)
Electricity for lighting		23.29	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		380.68	(272)
Dwelling CO2 Emission Rate		5.92	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			484.36	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1524.85	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			2009.21	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			281.26	(281)
Electricity for lighting			247.54	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2538	(286)
Dwelling PE Rate			39.47	(287)

SAP WORKSHEET

Dwelling Reference: Flat 10
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7	(1a) x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	7.78	636.3	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	30.99	(33)
Heat capacity Cm = ∑(A x k)	13900.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	5.18	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	5.18	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	36.17	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

64.41	64.22	64.03	63.05	62.86	61.89	61.89	61.69	62.28	62.86	63.25	63.64	(39)

Heat loss parameter (HLP), W/m²K

0.91	0.91	0.91	0.89	0.89	0.88	0.88	0.87	0.88	0.89	0.89	0.9	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36	(45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

169.49 151.53 164.44 152.1 152.71 77.42 77.14 79.51 79.62 155.5 157.23 168.56 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	227.8	225.49	221.03	211.25	205.26	107.53	103.69	106.86	110.59	209	218.38	226.55	(72)

Total internal gains

	648.95	646.91	630.51	599.79	569.47	447.53	431.28	434.19	449.85	572.2	605.91	635.3	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	730.71	794.72	855.49	916.64	959.13	849.67	812.63	758.87	706.27	741.7	705.4	704.26	(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, ⍰1,m (see Table 9a)

	0.97	0.94	0.89	0.77	0.6	0.46	0.33	0.37	0.6	0.8	0.94	0.97	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.51	20.61	20.75	20.88	20.94	20.95	20.95	20.95	20.94	20.88	20.69	20.49	(87)

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

	20.16	20.16	20.16	20.17	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.17	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.96	0.93	0.87	0.73	0.55	0.41	0.27	0.31	0.53	0.76	0.92	0.97	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	19.6	19.73	19.9	20.05	20.1	20.12	20.13	20.13	20.11	20.05	19.83	19.59	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	19.95	20.06	20.22	20.37	20.42	20.44	20.44	20.44	20.43	20.37	20.16	19.93	(92)

Adjusted mean internal temperature:

	19.95	20.06	20.22	20.37	20.42	20.44	20.44	20.44	20.43	20.37	20.16	19.93	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.93	0.87	0.74	0.56	0.42	0.29	0.33	0.55	0.77	0.92	0.96	(94)

Useful gains, mGm , W

699.04	739.29	744.73	680.02	540.66	360.25	237.44	249.05	389.48	569.9	648.03	678.07	(95)

Monthly average external temperature from Table U1

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

1007.89	973.84	878.49	722.94	548.08	361.21	237.52	249.2	394.07	613.83	825.9	1001.04	(97)

Space heating requirement for each month

229.78	157.62	99.51	30.91	5.52	0	0	0	0	32.68	128.07	240.3	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

229.78	157.62	99.51	30.91	5.52	0	0	0	0	32.68	128.07	240.3	(98c)

Space heating requirement in kWh/m²/year 13.07 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
71.87	49.3	31.13	9.67	1.73	0	0	0	0	10.22	40.06	75.16		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
146.72	130.43	139.96	126.01	124.24	77.5	76.25	79.42	80.45	127.97	132.89	145.47	1387.31	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												289.14	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1387.31	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		204.42	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												204.42	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			2058.5	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		47.68	(240a)
Low-rate fraction	0		47.68	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		47.68	(241a)
Low-rate fraction	0		47.68	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		47.68	(242a)

Low-rate fraction	0		47.68	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		228.77	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		33.71	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		431.45	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.34	(257)
SAP rating		78.24	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			45.67	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			291.34	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		337	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		28.36	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		391	(272)
Dwelling CO2 Emission Rate		5.53	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			458.19	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1567.66	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			2025.86	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			309.25	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2607.55	(286)
Dwelling PE Rate			36.88	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	52	(1a) x	2.4	(2a) =	124.8	(3a)
Total floor area TFA					52	(4)
Dwelling volume					124.8	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.13	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	1.67	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

Effective air change rate from PCDB:

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.58	9617.8	(29a)
Roof	5.72	468	(30)
Total area of external elements ∑A, m²		111.44	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	22.12	(33)
Heat capacity Cm = ∑(A x k)	13097.2	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	9.93	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	9.93	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	32.05	(37)

Ventilation heat loss calculated monthly

20.18	20.05	19.92	19.26	19.13	18.48	18.48	18.34	18.74	19.13	19.4	19.66	(38)

Heat transfer coefficient, W/K

52.23	52.1	51.97	51.31	51.18	50.52	50.52	50.39	50.78	51.18	51.44	51.7	(39)

Heat loss parameter (HLP), W/m²K

1	1	1	0.99	0.98	0.97	0.97	0.97	0.98	0.98	0.99	0.99	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.75 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

53.55	52.74	51.57	49.32	47.67	45.82	44.77	45.94	47.21	49.2	51.49	53.34	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

23.15	22.81	22.32	21.43	20.76	20.02	19.62	20.1	20.62	21.42	22.33	23.07	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.54	31.36	30.18	28.99	27.81	26.63	26.63	27.81	28.99	30.18	31.36	32.54	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 100.56 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

109.24	106.91	104.07	99.75	96.24	92.47	91.02	93.85	96.83	100.79	105.17	108.95	1205.27 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

173.01	152.23	159.94	136.55	129.56	113.7	110.08	116.2	119.4	136.77	149.84	170.6	1667.86 (45)

Distribution loss (46) = 0.15 x (45)

25.95	22.83	23.99	20.48	19.43	17.05	16.51	17.43	17.91	20.52	22.48	25.59	(46)

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

Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.14 (51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

301.38 268.19 288.32 260.78 257.93 155.62 153.39 159.51 161.31 265.14 274.07 298.97 2844.63 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

301.38 268.19 288.32 260.78 257.93 155.62 153.39 159.51 161.31 265.14 274.07 298.97 2844.63 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

160.23 143.38 155.88 144.79 145.78 71.34 71.25 73.29 73.23 148.18 149.21 159.42 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

18.45 16.38 13.32 10.09 7.54 6.37 6.88 8.94 12 15.24 17.78 18.96 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

227.5 229.86 223.91 211.25 195.26 180.24 170.2 167.84 173.79 186.45 202.44 217.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	(71)

Water heating gains (Table 5)

	215.36	213.36	209.52	201.1	195.94	99.08	95.77	98.5	101.71	199.16	207.24	214.28	(72)

Total internal gains

	546.53	544.83	531.98	507.66	483.97	367.91	355.07	357.51	369.72	486.08	512.68	535.93	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	77.36	131.78	180.3	223.41	250.23	248.42	239.51	219.49	195.23	145.64	92.66	66.21	(83)

Total gains – internal and solar (watts)

	623.89	676.61	712.29	731.07	734.2	616.33	594.58	577	564.96	631.72	605.35	602.13	(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, ⍰1,m (see Table 9a)

	0.95	0.92	0.87	0.77	0.63	0.52	0.37	0.4	0.6	0.77	0.91	0.96	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.5	20.61	20.73	20.86	20.92	20.94	20.95	20.95	20.93	20.87	20.69	20.48	(87)

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

	20.08	20.08	20.08	20.09	20.1	20.11	20.11	20.11	20.1	20.1	20.09	20.09	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.94	0.91	0.85	0.73	0.57	0.45	0.3	0.32	0.53	0.72	0.89	0.95	(89)

Roof Mean internal temperature in the rest of dwelling T2

	19.52	19.65	19.8	19.94	20.01	20.03	20.04	20.04	20.03	19.96	19.76	19.5	(90)

Living area fraction 0.46 (91)

Mean internal temperature (for the whole dwelling)

	19.98	20.09	20.23	20.37	20.43	20.45	20.46	20.46	20.44	20.38	20.19	19.96	(92)

Adjusted mean internal temperature:

	19.98	20.09	20.23	20.37	20.43	20.45	20.46	20.46	20.44	20.38	20.19	19.96	(93)

8. Space heating requirement

Utilisation factor for gains,

0.94	0.91	0.85	0.75	0.59	0.48	0.33	0.35	0.56	0.74	0.89	0.95	(94)

Useful gains, mGm , W

585.14	613.64	605.49	544.83	436.19	293.51	194.71	204.21	316.58	465.81	539.68	569.34	(95)

Monthly average external temperature from Table U1

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

818.77	791.46	713.68	588.38	446.88	295.76	194.92	204.54	322.22	500.77	673.18	814.68	(97)

Space heating requirement for each month

173.82	119.5	80.5	31.36	7.95	0	0	0	0	26.01	96.12	182.54	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

173.82	119.5	80.5	31.36	7.95	0	0	0	0	26.01	96.12	182.54	(98c)

Space heating requirement in kWh/m²/year 13.8 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													319.7	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
54.37	37.38	25.18	9.81	2.49	0	0	0	0	8.14	30.07	57.1			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					224.4	(216)
Efficiency of water heater														
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4			(217)
Fuel for water heating														
134.31	119.51	128.49	116.21	114.94	69.35	68.36	71.08	71.89	118.16	122.14	133.23		1267.66	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													224.52	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1267.66	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			150.35	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													150.35	(231)
Electricity for lighting													130.3	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1772.84	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		37.02	(240a)
Low-rate fraction	0		37.02	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		37.02	(241a)
Low-rate fraction	0		37.02	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		37.02	(242a)

Low-rate fraction	0		37.02	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		209.04	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		24.79	(249)
Energy For lighting	0		21.49	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		384.34	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.43	(257)
SAP rating		76.88	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			35.38	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			266.21	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		301.59	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		20.86	(267)
Electricity for lighting		18.81	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		341.25	(272)
Dwelling CO2 Emission Rate		6.56	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			355.49	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1432.46	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1787.95	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			227.45	(281)
Electricity for lighting			199.87	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2215.27	(286)
Dwelling PE Rate			42.6	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	56.3	(1a) x	2.4	(2a) =	135.12	(3a)
Total floor area TFA					56.3	(4)
Dwelling volume					135.12	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80	=	0 (6a)
Open chimneys	0	x	20	=	0 (6b)
Chimneys / flues attached to closed fire	0	x	10	=	0 (6c)
Flues attached to solid fuel boiler	0	x	20	=	0 (6d)
Flues attached to other heater	0	x	35	=	0 (6e)
Number of blocked chimneys	0	x	20	=	0 (6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	9.57		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.32	4222.5	(28b)
Basement wall	0	0	(29)
External wall	4.85	5114.8	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		93.52	(31)
Party Wall	0	10929.6	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.68	(33)
Heat capacity Cm = ∑(A x k)	20266.9	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	25.09	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	25.09	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	48.77	(37)

Ventilation heat loss calculated monthly

25.62	25.4	25.19	24.11	23.89	22.81	22.81	22.59	23.24	23.89	24.32	24.75	(38)

Heat transfer coefficient, W/K

74.38	74.17	73.95	72.87	72.66	71.58	71.58	71.36	72.01	72.66	73.09	73.52	(39)

Heat loss parameter (HLP), W/m²K

1.32	1.32	1.31	1.29	1.29	1.27	1.27	1.27	1.28	1.29	1.3	1.31	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.88 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

55.66	54.83	53.61	51.28	49.55	47.63	46.54	47.75	49.08	51.14	53.52	55.45	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

24.06	23.7	23.2	22.27	21.58	20.81	20.39	20.89	21.43	22.26	23.21	23.98	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

33.84	32.6	31.37	30.14	28.91	27.68	27.68	28.91	30.14	31.37	32.6	33.84	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 104.53 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

113.56	111.13	108.18	103.69	100.04	96.12	94.62	97.56	100.66	104.77	109.33	113.26	1252.94 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

179.85	158.25	166.27	141.95	134.68	118.2	114.43	120.8	124.12	142.18	155.76	177.34	1733.83 (45)

Distribution loss (46) = 0.15 x (45)

26.98	23.74	24.94	21.29	20.2	17.73	17.16	18.12	18.62	21.33	23.36	26.6	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

308.23 274.21 294.65 266.18 263.06 160.11 157.74 164.11 166.04 270.55 280 305.72 2910.6 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

308.23 274.21 294.65 266.18 263.06 160.11 157.74 164.11 166.04 270.55 280 305.72 2910.6 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

162.5 145.38 157.99 146.59 147.48 72.83 72.7 74.82 74.8 149.98 151.18 161.67 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

112.52 112.52 112.52 112.52 112.52 112.52 112.52 112.52 112.52 112.52 112.52 112.52 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

19.58 17.39 14.14 10.71 8 6.76 7.3 9.49 12.74 16.18 18.88 20.13 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

244.07 246.61 240.22 226.64 209.48 193.36 182.6 180.06 186.45 200.03 217.18 233.3 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13	48.13		(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3		(70)

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

-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01	-75.01		(71)

Water heating gains (Table 5)

218.42	216.34	212.35	203.59	198.23	101.16	97.71	100.56	103.89	201.58	209.97	217.3		(72)

Total internal gains

570.7	568.97	555.35	529.57	504.35	386.91	373.25	375.75	388.71	506.42	534.67	559.36		(73)

6. Solar gains

Solar gains in watts, calculated for each month

61.57	109.64	162.68	222.78	268.89	275.46	262.03	226.33	183.28	124.59	74.62	52.13		(83)

Total gains – internal and solar (watts)

632.28	678.62	718.03	752.35	773.24	662.38	635.28	602.07	572	631.01	609.29	611.49		(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, ⍰1,m (see Table 9a)

0.98	0.96	0.94	0.88	0.76	0.65	0.49	0.53	0.76	0.89	0.96	0.98		(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.07	20.18	20.38	20.63	20.81	20.89	20.92	20.92	20.85	20.66	20.33	20.05		(87)

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

19.82	19.83	19.83	19.85	19.85	19.86	19.86	19.87	19.86	19.85	19.84	19.84		(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.97	0.95	0.92	0.84	0.7	0.55	0.37	0.41	0.67	0.85	0.95	0.97		(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.77	18.92	19.17	19.47	19.67	19.76	19.78	19.78	19.72	19.51	19.12	18.76		(90)

Living area fraction 0.48 (91)

Mean internal temperature (for the whole dwelling)

19.39	19.52	19.75	20.02	20.21	20.3	20.32	20.32	20.26	20.06	19.7	19.37		(92)

Adjusted mean internal temperature:

19.39	19.52	19.75	20.02	20.21	20.3	20.32	20.32	20.26	20.06	19.7	19.37		(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.95	0.92	0.85	0.72	0.59	0.42	0.46	0.7	0.85	0.94	0.97	(94)

Useful gains, mGm , W

610.53	645.54	660.68	639.31	556.19	390.19	263.74	275.6	402.88	539.05	574.52	592.86	(95)

Monthly average external temperature from Table U1

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

1122.4	1084.64	979.5	810.35	618.55	407.83	266.51	279.9	443.21	687.37	920.8	1115.63	(97)

Space heating requirement for each month

380.83	295.07	237.2	123.15	46.4	0	0	0	0	110.35	249.32	388.94	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

380.83	295.07	237.2	123.15	46.4	0	0	0	0	110.35	249.32	388.94	(98c)

Space heating requirement in kWh/m²/year 32.53 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													84	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
453.37	351.28	282.38	146.6	55.23	0	0	0	0	131.37	296.81	463.02			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					84	(216)
Efficiency of water heater														
84	84	84	84	84	84	84	84	84	84	84	84			(217)
Fuel for water heating														
366.94	326.44	350.77	316.89	313.16	190.61	187.79	195.37	197.66	322.09	333.33	363.95	3465		(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													2180.07	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													3465	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			162.79	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													162.79	(231)
Electricity for lighting													138.33	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			5946.18	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		359.49	(240a)
Low-rate fraction	0		359.49	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		359.49	(241a)
Low-rate fraction	0		359.49	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		359.49	(242a)

Low-rate fraction	0		359.49	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		571.38	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		26.84	(249)
Energy For lighting	0		22.81	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		1072.53	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		3.81	(257)
SAP rating		38.78	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			339.72	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			727.65	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1067.37	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		22.58	(267)
Electricity for lighting		19.96	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1109.92	(272)
Dwelling CO2 Emission Rate		19.71	(273)
EI rating		85	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			3437.79	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3915.45	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			7353.24	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			246.26	(281)
Electricity for lighting			212.17	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			7811.67	(286)
Dwelling PE Rate			138.75	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	49.96 (1a)	x	2.4	(2a) =	119.9	(3a)
Total floor area TFA					49.96	(4)
Dwelling volume					119.9	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	10.09		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.49	3747	(28b)
Basement wall	0	0	(29)
External wall	4.76	5029.3	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		87.18	(31)
Party Wall	0	10929.6	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.29	(33)
Heat capacity Cm = ∑(A x k)	19705.9	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	17.32	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	17.32	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	40.61	(37)

Ventilation heat loss calculated monthly

22.73	22.54	22.35	21.39	21.2	20.24	20.24	20.05	20.62	21.2	21.58	21.97	(38)

Heat transfer coefficient, W/K

63.34	63.15	62.96	62	61.81	60.85	60.85	60.66	61.24	61.81	62.19	62.58	(39)

Heat loss parameter (HLP), W/m²K

1.27	1.26	1.26	1.24	1.24	1.22	1.22	1.21	1.23	1.24	1.24	1.25	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	1.69	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

52.54	51.75	50.6	48.4	46.77	44.96	43.93	45.07	46.32	48.27	50.52	52.34	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

22.72	22.38	21.9	21.03	20.37	19.64	19.25	19.72	20.24	21.02	21.91	22.64	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

31.93	30.77	29.6	28.44	27.28	26.12	26.12	27.28	28.44	29.6	30.77	31.93	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	98.66	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

107.18	104.89	102.1	97.87	94.43	90.73	89.3	92.08	95	98.89	103.19	106.9	1182.56	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

169.75	149.36	156.93	133.97	127.11	111.56	108	114.01	117.15	134.19	147.02	167.38	1636.44	(45)

Distribution loss (46) = 0.15 x (45)

25.46	22.4	23.54	20.1	19.07	16.73	16.2	17.1	17.57	20.13	22.05	25.11	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

298.12 265.32 285.31 258.21 255.49 153.47 151.32 157.32 159.07 262.57 271.25 295.76 2813.21 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

298.12 265.32 285.31 258.21 255.49 153.47 151.32 157.32 159.07 262.57 271.25 295.76 2813.21 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

159.14 142.43 154.88 143.94 144.97 70.63 70.56 72.56 72.48 147.32 148.27 158.36 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 101.34 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

16.8 14.92 12.13 9.19 6.87 5.8 6.26 8.14 10.93 13.88 16.2 17.27 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

219.6 221.88 216.13 203.91 188.48 173.97 164.28 162.01 167.75 179.97 195.4 209.91 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	46.82	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	-67.56	(71)

Water heating gains (Table 5)

213.9	211.94	208.17	199.91	194.85	98.09	94.84	97.53	100.67	198.01	205.93	212.84	(72)

Total internal gains

533.9	532.34	520.04	496.61	473.79	358.46	345.99	348.28	359.95	475.46	501.13	523.62	(73)

6. Solar gains

Solar gains in watts, calculated for each month

52.88	103.45	170.36	248.46	304.5	311.71	296.76	254.91	198.14	122.75	65.94	43.49	(83)

Total gains – internal and solar (watts)

586.78	635.79	690.4	745.07	778.29	670.17	642.75	603.19	558.09	598.21	567.07	567.1	(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, 1,m (see Table 9a)

0.97	0.95	0.92	0.83	0.68	0.56	0.41	0.46	0.7	0.85	0.95	0.97	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.16	20.29	20.49	20.72	20.87	20.92	20.93	20.93	20.88	20.73	20.42	20.15	(87)

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

19.87	19.87	19.87	19.89	19.89	19.91	19.91	19.91	19.9	19.89	19.88	19.88	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.96	0.94	0.89	0.79	0.62	0.47	0.31	0.35	0.61	0.81	0.93	0.97	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.93	19.08	19.33	19.61	19.76	19.81	19.82	19.82	19.78	19.62	19.26	18.92	(90)

Living area fraction 0.44 (91)

Mean internal temperature (for the whole dwelling)

19.47	19.62	19.85	20.1	20.25	20.3	20.31	20.31	20.27	20.11	19.77	19.46	(92)

Adjusted mean internal temperature:

19.47	19.62	19.85	20.1	20.25	20.3	20.31	20.31	20.27	20.11	19.77	19.46	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.94	0.89	0.8	0.64	0.51	0.35	0.39	0.64	0.82	0.93	0.96	(94)

Useful gains, mGm , W

562.26	597.07	617.23	592.58	497.98	339.63	224.95	235.75	356.62	489.66	527.38	546.09	(95)

Monthly average external temperature from Table U1

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

961.22	929.36	840.26	694.59	528.27	346.87	225.92	237.37	377.76	587.84	788.08	954.91	(97)

Space heating requirement for each month

296.83	223.3	165.93	73.45	22.54	0	0	0	0	73.05	187.71	304.16	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

296.83	223.3	165.93	73.45	22.54	0	0	0	0	73.05	187.71	304.16	(98c)

Space heating requirement in kWh/m²/year 26.96 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													249.9	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
118.78	89.36	66.4	29.39	9.02	0	0	0	0	29.23	75.11	121.71			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					175.1	(216)
Efficiency of water heater														
175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1			(217)
Fuel for water heating														
170.26	151.52	162.94	147.46	145.91	87.65	86.42	89.85	90.84	149.95	154.91	168.91		1606.63	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													539	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1606.63	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			144.45	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													144.45	(231)
Electricity for lighting													118.67	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			2408.75	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.88	(240a)
Low-rate fraction	0		88.88	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.88	(241a)
Low-rate fraction	0		88.88	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.88	(242a)

Low-rate fraction	0		88.88	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		264.93	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		23.82	(249)
Energy For lighting	0		19.57	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		489.2	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator	0.36	(256)
Energy cost factor (ECF)	1.85	(257)
SAP rating	69.94	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			84.37	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			337.39	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		421.76	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		20.04	(267)
Electricity for lighting		17.13	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		458.92	(272)
Dwelling CO2 Emission Rate		9.19	(273)
EI rating		94	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			851.34	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1815.49	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			2666.83	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			218.53	(281)
Electricity for lighting			182.02	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			3067.37	(286)
Dwelling PE Rate			61.4	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	54.15 (1a)	x	3	(2a) =	162.45	(3a)
First Floor	28.04 (1b)	x	2.4	(2b) =	67.3	(3b)
Total floor area TFA					82.19	(4)
Dwelling volume					229.75	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Monthly average wind speed from Table U2													
5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)
Wind Factor													
1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)
Adjusted infiltration rate (allowing for shelter and wind speed)													
0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	13.65		(27)
Roof window	6.8		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	12.72	13421.79	(29a)
Roof	7.71	433.89	(30)
Total area of external elements ∑A, m²		138.65	(31)

Party Wall	0	14785.2	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)
Internal wall **		0	(33c)
Internal floor		0	(32d)
Internal ceiling floor		0	(32e)
Fabric heat loss, W/K = ∑ (A x U)		42.82	(33)
Heat capacity Cm = ∑(A x k)		28640.88	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K		250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K		212.16	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available		212.16	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ		254.98	(37)

Ventilation heat loss calculated monthly

43.56	43.19	42.82	40.99	40.62	38.78	38.78	38.42	39.52	40.62	41.36	42.09	(38)

Heat transfer coefficient, W/K

298.54	298.17	297.81	295.97	295.6	293.77	293.77	293.4	294.5	295.6	296.34	297.07	(39)

Heat loss parameter (HLP), W/m²K

3.63	3.63	3.62	3.6	3.6	3.57	3.57	3.57	3.58	3.6	3.61	3.61	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.5	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

66.19	65.19	63.74	60.97	58.92	56.64	55.34	56.78	58.36	60.81	63.64	65.93	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

28.59	28.16	27.56	26.46	25.64	24.72	24.23	24.82	25.47	26.45	27.57	28.49	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

40.26	38.8	37.34	35.87	34.41	32.94	32.94	34.41	35.87	37.34	38.8	40.26	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	124.31	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

135.04	132.16	128.64	123.3	118.97	114.31	112.52	116.01	119.7	124.59	130.01	134.69	1489.94	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

213.87	188.19	197.72	168.8	160.15	140.55	136.08	143.65	147.6	169.07	185.23	210.89	2061.8	(45)

Distribution loss (46) = 0.15 x (45)

32.08	28.23	29.66	25.32	24.02	21.08	20.41	21.55	22.14	25.36	27.78	31.63	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.14 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

342.25 304.14 326.1 293.03 288.53 182.47 179.39 186.96 189.52 297.45 309.47 339.27 3238.57 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

342.25 304.14 326.1 293.03 288.53 182.47 179.39 186.96 189.52 297.45 309.47 339.27 3238.57 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

173.81 155.34 168.44 155.51 155.95 80.27 79.9 82.41 82.61 158.92 160.98 172.82 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 150.19 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

28.87 25.65 20.86 15.79 11.8 9.96 10.77 14 18.79 23.85 27.84 29.68 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

	334.26	337.73	328.99	310.38	286.89	264.82	250.07	246.6	255.34	273.95	297.44	319.52	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	52.52	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	-100.12	(71)

Water heating gains (Table 5)

	233.62	231.15	226.4	215.99	209.61	111.48	107.39	110.77	114.74	213.6	223.58	232.29	(72)

Total internal gains

	702.34	700.12	681.84	647.75	613.9	488.85	470.81	473.95	491.45	616.98	654.44	687.06	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	134.28	266.78	449.63	671.98	838.03	864.31	820.22	694.83	528.21	319.25	168.16	109.95	(83)

Total gains – internal and solar (watts)

	836.62	966.9	1131.46	1319.73	1451.93	1353.16	1291.02	1168.78	1019.65	936.24	822.6	797.02	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, 1,m (see Table 9a)

	0.99	0.98	0.96	0.93	0.88	0.8	0.7	0.75	0.89	0.95	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	18.06	18.27	18.69	19.28	19.87	20.33	20.6	20.54	20.1	19.39	18.63	18.03	(87)

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

	18.47	18.47	18.47	18.48	18.48	18.49	18.49	18.49	18.49	18.48	18.48	18.47	(88)

Roof Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

	0.98	0.97	0.95	0.9	0.8	0.64	0.39	0.46	0.77	0.92	0.97	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	15.35	15.61	16.14	16.88	17.58	18.07	18.28	18.26	17.88	17.04	16.07	15.31	(90)

Living area fraction 0.24 (91)

Mean internal temperature (for the whole dwelling)

	16.01	16.26	16.76	17.46	18.13	18.62	18.84	18.81	18.42	17.61	16.7	15.97	(92)

Adjusted mean internal temperature:

	16.01	16.26	16.76	17.46	18.13	18.62	18.84	18.81	18.42	17.61	16.7	15.97	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.96	0.93	0.88	0.78	0.65	0.45	0.51	0.77	0.9	0.96	0.97	(94)

Useful gains, mGm , W

811.77	926.39	1054.4	1158.45	1137	877.02	581.6	598.75	784.05	846.24	787.61	775.75	(95)

Monthly average external temperature from Table U1

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

3495.78	3386.48	3056.56	2534.03	1901.85	1181.66	658.94	707.86	1272.18	2072.15	2843.63	3496.57	(97)

Space heating requirement for each month

1996.9	1653.18	1489.61	990.41	569.05	0	0	0	0	912.08	1480.34	2024.29	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

1996.9	1653.18	1489.61	990.41	569.05	0	0	0	0	912.08	1480.34	2024.29	(98c)

Space heating requirement in kWh/m²/year 135.25 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													249.9	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
799.08	661.54	596.08	396.32	227.71	0	0	0	0	364.98	592.37	810.04			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					175.1	(216)
Efficiency of water heater														
175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1			(217)
Fuel for water heating														
195.46	173.7	186.24	167.35	164.78	104.21	102.45	106.77	108.23	169.87	176.74	193.76		1849.55	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													4448.12	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1849.55	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			311.82	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													311.82	(231)
Electricity for lighting													203.98	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			6813.48	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		733.5	(240a)
Low-rate fraction	0		733.5	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		733.5	(241a)
Low-rate fraction	0		733.5	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		733.5	(242a)

Low-rate fraction	0		733.5	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		304.99	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		51.42	(249)
Energy For lighting	0		33.64	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		1215.54	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		3.44	(257)
SAP rating		44.23	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			685.15	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			388.41	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		1073.56	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		43.25	(267)
Electricity for lighting		29.44	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		1146.25	(272)
Dwelling CO2 Emission Rate		13.95	(273)
EI rating		88	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			6984.74	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2090	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			9074.73	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			471.73	(281)
Electricity for lighting			312.87	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			9859.33	(286)
Dwelling PE Rate			119.96	(287)

SAP WORKSHEET

Dwelling Reference: Flat 12
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	52.93 (1a)	x	3	(2a) =	158.79	(3a)
First Floor	31.36 (1b)	x	2.4	(2b) =	75.26	(3b)
Total floor area TFA					84.29	(4)
Dwelling volume					234.05	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	5	5	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.25	0.25	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.19	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Monthly average wind speed from Table U2													
5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)
Wind Factor													
1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)
Adjusted infiltration rate (allowing for shelter and wind speed)													
0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	2.54	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.54	0.54	0.51	0.51	0.51	0.52	0.54	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	12.57		(27)
Roof window	6.8		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0.12	72	(28b)
Basement wall	0	0	(29)
External wall	13.69	14445.7	(29a)
Roof	7.67	431.55	(30)
Total area of external elements ∑A, m²		143.8	(31)

Party Wall	0	12925.8	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)
Internal wall **		0	(33c)
Internal floor		0	(32d)
Internal ceiling floor		0	(32e)
Fabric heat loss, W/K = ∑ (A x U)		42.8	(33)
Heat capacity Cm = ∑(A x k)		27875.05	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K		250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K		15.39	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available		15.39	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ		58.19	(37)

Ventilation heat loss calculated monthly

	44.38	44	43.63	41.76	41.38	39.51	39.51	39.14	40.26	41.38	42.13	42.88	(38)

Heat transfer coefficient, W/K

	102.57	102.19	101.82	99.95	99.57	97.7	97.7	97.33	98.45	99.57	100.32	101.07	(39)

Heat loss parameter (HLP), W/m²K

	1.22	1.21	1.21	1.19	1.18	1.16	1.16	1.15	1.17	1.18	1.19	1.2	(40)

Number of days in month (Table 1a)

	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N	2.54	(42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

	66.79	65.79	64.33	61.53	59.46	57.16	55.85	57.3	58.89	61.37	64.23	66.54	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

	28.85	28.42	27.82	26.7	25.87	24.95	24.45	25.05	25.7	26.69	27.82	28.75	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

	40.63	39.16	37.68	36.2	34.72	33.25	33.25	34.72	36.2	37.68	39.16	40.63	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	125.44	(43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

	136.28	133.37	129.82	124.43	120.06	115.35	113.55	117.07	120.79	125.73	131.21	135.92	1503.58 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

	215.83	189.91	199.53	170.34	161.62	141.84	137.32	144.96	148.95	170.62	186.93	212.82	2080.68 (45)

Distribution loss (46) = 0.15 x (45)

	32.37	28.49	29.93	25.55	24.24	21.28	20.6	21.74	22.34	25.59	28.04	31.92	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.14 (51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

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

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

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

344.2 305.86 327.91 294.58 290 183.76 180.64 188.27 190.87 299 311.16 341.2 3257.45 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

344.2 305.86 327.91 294.58 290 183.76 180.64 188.27 190.87 299 311.16 341.2 3257.45 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

174.46 155.91 169.05 156.03 156.44 80.69 80.31 82.85 83.06 159.43 161.54 173.46 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

152.35 152.35 152.35 152.35 152.35 152.35 152.35 152.35 152.35 152.35 152.35 152.35 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

29.65 26.34 21.42 16.22 12.12 10.23 11.06 14.37 19.29 24.49 28.59 30.48 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

340.56	344.09	335.18	316.23	292.29	269.8	254.78	251.24	260.15	279.11	303.04	325.53	(68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	52.77	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	-101.57	(71)

Water heating gains (Table 5)

234.5	232.01	227.21	216.71	210.27	112.08	107.94	111.36	115.36	214.29	224.36	233.15	(72)

Total internal gains

711.26	708.99	690.38	655.71	621.25	495.67	477.34	480.53	498.36	624.45	662.55	695.72	(73)

6. Solar gains

Solar gains in watts, calculated for each month

170.19	317.01	494.98	698.31	846.98	865.96	824.69	712.18	566.33	367.92	209.05	142.14	(83)

Total gains – internal and solar (watts)

881.45	1026.01	1185.36	1354.02	1468.23	1361.63	1302.02	1192.72	1064.69	992.37	871.6	837.86	(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, 1,m (see Table 9a)

0.98	0.96	0.91	0.78	0.6	0.45	0.33	0.37	0.61	0.85	0.96	0.98	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.14	20.31	20.56	20.79	20.9	20.93	20.94	20.94	20.91	20.75	20.41	20.11	(87)

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

19.91	19.91	19.91	19.93	19.93	19.95	19.95	19.96	19.95	19.93	19.93	19.92	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.97	0.95	0.88	0.74	0.54	0.38	0.25	0.29	0.53	0.8	0.95	0.98	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.93	19.15	19.44	19.72	19.83	19.87	19.87	19.88	19.85	19.69	19.29	18.91	(90)

Living area fraction 0.25 (91)

Mean internal temperature (for the whole dwelling)

19.23	19.44	19.72	19.99	20.1	20.14	20.14	20.14	20.12	19.96	19.57	19.21	(92)

Adjusted mean internal temperature:

19.23	19.44	19.72	19.99	20.1	20.14	20.14	20.14	20.12	19.96	19.57	19.21	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.94	0.88	0.74	0.55	0.39	0.27	0.3	0.54	0.8	0.94	0.97	(94)

Useful gains, mGm , W

854.01	965.71	1039.23	999.77	812.81	537.71	345.58	363.64	577.6	797.79	820.31	816.25	(95)

Monthly average external temperature from Table U1

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

1531.33	1485.91	1346.32	1108.47	836.23	540.97	345.92	364.3	592.36	931.94	1250.8	1516.95	(97)

Space heating requirement for each month

503.93	349.57	228.47	78.26	17.42	0	0	0	0	99.81	309.95	521.32	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

503.93	349.57	228.47	78.26	17.42	0	0	0	0	99.81	309.95	521.32	(98c)

Space heating requirement in kWh/m²/year 25.02 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													249.9	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
201.65	139.89	91.43	31.32	6.97	0	0	0	0	39.94	124.03	208.61			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					175.1	(216)
Efficiency of water heater														
175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1			(217)
Fuel for water heating														
196.58	174.68	187.27	168.24	165.62	104.94	103.16	107.52	109.01	170.76	177.71	194.86		1860.34	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													843.83	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1860.34	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			317.67	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													317.67	(231)
Electricity for lighting													209.47	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			3231.31	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		139.15	(240a)
Low-rate fraction	0		139.15	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		139.15	(241a)
Low-rate fraction	0		139.15	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		139.15	(242a)

Low-rate fraction	0		139.15	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		306.77	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		52.38	(249)
Energy For lighting	0		34.54	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		624.84	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.74	(257)
SAP rating		71.8	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			132.8	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			390.67	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		523.47	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		44.06	(267)
Electricity for lighting		30.23	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		597.77	(272)
Dwelling CO2 Emission Rate		7.09	(273)
EI rating		94	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			1335.44	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2102.18	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			3437.62	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			480.57	(281)
Electricity for lighting			321.29	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			4239.48	(286)
Dwelling PE Rate			50.3	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.78	5302.5	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	30.99	(33)
Heat capacity Cm = ∑(A x k)	18566.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	15.36	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	15.36	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	46.35	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

74.59	74.4	74.2	73.23	73.04	72.06	72.06	71.87	72.45	73.04	73.42	73.81	(39)

Heat loss parameter (HLP), W/m²K

1.06	1.05	1.05	1.04	1.03	1.02	1.02	1.02	1.02	1.03	1.04	1.04	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36	(45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

169.49 151.53 164.44 152.1 152.71 77.42 77.14 79.51 79.62 155.5 157.23 168.56 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	227.8	225.49	221.03	211.25	205.26	107.53	103.69	106.86	110.59	209	218.38	226.55	(72)

Total internal gains

	648.95	646.91	630.51	599.79	569.47	447.53	431.28	434.19	449.85	572.2	605.91	635.3	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	730.71	794.72	855.49	916.64	959.13	849.67	812.63	758.87	706.27	741.7	705.4	704.26	(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, ⍰1,m (see Table 9a)

	0.98	0.96	0.92	0.83	0.67	0.53	0.39	0.43	0.67	0.86	0.95	0.98	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.33	20.44	20.61	20.8	20.9	20.94	20.94	20.94	20.92	20.8	20.54	20.3	(87)

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

	20.04	20.04	20.04	20.05	20.06	20.07	20.07	20.07	20.06	20.06	20.05	20.05	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.97	0.95	0.9	0.79	0.62	0.46	0.31	0.35	0.6	0.81	0.94	0.97	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	19.27	19.41	19.62	19.85	19.95	19.99	20	20	19.97	19.85	19.55	19.25	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	19.67	19.8	20	20.21	20.31	20.35	20.35	20.36	20.33	20.21	19.93	19.65	(92)

Adjusted mean internal temperature:

	19.67	19.8	20	20.21	20.31	20.35	20.35	20.36	20.33	20.21	19.93	19.65	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.95	0.9	0.8	0.63	0.48	0.33	0.37	0.62	0.82	0.94	0.97	(94)

Useful gains, mGm , W

705.92	752.42	771.9	732.8	606.2	410.29	270.14	283.5	436.84	609.33	662.13	683.72	(95)

Monthly average external temperature from Table U1

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

1146.57	1108.7	1001.56	828.04	629.14	414.29	270.55	284.26	451.41	702	941.71	1140.55	(97)

Space heating requirement for each month

327.84	239.42	170.87	68.57	17.07	0	0	0	0	68.94	201.3	339.88	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

327.84	239.42	170.87	68.57	17.07	0	0	0	0	68.94	201.3	339.88	(98c)

Space heating requirement in kWh/m²/year 20.28 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													319.7	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
102.55	74.89	53.45	21.45	5.34	0	0	0	0	21.57	62.96	106.31			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					224.4	(216)
Efficiency of water heater														
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4			(217)
Fuel for water heating														
146.72	130.43	139.96	126.01	124.24	77.5	76.25	79.42	80.45	127.97	132.89	145.47		1387.31	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													448.51	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1387.31	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			204.42	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													204.42	(231)
Electricity for lighting													177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			2217.87	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		73.96	(240a)
Low-rate fraction	0		73.96	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		73.96	(241a)
Low-rate fraction	0		73.96	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		73.96	(242a)

Low-rate fraction	0		73.96	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		228.77	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		33.71	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		457.73	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.42	(257)
SAP rating		76.91	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			70.42	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			291.34	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		361.75	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		28.36	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		415.74	(272)
Dwelling CO2 Emission Rate		5.88	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			709.2	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1567.66	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			2276.86	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			309.25	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2858.55	(286)
Dwelling PE Rate			40.43	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	50.65 (1a)	x	2.4	(2a) =	121.56	(3a)
Total floor area TFA					50.65	(4)
Dwelling volume					121.56	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.12	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	1.53	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

Effective air change rate from PCDB:

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.57	3798.75	(28b)
Basement wall	0	0	(29)
External wall	4.57	6676.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		94.61	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	19.96	(33)
Heat capacity Cm = ∑(A x k)	15673.75	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	13.87	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	13.87	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	33.83	(37)

Ventilation heat loss calculated monthly

19.08	18.97	18.85	18.27	18.15	17.57	17.57	17.45	17.8	18.15	18.38	18.62	(38)

Heat transfer coefficient, W/K

52.91	52.79	52.68	52.1	51.98	51.4	51.4	51.28	51.63	51.98	52.21	52.44	(39)

Heat loss parameter (HLP), W/m²K

1.04	1.04	1.04	1.03	1.03	1.01	1.01	1.01	1.02	1.03	1.03	1.04	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.71 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

52.88	52.08	50.93	48.71	47.07	45.25	44.22	45.36	46.62	48.58	50.84	52.68	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

22.86	22.52	22.04	21.16	20.5	19.77	19.38	19.85	20.37	21.15	22.05	22.79	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.13	30.97	29.8	28.63	27.46	26.29	26.29	27.46	28.63	29.8	30.97	32.13	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 99.3 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

107.87	105.57	102.77	98.5	95.04	91.31	89.88	92.68	95.62	99.53	103.86	107.6	1190.23 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

170.85	150.33	157.95	134.84	127.94	112.28	108.71	114.75	117.91	135.06	147.97	168.47	1647.06 (45)

Distribution loss (46) = 0.15 x (45)

25.63	22.55	23.69	20.23	19.19	16.84	16.31	17.21	17.69	20.26	22.2	25.27	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

299.22 266.29 286.33 259.08 256.32 154.2 152.02 158.06 159.83 263.44 272.21 296.85 2823.83 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

299.22 266.29 286.33 259.08 256.32 154.2 152.02 158.06 159.83 263.44 272.21 296.85 2823.83 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

159.51 142.75 155.22 144.22 145.24 70.87 70.8 72.81 72.74 147.61 148.59 158.72 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

17.92 15.91 12.94 9.8 7.32 6.18 6.68 8.68 11.66 14.8 17.27 18.42 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

222.27 224.58 218.77 206.39 190.77 176.09 166.29 163.98 169.79 182.16 197.78 212.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	(69)

Pumps and fans gains (Table 5a)

	3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	(71)

Water heating gains (Table 5)

	214.39	212.42	208.63	200.31	195.22	98.43	95.15	97.86	101.02	198.4	206.37	213.33	(72)

Total internal gains

	538.73	537.07	524.49	500.65	477.46	361.85	349.27	351.67	363.62	479.52	505.58	528.36	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	23.72	48.29	87	142.89	192.07	204.76	191.55	152.71	106.02	59.01	29.85	19.37	(83)

Total gains – internal and solar (watts)

	562.46	585.36	611.49	643.54	669.53	566.61	540.82	504.38	469.64	538.53	535.43	547.73	(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, ⍰1,m (see Table 9a)

	0.97	0.96	0.92	0.84	0.68	0.57	0.42	0.46	0.71	0.85	0.94	0.97	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	20.39	20.47	20.62	20.8	20.9	20.93	20.94	20.94	20.91	20.81	20.58	20.38	(87)

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

	20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.05	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.96	0.94	0.9	0.8	0.63	0.49	0.33	0.37	0.63	0.81	0.93	0.96	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	19.36	19.46	19.64	19.85	19.96	19.99	20	20	19.97	19.87	19.61	19.35	(90)

Living area fraction 0.49 (91)

Mean internal temperature (for the whole dwelling)

	19.86	19.95	20.12	20.31	20.42	20.45	20.46	20.46	20.43	20.33	20.08	19.85	(92)

Adjusted mean internal temperature:

	19.86	19.95	20.12	20.31	20.42	20.45	20.46	20.46	20.43	20.33	20.08	19.85	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.94	0.9	0.81	0.65	0.52	0.37	0.41	0.66	0.82	0.93	0.96	(94)

Useful gains, mGm , W

537.86	551.42	552.72	521.71	434.68	296.51	197.86	207.27	312.05	440.77	496.14	526.23	(95)

Monthly average external temperature from Table U1

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

823.54	794.75	717.35	594.41	453.17	300.74	198.33	208.15	326.73	505.56	677.96	820.75	(97)

Space heating requirement for each month

212.55	163.52	122.48	52.34	13.76	0	0	0	0	48.2	130.91	219.12	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

212.55	163.52	122.48	52.34	13.76	0	0	0	0	48.2	130.91	219.12	(98c)

Space heating requirement in kWh/m²/year 19.01 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
66.48	51.15	38.31	16.37	4.3	0	0	0	0	15.08	40.95	68.54		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
133.34	118.67	127.6	115.45	114.22	68.72	67.74	70.44	71.22	117.4	121.3	132.28	1258.39	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												301.19	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1258.39	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		146.45	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												146.45	(231)
Electricity for lighting												126.57	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1832.6	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.67	(240a)
Low-rate fraction	0		49.67	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.67	(241a)
Low-rate fraction	0		49.67	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.67	(242a)

Low-rate fraction	0		49.67	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		207.51	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		24.15	(249)
Energy For lighting	0		20.87	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		394.2	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator	0.36	(256)
Energy cost factor (ECF)	1.48	(257)
SAP rating	75.95	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			47.2	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			264.26	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		311.46	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		20.31	(267)
Electricity for lighting		18.27	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		350.04	(272)
Dwelling CO2 Emission Rate		6.91	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			475.92	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1421.98	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1897.9	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			221.55	(281)
Electricity for lighting			194.14	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2313.59	(286)
Dwelling PE Rate			45.68	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	75.99 (1a)	x	2.4	(2a) =	182.38	(3a)
Total floor area TFA					75.99	(4)
Dwelling volume					182.38	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	15.25		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	8.36	5699.25	(28b)
Basement wall	0	0	(29)
External wall	7.53	11008.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		149.19	(31)
Party Wall	0	2187	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	33.08	(33)
Heat capacity Cm = ∑(A x k)	18894.85	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	15.08	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	15.08	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	48.16	(37)

Ventilation heat loss calculated monthly

30.36	30.15	29.94	28.9	28.69	27.64	27.64	27.43	28.06	28.69	29.1	29.52	(38)

Heat transfer coefficient, W/K

78.52	78.31	78.1	77.05	76.85	75.8	75.8	75.59	76.22	76.85	77.26	77.68	(39)

Heat loss parameter (HLP), W/m²K

1.03	1.03	1.03	1.01	1.01	1	1	0.99	1	1.01	1.02	1.02	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.38 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

64.16	63.2	61.79	59.11	57.12	54.91	53.65	55.05	56.58	58.95	61.7	63.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

27.72	27.3	26.72	25.66	24.86	23.97	23.49	24.06	24.69	25.64	26.73	27.62	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

39.03	37.61	36.19	34.77	33.35	31.93	31.93	33.35	34.77	36.19	37.61	39.03	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 120.5 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

130.91	128.11	124.71	119.53	115.33	110.81	109.07	112.46	116.04	120.78	126.04	130.57	1444.36	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

207.33	182.43	191.67	163.63	155.26	136.25	131.91	139.25	143.09	163.9	179.56	204.44	1998.73	(45)

Distribution loss (46) = 0.15 x (45)

31.1	27.36	28.75	24.55	23.29	20.44	19.79	20.89	21.46	24.58	26.93	30.67	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

335.7 298.38 320.05 287.87 283.63 178.17 175.23 182.57 185 292.28 303.8 332.82 3175.5 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

335.7 298.38 320.05 287.87 283.63 178.17 175.23 182.57 185 292.28 303.8 332.82 3175.5 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

171.64 153.42 166.43 153.8 154.32 78.84 78.51 80.95 81.11 157.2 159.09 170.68 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

27.28 24.23 19.7 14.92 11.15 9.41 10.17 13.22 17.75 22.53 26.3 28.04 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

314.71 317.98 309.75 292.23 270.11 249.33 235.44 232.18 240.4 257.92 280.04 300.83 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	(71)

Water heating gains (Table 5)

230.7	228.31	223.7	213.61	207.42	109.5	105.53	108.81	112.65	211.29	220.96	229.41	(72)

Total internal gains

675.01	672.83	655.48	623.08	591.01	467.56	450.46	453.53	470.13	594.07	629.63	660.59	(73)

6. Solar gains

Solar gains in watts, calculated for each month

149.78	255.13	349.08	432.53	484.46	480.96	463.7	424.95	377.98	281.97	179.4	128.18	(83)

Total gains – internal and solar (watts)

824.79	927.96	1004.55	1055.6	1075.48	948.52	914.16	878.48	848.1	876.04	809.03	788.77	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

0.97	0.94	0.89	0.79	0.64	0.51	0.36	0.39	0.6	0.81	0.94	0.97	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.39	20.53	20.69	20.84	20.92	20.94	20.94	20.94	20.93	20.84	20.6	20.36	(87)

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

20.06	20.06	20.06	20.07	20.07	20.09	20.09	20.09	20.08	20.07	20.07	20.06	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.96	0.93	0.87	0.75	0.58	0.44	0.29	0.32	0.53	0.76	0.92	0.97	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.37	19.53	19.73	19.9	19.98	20.01	20.01	20.02	20	19.92	19.64	19.34	(90)

Living area fraction 0.28 (91)

Mean internal temperature (for the whole dwelling)

19.65	19.81	20	20.17	20.24	20.27	20.28	20.28	20.26	20.18	19.91	19.63	(92)

Adjusted mean internal temperature:

19.65	19.81	20	20.17	20.24	20.27	20.28	20.28	20.26	20.18	19.91	19.63	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.93	0.87	0.75	0.59	0.45	0.3	0.33	0.54	0.77	0.92	0.96	(94)

Useful gains, mGm , W

789.22	858.43	869.85	796.32	639.63	427.28	278.43	292.74	461.93	670.69	743.31	760.23	(95)

Monthly average external temperature from Table U1

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

1205.59	1167.88	1054.18	868.16	656.6	430	278.67	293.14	469.67	735.96	989.92	1198.5	(97)

Space heating requirement for each month

309.78	207.95	137.14	51.72	12.62	0	0	0	0	48.56	177.56	326.08	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

309.78	207.95	137.14	51.72	12.62	0	0	0	0	48.56	177.56	326.08	(98c)

Space heating requirement in kWh/m²/year 16.73 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													319.7	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0		0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
96.9	65.04	42.9	16.18	3.95	0	0	0		0	15.19	55.54	101.99		(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(215)
Output from water heater),								0					224.4	(216)
Efficiency of water heater														
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		224.4	224.4	224.4	224.4		(217)
Fuel for water heating														
149.6	132.97	142.62	128.28	126.4	79.4	78.09	81.36		82.44	130.25	135.38	148.31	1415.11	(219)
Space Cooling														
0	0	0	0	0	0	0	0		0	0	0	0		(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													397.69	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1415.11	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			219.72	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													219.72	(231)
Electricity for lighting													192.7	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			2225.21	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		65.58	(240a)
Low-rate fraction	0		65.58	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		65.58	(241a)
Low-rate fraction	0		65.58	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		65.58	(242a)

Low-rate fraction	0		65.58	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		233.35	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		36.23	(249)
Energy For lighting	0		31.78	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		458.94	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.37	(257)
SAP rating		77.86	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			62.68	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			297.17	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		359.85	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		30.48	(267)
Electricity for lighting		27.81	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		418.14	(272)
Dwelling CO2 Emission Rate		5.5	(273)
EI rating		95	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			629.71	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1599.07	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			2228.78	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			332.39	(281)
Electricity for lighting			295.57	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2856.73	(286)
Dwelling PE Rate			37.59	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.21	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	4.27	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	4.27	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	27.48	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

55.72	55.53	55.33	54.36	54.17	53.2	53.2	53	53.58	54.17	54.56	54.94	(39)

Heat loss parameter (HLP), W/m²K

0.79	0.79	0.78	0.77	0.77	0.75	0.75	0.75	0.76	0.77	0.77	0.78	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36 (45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

329.23 292.69 314.07 282.76 278.79 173.92 171.11 178.22 180.54 287.16 298.2 326.44 3113.13 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

169.49 151.53 164.44 152.1 152.71 77.42 77.14 79.51 79.62 155.5 157.23 168.56 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

227.8	225.49	221.03	211.25	205.26	107.53	103.69	106.86	110.59	209	218.38	226.55	(72)

Total internal gains

648.95	646.91	630.51	599.79	569.47	447.53	431.28	434.19	449.85	572.2	605.91	635.3	(73)

6. Solar gains

Solar gains in watts, calculated for each month

81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

730.71	794.72	855.49	916.64	959.13	849.67	812.63	758.87	706.27	741.7	705.4	704.26	(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, 1,m (see Table 9a)

0.95	0.92	0.84	0.7	0.52	0.4	0.29	0.32	0.52	0.73	0.9	0.96	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.67	20.76	20.86	20.93	20.95	20.96	20.96	20.96	20.95	20.93	20.81	20.65	(87)

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

20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.94	0.9	0.82	0.66	0.48	0.36	0.24	0.27	0.47	0.69	0.88	0.95	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.89	20	20.11	20.2	20.22	20.24	20.24	20.24	20.23	20.2	20.07	19.88	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

20.19	20.28	20.4	20.48	20.5	20.51	20.51	20.51	20.51	20.48	20.35	20.17	(92)

Adjusted mean internal temperature:

20.19	20.28	20.4	20.48	20.5	20.51	20.51	20.51	20.51	20.48	20.35	20.17	(93)

8. Space heating requirement

Utilisation factor for gains,

0.94	0.9	0.82	0.67	0.5	0.37	0.26	0.29	0.48	0.7	0.89	0.95	(94)

Useful gains, mGm , W

686.91	717.26	703.63	614.64	474.92	314.26	208.03	217.95	342.21	518.98	624.58	667.85	(95)

Monthly average external temperature from Table U1

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

885.16	854.17	768.85	629.45	476.67	314.42	208.04	217.97	343.26	535.09	722.87	877.64	(97)

Space heating requirement for each month

147.5	92.01	48.53	10.67	1.3	0	0	0	0	11.99	70.77	156.08	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

147.5	92.01	48.53	10.67	1.3	0	0	0	0	11.99	70.77	156.08	(98c)

Space heating requirement in kWh/m²/year 7.62 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
46.14	28.78	15.18	3.34	0.41	0	0	0	0	3.75	22.14	48.82		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
146.72	130.43	139.96	126.01	124.24	77.5	76.25	79.42	80.45	127.97	132.89	145.47	1387.31	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												168.54	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1387.31	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		204.42	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												204.42	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1937.9	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(240a)
Low-rate fraction	0		27.79	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(241a)
Low-rate fraction	0		27.79	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		27.79	(242a)

Low-rate fraction	0		27.79	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		228.77	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		33.71	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		411.56	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.28	(257)
SAP rating		79.24	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			26.79	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			291.34	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		318.12	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		28.36	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		372.12	(272)
Dwelling CO2 Emission Rate		5.26	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			267.7	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1567.66	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1835.37	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			309.25	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2417.06	(286)
Dwelling PE Rate			34.19	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	5.07	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	18.33	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.73	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.73	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	22.06	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

46.71	46.54	46.38	45.53	45.36	44.51	44.51	44.34	44.85	45.36	45.7	46.04	(39)

Heat loss parameter (HLP), W/m²K

0.76	0.75	0.75	0.74	0.73	0.72	0.72	0.72	0.73	0.73	0.74	0.75	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

58.25	57.38	56.1	53.66	51.86	49.85	48.71	49.98	51.36	53.52	56.01	58.03	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 109.4 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

118.84	116.31	113.22	108.52	104.7	100.6	99.02	102.1	105.34	109.65	114.42	118.54	1311.26	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

188.22	165.62	174.01	148.56	140.95	123.7	119.76	126.42	129.9	148.8	163.02	185.6	1814.54	(45)

Distribution loss (46) = 0.15 x (45)

28.23	24.84	26.1	22.28	21.14	18.55	17.96	18.96	19.48	22.32	24.45	27.84	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU 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/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.14	(51)

Volume factor from Table 2a 0 (52)
Temperature factor from Table 2b 0 (53)
Energy lost from water storage, kWh/day 0 (54)
Enter (50) or (54) in (55) 0 (55)
Water storage (or HIU) loss calculated for each month (56) = (55) × (41)

0 0 0 0 0 0 0 0 0 0 0 0 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,
(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m
where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

0 0 0 0 0 0 0 0 0 0 0 0 (57)

Primary circuit loss for each month from Table 3
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

128.38 115.95 128.38 124.24 128.38 41.92 43.31 43.31 41.92 128.38 124.24 128.38 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

316.6 281.57 302.39 272.79 269.33 165.61 163.07 169.73 171.82 277.17 287.25 313.98 2991.31 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

316.6 281.57 302.39 272.79 269.33 165.61 163.07 169.73 171.82 277.17 287.25 313.98 2991.31 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

165.29 147.83 160.56 148.78 149.57 74.66 74.47 76.69 76.72 152.18 153.59 164.41 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

21.72 19.29 15.69 11.88 8.88 7.5 8.1 10.53 14.13 17.94 20.94 22.33 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

3	3	3	3	3	0	0	0	0	3	3	3	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

222.16	219.99	215.81	206.64	201.03	103.7	100.09	103.07	106.56	204.54	213.32	220.99	(72)

Total internal gains

601.26	599.4	584.7	557	529.79	410.6	395.93	398.59	412.6	532.12	562.49	589.01	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

712.35	788.64	843.63	877.82	889.14	767.35	739.87	713.79	692.96	741.27	695.56	684.09	(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, ⍰1,m (see Table 9a)

0.91	0.85	0.76	0.62	0.47	0.37	0.26	0.29	0.45	0.63	0.84	0.92	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

20.77	20.85	20.91	20.95	20.96	20.96	20.96	20.96	20.96	20.95	20.88	20.76	(87)

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

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.9	0.83	0.73	0.59	0.44	0.33	0.22	0.24	0.4	0.59	0.81	0.91	(89)

Roof Mean internal temperature in the rest of dwelling T2

20.04	20.13	20.2	20.24	20.25	20.27	20.27	20.27	20.26	20.25	20.18	20.03	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

20.33	20.42	20.48	20.53	20.54	20.54	20.54	20.55	20.54	20.53	20.46	20.32	(92)

Adjusted mean internal temperature:

20.33	20.42	20.48	20.53	20.54	20.54	20.54	20.55	20.54	20.53	20.46	20.32	(93)

8. Space heating requirement

Utilisation factor for gains,

0.9	0.84	0.74	0.6	0.45	0.34	0.24	0.26	0.42	0.6	0.81	0.91	(94)

Useful gains, mGm , W

639.43	658.74	622.65	523.9	400.09	264.51	175.56	183.82	288.59	445.6	566.47	623.09	(95)

Monthly average external temperature from Table U1

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

748.99	722.21	648.46	529.28	400.74	264.57	175.56	183.83	288.85	450.32	610.41	742.21	(97)

Space heating requirement for each month

81.51	42.65	19.2	3.87	0.49	0	0	0	0	3.51	31.63	88.63	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

81.51	42.65	19.2	3.87	0.49	0	0	0	0	3.51	31.63	88.63	(98c)

Space heating requirement in kWh/m²/year 4.4 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												319.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
25.5	13.34	6.01	1.21	0.15	0	0	0	0	1.1	9.9	27.72		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				224.4	(216)
Efficiency of water heater													
224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4		(217)
Fuel for water heating													
141.09	125.48	134.75	121.56	120.02	73.8	72.67	75.64	76.57	123.52	128.01	139.92	1333.03	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												84.92	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1333.03	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		178.46	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												178.46	(231)
Electricity for lighting												153.44	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1749.85	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(240a)
Low-rate fraction	0		14	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(241a)
Low-rate fraction	0		14	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		14	(242a)

Low-rate fraction	0		14	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		219.82	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		29.43	(249)
Energy For lighting	0		25.3	(250)
Additional standing charges	0		92	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		380.55	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.28	(257)
SAP rating		79.19	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			13.57	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			279.94	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		293.5	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		24.75	(267)
Electricity for lighting		22.15	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		340.4	(272)
Dwelling CO2 Emission Rate		5.52	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			135.13	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1506.32	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			1641.45	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			269.97	(281)
Electricity for lighting			235.36	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2146.78	(286)
Dwelling PE Rate			34.78	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	75.99 (1a)	x	2.4	(2a) =	182.38	(3a)
Total floor area TFA					75.99	(4)
Dwelling volume					182.38	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	15.25		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	8.36	5699.25	(28b)
Basement wall	0	0	(29)
External wall	7.53	11008.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		149.19	(31)
Party Wall	0	2187	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	33.08	(33)
Heat capacity Cm = ∑(A x k)	18894.85	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	15.08	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	15.08	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	48.16	(37)

Ventilation heat loss calculated monthly

30.36	30.15	29.94	28.9	28.69	27.64	27.64	27.43	28.06	28.69	29.1	29.52	(38)

Heat transfer coefficient, W/K

78.52	78.31	78.1	77.05	76.85	75.8	75.8	75.59	76.22	76.85	77.26	77.68	(39)

Heat loss parameter (HLP), W/m²K

1.03	1.03	1.03	1.01	1.01	1	1	0.99	1	1.01	1.02	1.02	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.38 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

64.16	63.2	61.79	59.11	57.12	54.91	53.65	55.05	56.58	58.95	61.7	63.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

27.72	27.3	26.72	25.66	24.86	23.97	23.49	24.06	24.69	25.64	26.73	27.62	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

39.03	37.61	36.19	34.77	33.35	31.93	31.93	33.35	34.77	36.19	37.61	39.03	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 120.5 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

130.91	128.11	124.71	119.53	115.33	110.81	109.07	112.46	116.04	120.78	126.04	130.57	1444.36	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

207.33	182.43	191.67	163.63	155.26	136.25	131.91	139.25	143.09	163.9	179.56	204.44	1998.73	(45)

Distribution loss (46) = 0.15 x (45)

31.1	27.36	28.75	24.55	23.29	20.44	19.79	20.89	21.46	24.58	26.93	30.67	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

233.44 206.02 217.79 188.91 181.37 161.53 158.03 165.37 168.36 190.01 204.84 230.55 2306.2 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

233.44 206.02 217.79 188.91 181.37 161.53 158.03 165.37 168.36 190.01 204.84 230.55 2306.2 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

68.94 60.66 63.73 54.41 51.62 45.3 43.86 46.3 47.58 54.5 59.7 67.98 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 142.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

27.28 24.23 19.7 14.92 11.15 9.41 10.17 13.22 17.75 22.53 26.3 28.04 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

314.71 317.98 309.75 292.23 270.11 249.33 235.44 232.18 240.4 257.92 280.04 300.83 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	(71)

Water heating gains (Table 5)

92.66	90.27	85.66	75.57	69.38	62.92	58.95	62.23	66.08	73.25	82.92	91.37	(72)

Total internal gains

533.97	531.79	514.44	482.04	449.97	420.99	403.89	406.95	423.55	453.03	488.59	519.55	(73)

6. Solar gains

Solar gains in watts, calculated for each month

149.78	255.13	349.08	432.53	484.46	480.96	463.7	424.95	377.98	281.97	179.4	128.18	(83)

Total gains – internal and solar (watts)

683.75	786.92	863.51	914.56	934.44	901.95	867.59	831.9	801.53	735	667.99	647.73	(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, ⍰1,m (see Table 9a)

0.99	0.97	0.94	0.86	0.72	0.53	0.38	0.42	0.63	0.88	0.97	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

20.06	20.06	20.06	20.07	20.07	20.09	20.09	20.09	20.08	20.07	20.07	20.06	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.96	0.92	0.82	0.66	0.46	0.3	0.33	0.56	0.84	0.96	0.99	(89)

Roof Mean internal temperature in the rest of dwelling T2

20.06	20.06	20.06	20.07	20.07	20.09	20.09	20.09	20.08	20.07	20.07	20.06	(90)

Living area fraction 0.28 (91)

Mean internal temperature (for the whole dwelling)

20.32	20.32	20.32	20.33	20.33	20.34	20.34	20.34	20.34	20.33	20.33	20.33	(92)

Adjusted mean internal temperature:

20.32	20.32	20.32	20.33	20.33	20.34	20.34	20.34	20.34	20.33	20.33	20.33	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.92	0.83	0.68	0.48	0.33	0.36	0.58	0.86	0.97	0.99	(94)

Useful gains, mGm , W

672.49	759.13	797.55	760.35	631.69	431.59	283.37	297.6	464.92	628.68	644.77	639.47	(95)

Monthly average external temperature from Table U1

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

1257.94	1207.74	1079.69	880.96	663.53	435.32	283.71	298.18	475.57	748.06	1022.29	1252.84	(97)

Space heating requirement for each month

435.58	301.47	209.91	86.84	23.69	0	0	0	0	88.82	271.82	456.35	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

435.58	301.47	209.91	86.84	23.69	0	0	0	0	88.82	271.82	456.35	(98c)

Space heating requirement in kWh/m²/year 24.67 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													329.37	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0	0	0	0	0			(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
132.24	91.53	63.73	26.36	7.19	0	0	0	0	26.97	82.53	138.55			(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0	0	0	0	0			(215)
Output from water heater),								0					220.69	(216)
Efficiency of water heater														
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69			(217)
Fuel for water heating														
105.78	93.35	98.69	85.6	82.18	73.19	71.61	74.93	76.29	86.1	92.82	104.47		1045.02	(219)
Space Cooling														
0	0	0	0	0	0	0	0	0	0	0	0			(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													569.1	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1045.02	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			159.42	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													159.42	(231)
Electricity for lighting													192.7	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1966.24	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		93.84	(240a)
Low-rate fraction	0		93.84	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		93.84	(241a)
Low-rate fraction	0		93.84	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		93.84	(242a)

Low-rate fraction	0		93.84	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		172.32	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		26.29	(249)
Energy For lighting	0		31.78	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		324.23	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.96	(257)
SAP rating		84.36	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			89.38	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			147.55	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		22.11	(267)
Electricity for lighting		27.81	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		286.86	(272)
Dwelling CO2 Emission Rate		3.77	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			899.99	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1590.63	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			241.17	(281)
Electricity for lighting			295.57	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			3027.35	(286)
Dwelling PE Rate			39.84	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.21	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	4.27	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	4.27	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	27.48	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

55.72	55.53	55.33	54.36	54.17	53.2	53.2	53	53.58	54.17	54.56	54.94	(39)

Heat loss parameter (HLP), W/m²K

0.79	0.79	0.78	0.77	0.77	0.75	0.75	0.75	0.76	0.77	0.77	0.78	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36 (45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

66.78 58.77 61.74 52.71 50.01 43.89 42.49 44.86 46.09 52.8 57.84 65.85 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	89.76	87.45	82.99	73.21	67.22	60.96	57.11	60.29	64.02	70.96	80.34	88.51	(72)

Total internal gains

	507.91	505.87	489.47	458.75	428.43	400.96	384.71	387.62	403.28	431.16	464.87	494.26	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	589.67	653.68	714.45	775.6	818.09	803.1	766.05	712.3	659.7	600.66	564.36	563.22	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.98	0.97	0.92	0.79	0.61	0.42	0.31	0.34	0.56	0.85	0.96	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

	20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.98	0.96	0.9	0.76	0.56	0.38	0.26	0.29	0.5	0.81	0.95	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	20.54	20.54	20.55	20.55	20.55	20.56	20.56	20.56	20.56	20.55	20.55	20.55	(92)

Adjusted mean internal temperature:

	20.54	20.54	20.55	20.55	20.55	20.56	20.56	20.56	20.56	20.55	20.55	20.55	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.91	0.77	0.58	0.39	0.28	0.31	0.52	0.82	0.96	0.99	(94)

Useful gains, mGm , W

578.48	628.21	648.19	598.57	474.94	316.9	210.75	220.64	344.42	494.75	540.73	554.85	(95)

Monthly average external temperature from Table U1

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

905.06	868.67	777.18	633.48	479.63	317.15	210.76	220.67	346.1	539.21	733.86	898.26	(97)

Space heating requirement for each month

242.97	161.59	95.97	25.13	3.48	0	0	0	0	33.08	139.05	255.5	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

242.97	161.59	95.97	25.13	3.48	0	0	0	0	33.08	139.05	255.5	(98c)

Space heating requirement in kWh/m²/year 13.53 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												316.5	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
76.77	51.06	30.32	7.94	1.1	0	0	0	0	10.45	43.93	80.72		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
102.85	90.77	95.98	83.29	79.99	71.27	69.74	72.96	74.27	83.78	90.28	101.58	1016.76	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												302.3	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1016.76	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		161.91	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												161.91	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1658.59	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(240a)
Low-rate fraction	0		49.85	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(241a)
Low-rate fraction	0		49.85	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(242a)

Low-rate fraction	0		49.85	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		167.66	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		26.7	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		273.5	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.85	(257)
SAP rating		86.21	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			47.82	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			143.55	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		22.46	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		239.46	(272)
Dwelling CO2 Emission Rate		3.39	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			479.3	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1547.58	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			244.94	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2544.26	(286)
Dwelling PE Rate			35.99	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	5.07	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	18.33	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.73	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.73	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	22.06	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

46.71	46.54	46.38	45.53	45.36	44.51	44.51	44.34	44.85	45.36	45.7	46.04	(39)

Heat loss parameter (HLP), W/m²K

0.76	0.75	0.75	0.74	0.73	0.72	0.72	0.72	0.73	0.73	0.74	0.75	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

58.25	57.38	56.1	53.66	51.86	49.85	48.71	49.98	51.36	53.52	56.01	58.03	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 109.4 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

118.84	116.31	113.22	108.52	104.7	100.6	99.02	102.1	105.34	109.65	114.42	118.54	1311.26 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

188.22	165.62	174.01	148.56	140.95	123.7	119.76	126.42	129.9	148.8	163.02	185.6	1814.54 (45)

Distribution loss (46) = 0.15 x (45)

28.23	24.84	26.1	22.28	21.14	18.55	17.96	18.96	19.48	22.32	24.45	27.84	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

214.33 189.21 200.12 173.83 167.06 148.97 145.87 152.53 155.17 174.91 188.29 211.71 2122.02 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

214.33 189.21 200.12 173.83 167.06 148.97 145.87 152.53 155.17 174.91 188.29 211.71 2122.02 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

62.58 55.07 57.86 49.39 46.87 41.13 39.82 42.03 43.19 49.47 54.2 61.71 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

21.72 19.29 15.69 11.88 8.88 7.5 8.1 10.53 14.13 17.94 20.94 22.33 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

84.12	81.95	77.77	68.6	62.99	57.12	53.52	56.5	59.99	66.5	75.28	82.95	(72)

Total internal gains

460.22	458.36	443.66	415.96	388.75	364.03	349.36	352.02	366.03	391.08	421.45	447.97	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

571.31	647.6	702.59	736.78	748.1	720.78	693.3	667.22	646.39	600.23	554.52	543.05	(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, ⍰1,m (see Table 9a)

0.97	0.93	0.86	0.72	0.56	0.39	0.28	0.31	0.48	0.75	0.93	0.98	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.96	0.92	0.83	0.69	0.52	0.35	0.24	0.26	0.43	0.71	0.91	0.97	(89)

Roof Mean internal temperature in the rest of dwelling T2

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

20.57	20.58	20.58	20.58	20.59	20.59	20.59	20.59	20.59	20.59	20.58	20.58	(92)

Adjusted mean internal temperature:

20.57	20.58	20.58	20.58	20.59	20.59	20.59	20.59	20.59	20.59	20.58	20.58	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.92	0.84	0.7	0.54	0.37	0.26	0.28	0.45	0.73	0.92	0.97	(94)

Useful gains, mGm , W

550.7	597.58	592.24	517.15	401.01	266.66	177.74	185.99	290.64	437.19	510.06	527.75	(95)

Monthly average external temperature from Table U1

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

760.25	729.63	652.84	531.97	403.05	266.76	177.74	186	291.09	452.95	616.14	754.09	(97)

Space heating requirement for each month

155.91	88.74	45.09	10.67	1.52	0	0	0	0	11.72	76.38	168.39	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

155.91	88.74	45.09	10.67	1.52	0	0	0	0	11.72	76.38	168.39	(98c)

Space heating requirement in kWh/m²/year 9.05 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,							0					0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												295	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,							0					0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month							0					0	
52.85	30.08	15.28	3.62	0.52	0	0	0	0	3.97	25.89	57.08		(211)
Space heating fuel (main heating system 2), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),							0					220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
97.12	85.74	90.68	78.77	75.7	67.5	66.1	69.12	70.31	79.26	85.32	95.93	961.56	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												189.3	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												961.56	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		172.51	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												172.51	(231)
Electricity for lighting												153.44	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1476.81	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(240a)
Low-rate fraction	0		31.22	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(241a)
Low-rate fraction	0		31.22	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(242a)

Low-rate fraction	0		31.22	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		158.56	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		28.45	(249)
Energy For lighting	0		25.3	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		243.53	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.82	(257)
SAP rating		86.68	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			30.11	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			135.74	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		23.93	(267)
Electricity for lighting		22.15	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		211.92	(272)
Dwelling CO2 Emission Rate		3.43	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			300.73	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1463.48	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			260.98	(281)
Electricity for lighting			235.36	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2260.54	(286)
Dwelling PE Rate			36.63	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.85	10018.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		64.99	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	20.61	(33)
Heat capacity Cm = ∑(A x k)	13681.7	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.93	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.93	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	24.54	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

50.23	50.05	49.87	48.99	48.81	47.93	47.93	47.75	48.28	48.81	49.17	49.52	(39)

Heat loss parameter (HLP), W/m²K

0.78	0.78	0.78	0.76	0.76	0.75	0.75	0.74	0.75	0.76	0.76	0.77	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.1 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

59.43	58.54	57.24	54.75	52.91	50.86	49.7	50.99	52.4	54.6	57.15	59.21	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 111.62 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

121.25	118.67	115.51	110.72	106.82	102.64	101.03	104.17	107.48	111.87	116.74	120.94	1337.85 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

192.04	168.98	177.54	151.57	143.81	126.21	122.19	128.98	132.53	151.81	166.32	189.36	1851.33 (45)

Distribution loss (46) = 0.15 x (45)

28.81	25.35	26.63	22.74	21.57	18.93	18.33	19.35	19.88	22.77	24.95	28.4	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

218.15 192.57 203.65 176.84 169.92 151.48 148.3 155.1 157.81 177.93 191.59 215.48 2158.81 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

218.15 192.57 203.65 176.84 169.92 151.48 148.3 155.1 157.81 177.93 191.59 215.48 2158.81 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

63.85 56.19 59.03 50.4 47.82 41.96 40.63 42.89 44.07 50.48 55.3 62.96 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

22.85 20.29 16.5 12.49 9.34 7.88 8.52 11.07 14.86 18.87 22.03 23.48 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1 276.94 269.78 254.52 235.26 217.15 205.06 202.21 209.38 224.64 243.9 262.01 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7		(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0		(70)

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

-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01		(71)

Water heating gains (Table 5)

85.82	83.61	79.34	69.99	64.27	58.28	54.61	57.64	61.2	67.85	76.81	84.63		(72)

Total internal gains

474.48	472.55	457.33	428.71	400.57	375.03	359.89	362.64	377.16	403.07	434.44	461.82		(73)

6. Solar gains

Solar gains in watts, calculated for each month

116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31		(83)

Total gains – internal and solar (watts)

590.52	670.22	727.79	763.82	775.92	747.66	719.15	691.88	670	621.53	573.44	561.13		(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, ⍰1,m (see Table 9a)

0.97	0.94	0.87	0.74	0.58	0.41	0.29	0.32	0.5	0.77	0.94	0.98		(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21		(87)

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

20.27	20.27	20.27	20.29	20.29	20.3	20.3	20.3	20.3	20.29	20.28	20.28		(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.97	0.93	0.85	0.71	0.54	0.37	0.25	0.27	0.45	0.73	0.92	0.97		(89)

Roof Mean internal temperature in the rest of dwelling T2

20.27	20.27	20.27	20.29	20.29	20.3	20.3	20.3	20.3	20.29	20.28	20.28		(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

20.51	20.51	20.52	20.52	20.53	20.53	20.53	20.54	20.53	20.53	20.52	20.52		(92)

Adjusted mean internal temperature:

20.51	20.51	20.52	20.52	20.53	20.53	20.53	20.54	20.53	20.53	20.52	20.52		(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.93	0.86	0.72	0.55	0.38	0.26	0.29	0.46	0.75	0.93	0.97	(94)

Useful gains, mGm , W

571.51	623.66	623.12	549.44	427.83	284.22	188.52	197.45	309.8	463.46	532.26	547.08	(95)

Monthly average external temperature from Table U1

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

814.3	781.48	699.01	569.45	430.79	284.39	188.53	197.46	310.47	484.49	659.92	808.11	(97)

Space heating requirement for each month

180.63	106.06	56.46	14.4	2.21	0	0	0	0	15.64	91.92	194.2	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

180.63	106.06	56.46	14.4	2.21	0	0	0	0	15.64	91.92	194.2	(98c)

Space heating requirement in kWh/m²/year 10.29 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													298.35	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0		0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
60.55	35.55	18.93	4.83	0.74	0	0	0		0	5.24	30.81	65.09		(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(215)
Output from water heater),								0					220.69	(216)
Efficiency of water heater														
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		220.69	220.69	220.69	220.69		(217)
Fuel for water heating														
98.85	87.26	92.28	80.13	77	68.64	67.2	70.28		71.51	80.62	86.82	97.64	978.23	(219)
Space Cooling														
0	0	0	0	0	0	0	0		0	0	0	0		(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													221.73	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													978.23	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			174.65	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													174.65	(231)
Electricity for lighting													161.39	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1536	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		36.56	(240a)
Low-rate fraction	0		36.56	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		36.56	(241a)
Low-rate fraction	0		36.56	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		36.56	(242a)

Low-rate fraction	0		36.56	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		161.31	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		28.8	(249)
Energy For lighting	0		26.61	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		253.29	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.83	(257)
SAP rating		86.48	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			35.22	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			138.1	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		24.23	(267)
Electricity for lighting		23.29	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		220.83	(272)
Dwelling CO2 Emission Rate		3.43	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			352.08	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1488.87	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			264.21	(281)
Electricity for lighting			247.54	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2352.71	(286)
Dwelling PE Rate			36.59	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		68.35	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	23.21	(33)
Heat capacity Cm = ∑(A x k)	13263.8	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	4.27	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	4.27	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	27.48	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

55.72	55.53	55.33	54.36	54.17	53.2	53.2	53	53.58	54.17	54.56	54.94	(39)

Heat loss parameter (HLP), W/m²K

0.79	0.79	0.78	0.77	0.77	0.75	0.75	0.75	0.76	0.77	0.77	0.78	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36 (45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

66.78 58.77 61.74 52.71 50.01 43.89 42.49 44.86 46.09 52.8 57.84 65.85 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	89.76	87.45	82.99	73.21	67.22	60.96	57.11	60.29	64.02	70.96	80.34	88.51	(72)

Total internal gains

	507.91	505.87	489.47	458.75	428.43	400.96	384.71	387.62	403.28	431.16	464.87	494.26	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	589.67	653.68	714.45	775.6	818.09	803.1	766.05	712.3	659.7	600.66	564.36	563.22	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

	0.98	0.97	0.92	0.79	0.61	0.42	0.31	0.34	0.56	0.85	0.96	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

	20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

	0.98	0.96	0.9	0.76	0.56	0.38	0.26	0.29	0.5	0.81	0.95	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	20.26	20.27	20.27	20.28	20.28	20.29	20.29	20.3	20.29	20.28	20.28	20.27	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	20.54	20.54	20.55	20.55	20.55	20.56	20.56	20.56	20.56	20.55	20.55	20.55	(92)

Adjusted mean internal temperature:

	20.54	20.54	20.55	20.55	20.55	20.56	20.56	20.56	20.56	20.55	20.55	20.55	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.91	0.77	0.58	0.39	0.28	0.31	0.52	0.82	0.96	0.99	(94)

Useful gains, mGm , W

578.48	628.21	648.19	598.57	474.94	316.9	210.75	220.64	344.42	494.75	540.73	554.85	(95)

Monthly average external temperature from Table U1

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

905.06	868.67	777.18	633.48	479.63	317.15	210.76	220.67	346.1	539.21	733.86	898.26	(97)

Space heating requirement for each month

242.97	161.59	95.97	25.13	3.48	0	0	0	0	33.08	139.05	255.5	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

242.97	161.59	95.97	25.13	3.48	0	0	0	0	33.08	139.05	255.5	(98c)

Space heating requirement in kWh/m²/year 13.53 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												316.5	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
76.77	51.06	30.32	7.94	1.1	0	0	0	0	10.45	43.93	80.72		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
102.85	90.77	95.98	83.29	79.99	71.27	69.74	72.96	74.27	83.78	90.28	101.58	1016.76	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												302.3	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1016.76	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		161.91	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												161.91	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1658.59	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(240a)
Low-rate fraction	0		49.85	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(241a)
Low-rate fraction	0		49.85	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		49.85	(242a)

Low-rate fraction	0		49.85	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		167.66	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		26.7	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		273.5	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.85	(257)
SAP rating		86.21	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			47.82	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			143.55	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		22.46	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		239.46	(272)
Dwelling CO2 Emission Rate		3.39	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			479.3	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1547.58	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			244.94	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2544.26	(286)
Dwelling PE Rate			35.99	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.72 (1a)	x	2.4	(2a) =	148.13	(3a)
Total floor area TFA					61.72	(4)
Dwelling volume					148.13	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
													(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.31		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	5.07	7415.7	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		50.85	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	18.33	(33)
Heat capacity Cm = ∑(A x k)	12614.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	3.73	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	3.73	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	22.06	(37)

Ventilation heat loss calculated monthly

24.66	24.49	24.32	23.47	23.3	22.45	22.45	22.28	22.79	23.3	23.64	23.98	(38)

Heat transfer coefficient, W/K

46.71	46.54	46.38	45.53	45.36	44.51	44.51	44.34	44.85	45.36	45.7	46.04	(39)

Heat loss parameter (HLP), W/m²K

0.76	0.75	0.75	0.74	0.73	0.72	0.72	0.72	0.73	0.73	0.74	0.75	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.03 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

58.25	57.38	56.1	53.66	51.86	49.85	48.71	49.98	51.36	53.52	56.01	58.03	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.17	24.8	24.27	23.3	22.58	21.77	21.33	21.86	22.43	23.29	24.28	25.09	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

35.42	34.13	32.84	31.55	30.27	28.98	28.98	30.27	31.55	32.84	34.13	35.42	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 109.4 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

118.84	116.31	113.22	108.52	104.7	100.6	99.02	102.1	105.34	109.65	114.42	118.54	1311.26 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

188.22	165.62	174.01	148.56	140.95	123.7	119.76	126.42	129.9	148.8	163.02	185.6	1814.54 (45)

Distribution loss (46) = 0.15 x (45)

28.23	24.84	26.1	22.28	21.14	18.55	17.96	18.96	19.48	22.32	24.45	27.84	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

214.33 189.21 200.12 173.83 167.06 148.97 145.87 152.53 155.17 174.91 188.29 211.71 2122.02 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

214.33 189.21 200.12 173.83 167.06 148.97 145.87 152.53 155.17 174.91 188.29 211.71 2122.02 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

62.58 55.07 57.86 49.39 46.87 41.13 39.82 42.03 43.19 49.47 54.2 61.71 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 121.79 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

21.72 19.29 15.69 11.88 8.88 7.5 8.1 10.53 14.13 17.94 20.94 22.33 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

264.57 267.32 260.4 245.67 227.08 209.6 197.93 195.19 202.1 216.83 235.42 252.9 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	49.21	(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	-81.19	(71)

Water heating gains (Table 5)

84.12	81.95	77.77	68.6	62.99	57.12	53.52	56.5	59.99	66.5	75.28	82.95	(72)

Total internal gains

460.22	458.36	443.66	415.96	388.75	364.03	349.36	352.02	366.03	391.08	421.45	447.97	(73)

6. Solar gains

Solar gains in watts, calculated for each month

111.1	189.24	258.93	320.82	359.35	356.75	343.94	315.2	280.36	209.15	133.07	95.08	(83)

Total gains – internal and solar (watts)

571.31	647.6	702.59	736.78	748.1	720.78	693.3	667.22	646.39	600.23	554.52	543.05	(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, ⍰1,m (see Table 9a)

0.97	0.93	0.86	0.72	0.56	0.39	0.28	0.31	0.48	0.75	0.93	0.98	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(88)

Roof Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.96	0.92	0.83	0.69	0.52	0.35	0.24	0.26	0.43	0.71	0.91	0.97	(89)

Roof Mean internal temperature in the rest of dwelling T2

20.29	20.29	20.3	20.31	20.31	20.32	20.32	20.32	20.32	20.31	20.31	20.3	(90)

Living area fraction 0.4 (91)

Mean internal temperature (for the whole dwelling)

20.57	20.58	20.58	20.58	20.59	20.59	20.59	20.59	20.59	20.59	20.58	20.58	(92)

Adjusted mean internal temperature:

20.57	20.58	20.58	20.58	20.59	20.59	20.59	20.59	20.59	20.59	20.58	20.58	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.92	0.84	0.7	0.54	0.37	0.26	0.28	0.45	0.73	0.92	0.97	(94)

Useful gains, mGm , W

550.7	597.58	592.24	517.15	401.01	266.66	177.74	185.99	290.64	437.19	510.06	527.75	(95)

Monthly average external temperature from Table U1

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

760.25	729.63	652.84	531.97	403.05	266.76	177.74	186	291.09	452.95	616.14	754.09	(97)

Space heating requirement for each month

155.91	88.74	45.09	10.67	1.52	0	0	0	0	11.72	76.38	168.39	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

155.91	88.74	45.09	10.67	1.52	0	0	0	0	11.72	76.38	168.39	(98c)

Space heating requirement in kWh/m²/year 9.05 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,							0					0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												295	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,							0					0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month							0					0	
52.85	30.08	15.28	3.62	0.52	0	0	0	0	3.97	25.89	57.08		(211)
Space heating fuel (main heating system 2), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),							0					220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
97.12	85.74	90.68	78.77	75.7	67.5	66.1	69.12	70.31	79.26	85.32	95.93	961.56	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												189.3	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												961.56	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		172.51	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												172.51	(231)
Electricity for lighting												153.44	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1476.81	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(240a)
Low-rate fraction	0		31.22	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(241a)
Low-rate fraction	0		31.22	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		31.22	(242a)

Low-rate fraction	0		31.22	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		158.56	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		28.45	(249)
Energy For lighting	0		25.3	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		243.53	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.82	(257)
SAP rating		86.68	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			30.11	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			135.74	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		23.93	(267)
Electricity for lighting		22.15	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		211.92	(272)
Dwelling CO2 Emission Rate		3.43	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			300.73	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1463.48	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			260.98	(281)
Electricity for lighting			235.36	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2260.54	(286)
Dwelling PE Rate			36.63	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	64.3	(1a) x	2.4	(2a) =	154.32	(3a)
Total floor area TFA					64.3	(4)
Dwelling volume					154.32	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	11.82		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.85	10018.7	(29a)
Roof	7.07	578.7	(30)
Total area of external elements ∑A, m²		129.29	(31)
Party Wall	0	3663	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	27.68	(33)
Heat capacity Cm = ∑(A x k)	14260.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	11.9	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	11.9	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	39.58	(37)

Ventilation heat loss calculated monthly

25.69	25.51	25.33	24.45	24.27	23.39	23.39	23.21	23.74	24.27	24.63	24.98	(38)

Heat transfer coefficient, W/K

65.27	65.09	64.92	64.03	63.86	62.97	62.97	62.8	63.33	63.86	64.21	64.56	(39)

Heat loss parameter (HLP), W/m²K

1.02	1.01	1.01	1	0.99	0.98	0.98	0.98	0.98	0.99	1	1	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.1 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

59.43	58.54	57.24	54.75	52.91	50.86	49.7	50.99	52.4	54.6	57.15	59.21	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

25.68	25.3	24.76	23.77	23.03	22.21	21.76	22.3	22.88	23.76	24.77	25.59	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

36.14	34.82	33.51	32.2	30.88	29.57	29.57	30.88	32.2	33.51	34.82	36.14	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 111.62 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

121.25	118.67	115.51	110.72	106.82	102.64	101.03	104.17	107.48	111.87	116.74	120.94	1337.85 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

192.04	168.98	177.54	151.57	143.81	126.21	122.19	128.98	132.53	151.81	166.32	189.36	1851.33 (45)

Distribution loss (46) = 0.15 x (45)

28.81	25.35	26.63	22.74	21.57	18.93	18.33	19.35	19.88	22.77	24.95	28.4	(46)

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

Water storage loss (or HIU loss)

a) If manufacturer's declared loss factor is known (kWh/day): 1.56 (48)

Temperature factor from Table 2b 0.54 (49)

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

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

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

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

218.15 192.57 203.65 176.84 169.92 151.48 148.3 155.1 157.81 177.93 191.59 215.48 2158.81 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

218.15 192.57 203.65 176.84 169.92 151.48 148.3 155.1 157.81 177.93 191.59 215.48 2158.81 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

63.85 56.19 59.03 50.4 47.82 41.96 40.63 42.89 44.07 50.48 55.3 62.96 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 126.01 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

22.85 20.29 16.5 12.49 9.34 7.88 8.52 11.07 14.86 18.87 22.03 23.48 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

274.1 276.94 269.78 254.52 235.26 217.15 205.06 202.21 209.38 224.64 243.9 262.01 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7	49.7		(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0		(70)

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

-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01		(71)

Water heating gains (Table 5)

85.82	83.61	79.34	69.99	64.27	58.28	54.61	57.64	61.2	67.85	76.81	84.63		(72)

Total internal gains

474.48	472.55	457.33	428.71	400.57	375.03	359.89	362.64	377.16	403.07	434.44	461.82		(73)

6. Solar gains

Solar gains in watts, calculated for each month

116.05	197.67	270.46	335.11	375.35	372.64	359.26	329.24	292.85	218.46	139	99.31		(83)

Total gains – internal and solar (watts)

590.52	670.22	727.79	763.82	775.92	747.66	719.15	691.88	670	621.53	573.44	561.13		(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, 1,m (see Table 9a)

0.98	0.97	0.93	0.86	0.72	0.53	0.38	0.42	0.63	0.88	0.97	0.99		(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21		(87)

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

20.07	20.07	20.08	20.09	20.09	20.1	20.1	20.1	20.1	20.09	20.08	20.08		(88)

Roof Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.98	0.96	0.92	0.82	0.66	0.46	0.31	0.34	0.56	0.84	0.96	0.98		(89)

Roof Mean internal temperature in the rest of dwelling T2

20.07	20.07	20.08	20.09	20.09	20.1	20.1	20.1	20.1	20.09	20.08	20.08		(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

20.38	20.38	20.38	20.39	20.39	20.4	20.4	20.4	20.4	20.39	20.39	20.39		(92)

Adjusted mean internal temperature:

20.38	20.38	20.38	20.39	20.39	20.4	20.4	20.4	20.4	20.39	20.39	20.39		(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.96	0.92	0.83	0.68	0.48	0.33	0.36	0.58	0.85	0.96	0.99	(94)

Useful gains, mGm , W

579.72	645.4	671.59	636.46	528.48	362.12	238.99	250.79	390.1	529.82	551.88	553.07	(95)

Monthly average external temperature from Table U1

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

1049.52	1007.73	901.23	735.77	555.05	365.23	239.28	251.27	398.75	625.29	853.28	1045.01	(97)

Space heating requirement for each month

349.53	243.49	170.85	71.51	19.76	0	0	0	0	71.03	217.01	366.01	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

349.53	243.49	170.85	71.51	19.76	0	0	0	0	71.03	217.01	366.01	(98c)

Space heating requirement in kWh/m²/year 23.47 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,							0					0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												322.95	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,							0					0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month							0					0	
108.23	75.39	52.9	22.14	6.12	0	0	0	0	21.99	67.2	113.33		(211)
Space heating fuel (main heating system 2), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),							0					220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
98.85	87.26	92.28	80.13	77	68.64	67.2	70.28	71.51	80.62	86.82	97.64	978.23	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												467.31	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												978.23	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside							0		0			168.34	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												168.34	(231)
Electricity for lighting												161.39	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1775.27	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		77.06	(240a)
Low-rate fraction	0		77.06	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		77.06	(241a)
Low-rate fraction	0		77.06	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		77.06	(242a)

Low-rate fraction	0		77.06	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		161.31	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		27.76	(249)
Energy For lighting	0		26.61	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		292.74	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.96	(257)
SAP rating		84.37	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			73.38	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			138.1	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		23.35	(267)
Electricity for lighting		23.29	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		258.12	(272)
Dwelling CO2 Emission Rate		4.01	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			738.97	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1488.87	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			254.66	(281)
Electricity for lighting			247.54	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2730.05	(286)
Dwelling PE Rate			42.46	(287)

SAP WORKSHEET

Dwelling Reference: Flat 10
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7	(1a) x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	7.78	636.3	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	30.99	(33)
Heat capacity Cm = ∑(A x k)	13900.1	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	5.18	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	5.18	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	36.17	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

64.41	64.22	64.03	63.05	62.86	61.89	61.89	61.69	62.28	62.86	63.25	63.64	(39)

Heat loss parameter (HLP), W/m²K

0.91	0.91	0.91	0.89	0.89	0.88	0.88	0.87	0.88	0.89	0.89	0.9	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36	(45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

66.78 58.77 61.74 52.71 50.01 43.89 42.49 44.86 46.09 52.8 57.84 65.85 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84		(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0		(70)

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

-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52		(71)

Water heating gains (Table 5)

89.76	87.45	82.99	73.21	67.22	60.96	57.11	60.29	64.02	70.96	80.34	88.51		(72)

Total internal gains

507.91	505.87	489.47	458.75	428.43	400.96	384.71	387.62	403.28	431.16	464.87	494.26		(73)

6. Solar gains

Solar gains in watts, calculated for each month

81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96		(83)

Total gains – internal and solar (watts)

589.67	653.68	714.45	775.6	818.09	803.1	766.05	712.3	659.7	600.66	564.36	563.22		(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ⍰1,m (see Table 9a)

0.99	0.98	0.94	0.85	0.69	0.49	0.36	0.4	0.64	0.89	0.98	0.99		(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21		(87)

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

20.16	20.16	20.16	20.17	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.17		(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.97	0.93	0.82	0.63	0.43	0.29	0.33	0.57	0.86	0.97	0.99		(89)

Roof

Mean internal temperature in the rest of dwelling T2

20.16	20.16	20.16	20.17	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.17		(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

20.48	20.48	20.48	20.49	20.49	20.5	20.5	20.5	20.49	20.49	20.49	20.48		(92)

Adjusted mean internal temperature:

20.48	20.48	20.48	20.49	20.49	20.5	20.5	20.5	20.49	20.49	20.49	20.48		(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.97	0.94	0.83	0.65	0.45	0.31	0.35	0.59	0.88	0.97	0.99	(94)

Useful gains, mGm , W

581.5	635.9	668.93	646.81	535.79	363.5	241	252.55	391.26	525.91	548.09	557.07	(95)

Monthly average external temperature from Table U1

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

1042.03	1000.45	895.07	730.62	552.46	364.9	241.12	252.79	398.14	621.6	846.63	1036.19	(97)

Space heating requirement for each month

342.63	244.98	168.25	60.35	12.4	0	0	0	0	71.19	214.95	356.47	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

342.63	244.98	168.25	60.35	12.4	0	0	0	0	71.19	214.95	356.47	(98c)

Space heating requirement in kWh/m²/year 20.81 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												322.37	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
106.28	75.99	52.19	18.72	3.85	0	0	0	0	22.08	66.68	110.58		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
102.85	90.77	95.98	83.29	79.99	71.27	69.74	72.96	74.27	83.78	90.28	101.58	1016.76	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												456.37	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1016.76	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		167.79	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												167.79	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1818.54	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		75.26	(240a)
Low-rate fraction	0		75.26	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		75.26	(241a)
Low-rate fraction	0		75.26	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		75.26	(242a)

Low-rate fraction	0		75.26	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		167.66	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		27.67	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		299.88	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.93	(257)
SAP rating		84.87	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			71.75	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			143.55	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		23.27	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		264.21	(272)
Dwelling CO2 Emission Rate		3.74	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			721.98	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1547.58	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			253.83	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2795.83	(286)
Dwelling PE Rate			39.54	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	52	(1a) x	2.4	(2a) =	124.8	(3a)
Total floor area TFA					52	(4)
Dwelling volume					124.8	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.13	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	1.67	(22b)

Calculate effective air change rate for the applicable case:

0.5		(23a)
0.5		(23b)
34.5		(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0		(24d)

Effective air change rate

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

Effective air change rate from PCDB:

0.49	0.49	0.48	0.47	0.46	0.45	0.45	0.45	0.46	0.46	0.47	0.48		(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	0	0	(28b)
Basement wall	0	0	(29)
External wall	6.58	9617.8	(29a)
Roof	5.72	468	(30)
Total area of external elements ∑A, m²		111.44	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	22.12	(33)
Heat capacity Cm = ∑(A x k)	13097.2	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	9.93	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	9.93	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	32.05	(37)

Ventilation heat loss calculated monthly

20.18	20.05	19.92	19.26	19.13	18.48	18.48	18.34	18.74	19.13	19.4	19.66	(38)

Heat transfer coefficient, W/K

52.23	52.1	51.97	51.31	51.18	50.52	50.52	50.39	50.78	51.18	51.44	51.7	(39)

Heat loss parameter (HLP), W/m²K

1	1	1	0.99	0.98	0.97	0.97	0.97	0.98	0.98	0.99	0.99	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.75 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

53.55	52.74	51.57	49.32	47.67	45.82	44.77	45.94	47.21	49.2	51.49	53.34	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

23.15	22.81	22.32	21.43	20.76	20.02	19.62	20.1	20.62	21.42	22.33	23.07	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.54	31.36	30.18	28.99	27.81	26.63	26.63	27.81	28.99	30.18	31.36	32.54	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 100.56 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

109.24	106.91	104.07	99.75	96.24	92.47	91.02	93.85	96.83	100.79	105.17	108.95	1205.27 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

173.01	152.23	159.94	136.55	129.56	113.7	110.08	116.2	119.4	136.77	149.84	170.6	1667.86 (45)

Distribution loss (46) = 0.15 x (45)

25.95	22.83	23.99	20.48	19.43	17.05	16.51	17.43	17.91	20.52	22.48	25.59	(46)

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

Water storage loss (or HIU loss)

a) If manufacturer's declared loss factor is known (kWh/day): 1.56 (48)

Temperature factor from Table 2b 0.54 (49)

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

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

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

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

199.12 175.82 186.06 161.82 155.67 138.97 136.19 142.31 144.67 162.88 175.11 196.71 1975.34 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

199.12 175.82 186.06 161.82 155.67 138.97 136.19 142.31 144.67 162.88 175.11 196.71 1975.34 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

57.52 50.62 53.18 45.4 43.08 37.81 36.6 38.64 39.7 45.48 49.82 56.72 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 104.94 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

18.45 16.38 13.32 10.09 7.54 6.37 6.88 8.94 12 15.24 17.78 18.96 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

227.5 229.86 223.91 211.25 195.26 180.24 170.2 167.84 173.79 186.45 202.44 217.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	47.24	(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	-69.96	(71)

Water heating gains (Table 5)

77.32	75.32	71.48	63.06	57.9	52.51	49.19	51.93	55.14	61.12	69.2	76.24	(72)

Total internal gains

405.49	403.79	390.94	366.62	342.93	321.33	308.5	310.93	323.15	345.04	371.64	394.89	(73)

6. Solar gains

Solar gains in watts, calculated for each month

77.36	131.78	180.3	223.41	250.23	248.42	239.51	219.49	195.23	145.64	92.66	66.21	(83)

Total gains – internal and solar (watts)

482.85	535.57	571.25	590.03	593.16	569.76	548	530.43	518.38	490.68	464.31	461.09	(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, ⍰1,m (see Table 9a)

0.98	0.97	0.94	0.87	0.74	0.56	0.4	0.43	0.65	0.88	0.97	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

20.08	20.08	20.08	20.09	20.1	20.11	20.11	20.11	20.1	20.1	20.09	20.09	(88)

Roof

Utilisation factor for gains for rest of dwelling, ⍰2,m (see Table 9a)

0.98	0.96	0.92	0.84	0.69	0.48	0.32	0.35	0.58	0.85	0.96	0.98	(89)

Roof

Mean internal temperature in the rest of dwelling T2

20.08	20.08	20.08	20.09	20.1	20.11	20.11	20.11	20.1	20.1	20.09	20.09	(90)

Living area fraction 0.46 (91)

Mean internal temperature (for the whole dwelling)

20.51	20.51	20.51	20.51	20.51	20.52	20.52	20.52	20.52	20.51	20.51	20.51	(92)

Adjusted mean internal temperature:

20.51	20.51	20.51	20.51	20.51	20.52	20.52	20.52	20.52	20.51	20.51	20.51	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.93	0.85	0.72	0.52	0.36	0.39	0.61	0.86	0.96	0.98	(94)

Useful gains, mGm , W

473.73	516.91	531.99	504.32	424.16	295.61	197.72	207.13	317.13	424.31	447.08	454.1	(95)

Monthly average external temperature from Table U1

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

846.41	813.09	727.95	595.9	451.13	299.12	198.08	207.7	325.95	507.43	689.96	843.31	(97)

Space heating requirement for each month

277.28	199.03	145.79	65.94	20.07	0	0	0	0	61.85	174.88	289.57	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

277.28	199.03	145.79	65.94	20.07	0	0	0	0	61.85	174.88	289.57	(98c)

Space heating requirement in kWh/m²/year 23.74 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0					0	(201)
Fraction of space heat from main system(s),													1	(202)
Fraction of main heating from main system 2,													0	(203)
Fraction of total space heat from main system 1,													1	(204)
Fraction of total space heat from main system 2,													0	(205)
Efficiency of main space heating system 1 (in %),													300.38	(206)
Efficiency of main space heating system 2 (in %),													0	(207)
Efficiency of secondary/supplementary heating system, %,													0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0					0	(209)
Space heating requirement (calculated above),														
0	0	0	0	0	0	0	0		0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0					0	
92.31	66.26	48.54	21.95	6.68	0	0	0		0	20.59	58.22	96.4		(211)
Space heating fuel (main heating system 2), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0					0	
0	0	0	0	0	0	0	0		0	0	0	0		(215)
Output from water heater),								0					220.69	(216)
Efficiency of water heater														
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		220.69	220.69	220.69	220.69		(217)
Fuel for water heating														
90.23	79.67	84.31	73.33	70.54	62.97	61.71	64.49		65.56	73.81	79.35	89.14	895.09	(219)
Space Cooling														
0	0	0	0	0	0	0	0		0	0	0	0		(221)
Annual totals								kWh/year		kWh/year				
Space heating fuel used, main system 1													410.94	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													895.09	(219)
Electricity for instantaneous electric shower(s)													0	(64a)
Space cooling fuel used													0	(221)
Electricity for pumps, fans and electric keep-hot														
Mechanical vent fans - balanced, extract or positive input from outside								0		0			175.94	(230a)
warm air heating system fans													0	(230b)
Heating circulation pump or water pump within warm air heating unit													0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)													0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)													0	(230e)
Maintaining electric keep-hot facility for gas combi boiler													0	(230f)
Pump for solar water heating													0	(230g)
Pump for storage WWHRS													0	(230h)
Total electricity for the above													175.94	(231)
Electricity for lighting													130.3	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1612.29	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		67.76	(240a)
Low-rate fraction	0		67.76	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		67.76	(241a)
Low-rate fraction	0		67.76	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		67.76	(242a)

Low-rate fraction	0		67.76	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		147.6	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		29.01	(249)
Energy For lighting	0		21.49	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		265.87	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		0.99	(257)
SAP rating		84.01	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			64.4	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			126.33	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		24.41	(267)
Electricity for lighting		18.81	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		233.94	(272)
Dwelling CO2 Emission Rate		4.5	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			649.35	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1362.21	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			266.17	(281)
Electricity for lighting			199.87	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2477.6	(286)
Dwelling PE Rate			47.65	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	70.7 (1a)	x	2.4	(2a) =	169.68	(3a)
Total floor area TFA					70.7	(4)
Dwelling volume					169.68	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	1	1	(19)
Shelter factor		0.92	(20)
Infiltration rate incorporating shelter factor		0.14	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.18	0.17	0.17	0.15	0.15	0.13	0.13	0.13	0.14	0.15	0.16	0.16	1.82	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

Effective air change rate from PCDB:

0.5	0.5	0.5	0.48	0.48	0.46	0.46	0.46	0.47	0.48	0.48	0.49	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	14.26		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.78	5302.5	(28b)
Basement wall	0	0	(29)
External wall	7.01	10252.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		139.05	(31)
Party Wall	0	3011.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	30.99	(33)
Heat capacity Cm = ∑(A x k)	18566.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	15.36	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	15.36	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	46.35	(37)

Ventilation heat loss calculated monthly

28.24	28.05	27.86	26.88	26.69	25.72	25.72	25.52	26.11	26.69	27.08	27.47	(38)

Heat transfer coefficient, W/K

74.59	74.4	74.2	73.23	73.04	72.06	72.06	71.87	72.45	73.04	73.42	73.81	(39)

Heat loss parameter (HLP), W/m²K

1.06	1.05	1.05	1.04	1.03	1.02	1.02	1.02	1.02	1.03	1.04	1.04	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 2.26 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

62.16	61.23	59.87	57.26	55.34	53.2	51.98	53.33	54.81	57.11	59.77	61.92	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

26.86	26.46	25.89	24.86	24.08	23.22	22.76	23.32	23.92	24.84	25.9	26.76	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

37.81	36.43	35.06	33.68	32.31	30.93	30.93	32.31	33.68	35.06	36.43	37.81	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 116.74 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

126.82	124.12	120.82	115.8	111.73	107.35	105.67	108.95	112.42	117.01	122.1	126.49	1399.29	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

200.86	176.74	185.69	158.53	150.41	132	127.8	134.91	138.62	158.78	173.96	198.06	1936.36	(45)

Distribution loss (46) = 0.15 x (45)

30.13	26.51	27.85	23.78	22.56	19.8	19.17	20.24	20.79	23.82	26.09	29.71	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

226.97 200.33 211.81 183.8 176.53 157.27 153.91 161.02 163.89 184.9 199.23 224.17 2243.84 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

66.78 58.77 61.74 52.71 50.01 43.89 42.49 44.86 46.09 52.8 57.84 65.85 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 135.78 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

25.14 22.33 18.16 13.75 10.28 8.68 9.38 12.19 16.36 20.77 24.24 25.84 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

296.9 299.98 292.22 275.69 254.83 235.22 222.12 219.04 226.8 243.33 264.19 283.8 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	(69)

Pumps and fans gains (Table 5a)

	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	-90.52	(71)

Water heating gains (Table 5)

	89.76	87.45	82.99	73.21	67.22	60.96	57.11	60.29	64.02	70.96	80.34	88.51	(72)

Total internal gains

	507.91	505.87	489.47	458.75	428.43	400.96	384.71	387.62	403.28	431.16	464.87	494.26	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	81.76	147.82	224.98	316.85	389.67	402.14	381.34	324.68	256.42	169.5	99.48	68.96	(83)

Total gains – internal and solar (watts)

	589.67	653.68	714.45	775.6	818.09	803.1	766.05	712.3	659.7	600.66	564.36	563.22	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, 1,m (see Table 9a)

	0.99	0.98	0.96	0.9	0.76	0.56	0.41	0.46	0.71	0.93	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

	21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

	20.04	20.04	20.04	20.05	20.06	20.07	20.07	20.07	20.06	20.06	20.05	20.05	(88)

Roof Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

	0.99	0.98	0.95	0.87	0.7	0.49	0.33	0.37	0.63	0.9	0.98	0.99	(89)

Roof Mean internal temperature in the rest of dwelling T2

	20.04	20.04	20.04	20.05	20.06	20.07	20.07	20.07	20.06	20.06	20.05	20.05	(90)

Living area fraction 0.38 (91)

Mean internal temperature (for the whole dwelling)

	20.4	20.4	20.41	20.41	20.41	20.42	20.42	20.42	20.42	20.41	20.41	20.41	(92)

Adjusted mean internal temperature:

	20.4	20.4	20.41	20.41	20.41	20.42	20.42	20.42	20.42	20.41	20.41	20.41	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.95	0.88	0.72	0.52	0.36	0.4	0.66	0.91	0.98	0.99	(94)

Useful gains, mGm , W

583.1	640.13	681.23	681.28	592.01	413.91	274.73	287.92	437.2	546.5	552.1	558.21	(95)

Monthly average external temperature from Table U1

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

1201.07	1153.41	1031.78	843.04	636.41	419.47	275.34	289.07	457.75	716.75	977.34	1196.36	(97)

Space heating requirement for each month

459.77	344.92	260.81	116.47	33.03	0	0	0	0	126.67	306.17	474.78	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

459.77	344.92	260.81	116.47	33.03	0	0	0	0	126.67	306.17	474.78	(98c)

Space heating requirement in kWh/m²/year 30.02 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,							0					0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												327.7	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,							0					0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month							0					0	
140.3	105.26	79.59	35.54	10.08	0	0	0	0	38.65	93.43	144.88		(211)
Space heating fuel (main heating system 2), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month							0					0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),							0					220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
102.85	90.77	95.98	83.29	79.99	71.27	69.74	72.96	74.27	83.78	90.28	101.58	1016.76	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												647.74	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1016.76	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside							0		0			157.08	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												157.08	(231)
Electricity for lighting												177.62	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1999.21	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		106.81	(240a)
Low-rate fraction	0		106.81	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		106.81	(241a)
Low-rate fraction	0		106.81	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		106.81	(242a)

Low-rate fraction	0		106.81	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		167.66	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		25.9	(249)
Energy For lighting	0		29.29	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		329.67	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.03	(257)
SAP rating		83.37	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			101.28	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			143.55	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		21.79	(267)
Electricity for lighting		25.64	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		292.26	(272)
Dwelling CO2 Emission Rate		4.13	(273)
EI rating		97	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			1022.7	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1547.58	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			237.64	(281)
Electricity for lighting			272.44	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			3080.35	(286)
Dwelling PE Rate			43.57	(287)

SAP WORKSHEET

Dwelling Reference: Flat 01
Dwelling Type: New Dwelling Design Stage
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	50.65 (1a)	x	2.4	(2a) =	121.56	(3a)
Total floor area TFA					50.65	(4)
Dwelling volume					121.56	(5)

2. Ventilation Rate

Chimneys/Flues	0	x	80 =	0	(6a)
Open chimneys	0	x	20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x	10 =	0	(6c)
Flues attached to solid fuel boiler	0	x	20 =	0	(6d)
Flues attached to other heater	0	x	35 =	0	(6e)
Number of blocked chimneys	0	x	20 =	0	(6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0	(9)
Additional infiltration	0	0	(10)
Structural infiltration	0	0	(11)
Suspended wooden ground floor	0	0	(12)
No draught lobby	0	0	(13)
Percentage of windows and doors draught proofed	0	0	(14)
Window infiltration	0	0	(15)
Infiltration rate	0	0	(16)
Air permeability value, AP50, ($m^3/h/m^2$)	3	3	(17)
Air permeability value, AP4, ($m^3/h/m^2$)	0	0	(17a)
Air permeability value)	0.15	0.15	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.12	(21)
Infiltration rate modified for monthly wind speed			

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5	(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13	(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	1.53	(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
0.5	(23b)
34.5	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(24a)

b) If balanced mechanical ventilation without heat recovery (MV)

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

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

Effective air change rate from PCDB:

0.48	0.47	0.47	0.46	0.45	0.44	0.44	0.44	0.44	0.45	0.46	0.46	(25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k -value

ELEMENT	A X U (W/K)	A X k kJ/K	
Doors	1.94		(26)
Windows	7.88		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.57	3798.75	(28b)
Basement wall	0	0	(29)
External wall	4.57	6676.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		94.61	(31)
Party Wall	0	5198.4	(32)
Party floor		0	(32a)
Party ceiling		0	(32b)

Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = ∑ (A x U)	19.96	(33)
Heat capacity Cm = ∑(A x k)	15673.75	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	13.87	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	13.87	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	33.83	(37)

Ventilation heat loss calculated monthly

19.08	18.97	18.85	18.27	18.15	17.57	17.57	17.45	17.8	18.15	18.38	18.62	(38)

Heat transfer coefficient, W/K

52.91	52.79	52.68	52.1	51.98	51.4	51.4	51.28	51.63	51.98	52.21	52.44	(39)

Heat loss parameter (HLP), W/m²K

1.04	1.04	1.04	1.03	1.03	1.01	1.01	1.01	1.02	1.03	1.03	1.04	(40)

Number of days in month (Table 1a)

31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement

Assumed occupancy, N 1.71 (42)

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

52.88	52.08	50.93	48.71	47.07	45.25	44.22	45.36	46.62	48.58	50.84	52.68	(42a)

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

22.86	22.52	22.04	21.16	20.5	19.77	19.38	19.85	20.37	21.15	22.05	22.79	(42b)

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

32.13	30.97	29.8	28.63	27.46	26.29	26.29	27.46	28.63	29.8	30.97	32.13	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 99.3 (43)

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

107.87	105.57	102.77	98.5	95.04	91.31	89.88	92.68	95.62	99.53	103.86	107.6	1190.23 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

170.85	150.33	157.95	134.84	127.94	112.28	108.71	114.75	117.91	135.06	147.97	168.47	1647.06 (45)

Distribution loss (46) = 0.15 x (45)

25.63	22.55	23.69	20.23	19.19	16.84	16.31	17.21	17.69	20.26	22.2	25.27	(46)

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

Water storage loss (or HIU loss)

a) If manufacturer's declared loss factor is known (kWh/day): 1.56 (48)

Temperature factor from Table 2b 0.54 (49)

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

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

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

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/day 0 (54)

Enter (50) or (54) in (55) 0.84 (55)

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

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (56)

If the vessel contains dedicated solar storage or dedicated WWHRS storage,

(57)m = (56)m [(47) – Vs] ÷ (47), else (57)m = (56)m

where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).

26.11 23.59 26.11 25.27 26.11 25.27 26.11 26.11 25.27 26.11 25.27 26.11 (57)

Primary circuit loss for each month from Table 3

modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)

0 0 0 0 0 0 0 0 0 0 0 0 (59)

Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)

0 0 0 0 0 0 0 0 0 0 0 0 (61)

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

196.96 173.92 184.06 160.12 154.05 137.55 134.82 140.87 143.18 161.18 173.24 194.58 1954.54 (62)

CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63a)

PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)

0 0 0 0 0 0 0 0 0 0 0 0 (63b)

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

0 0 0 0 0 0 0 0 0 0 0 0 (63c)

FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)

0 0 0 0 0 0 0 0 0 0 0 0 (63d)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

196.96 173.92 184.06 160.12 154.05 137.55 134.82 140.87 143.18 161.18 173.24 194.58 1954.54 (64)

Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)

0 0 0 0 0 0 0 0 0 0 0 0 (64a)

Heat gains from water heating, kWh/month 0.25 x [0.85 × (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]

56.81 49.99 52.52 44.84 42.54 37.33 36.14 38.15 39.2 44.91 49.2 56.02 (65)

include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts

102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 102.56 (66)

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5

17.92 15.91 12.94 9.8 7.32 6.18 6.68 8.68 11.66 14.8 17.27 18.42 (67)

Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5

222.27 224.58 218.77 206.39 190.77 176.09 166.29 163.98 169.79 182.16 197.78 212.46 (68)

Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5

46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	46.96	(69)

Pumps and fans gains (Table 5a)

0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	-68.37	(71)

Water heating gains (Table 5)

76.35	74.38	70.59	62.27	57.18	51.85	48.58	51.28	54.45	60.36	68.33	75.29	(72)

Total internal gains

397.69	396.03	383.45	359.61	336.42	315.28	302.7	305.1	317.05	338.48	364.54	387.32	(73)

6. Solar gains

Solar gains in watts, calculated for each month

23.72	48.29	87	142.89	192.07	204.76	191.55	152.71	106.02	59.01	29.85	19.37	(83)

Total gains – internal and solar (watts)

421.42	444.32	470.45	502.5	528.49	520.04	494.25	457.8	423.06	397.49	394.39	406.69	(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, 1,m (see Table 9a)

0.99	0.99	0.97	0.92	0.81	0.61	0.45	0.51	0.77	0.94	0.98	0.99	(86)

Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)

21	21	21	21	21	21	21	21	21	21	21	21	(87)

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

20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.05	(88)

Roof

Utilisation factor for gains for rest of dwelling, 2,m (see Table 9a)

0.99	0.98	0.96	0.9	0.75	0.53	0.36	0.41	0.69	0.92	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

20.05	20.05	20.05	20.06	20.06	20.07	20.07	20.07	20.07	20.06	20.06	20.05	(90)

Living area fraction 0.49 (91)

Mean internal temperature (for the whole dwelling)

20.51	20.51	20.51	20.52	20.52	20.52	20.52	20.52	20.52	20.52	20.52	20.52	(92)

Adjusted mean internal temperature:

20.51	20.51	20.51	20.52	20.52	20.52	20.52	20.52	20.52	20.52	20.52	20.52	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.97	0.91	0.78	0.57	0.41	0.46	0.73	0.93	0.98	0.99	(94)

Useful gains, mGm , W

416.85	437.09	454.97	458.81	412.45	297.84	200.85	209.97	308.25	370.89	386.86	403.02	(95)

Monthly average external temperature from Table U1

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

857.75	824.24	738.19	605.24	458.4	304.46	201.67	211.52	331.56	515.58	700.53	855.64	(97)

Space heating requirement for each month

328.03	260.17	210.72	105.43	34.18	0	0	0	0	107.65	225.84	336.75	(98a)

Solar space heating calculated using Appendix H (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	(98b)

Space heating requirement for each month after solar contribution

328.03	260.17	210.72	105.43	34.18	0	0	0	0	107.65	225.84	336.75	(98c)

Space heating requirement in kWh/m²/year 31.76 (99)

8c. Space Cooling requirement

Heat loss rate,

0	0	0	0	0	0	0	0	0	0	0	0	(100)

Utilisation factor for loss

0	0	0	0	0	0	0	0	0	0	0	0	(101)

Useful loss, mLm (watts)

0	0	0	0	0	0	0	0	0	0	0	0	(102)

Gains

0	0	0	0	0	0	0	0	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) (104)

0	0	0	0	0	0	0	0	0	0	0	0	(104)

Cooled fraction 0 (105)

Intermittency factor

0	0	0	0	0	0	0	0	0	0	0	0	(106)

Space cooling requirement for month 0 0

0	0	0	0	0	0	0	0	0	0	0	0	(107)

Space cooling requirement in kWh/m²/year 0 (108)

8f. Space heating requirement

Fabric Energy Efficiency, 0 0 (109)

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

Fraction of space heat from secondary/supplementary system,								0				0	(201)
Fraction of space heat from main system(s),												1	(202)
Fraction of main heating from main system 2,												0	(203)
Fraction of total space heat from main system 1,												1	(204)
Fraction of total space heat from main system 2,												0	(205)
Efficiency of main space heating system 1 (in %),												301.04	(206)
Efficiency of main space heating system 2 (in %),												0	(207)
Efficiency of secondary/supplementary heating system, %,												0	(208)
Cooling System Seasonal Energy Efficiency Ratio,								0				0	(209)
Space heating requirement (calculated above),													
0	0	0	0	0	0	0	0	0	0	0	0		(210)
Space heating fuel (main heating system 1), kWh/month								0				0	
108.97	86.42	70	35.02	11.36	0	0	0	0	35.76	75.02	111.86		(211)
Space heating fuel (main heating system 2), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(213)
Space heating fuel (secondary), kWh/month								0				0	
0	0	0	0	0	0	0	0	0	0	0	0		(215)
Output from water heater),								0				220.69	(216)
Efficiency of water heater													
220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69		(217)
Fuel for water heating													
89.25	78.81	83.41	72.55	69.81	62.33	61.09	63.83	64.88	73.03	78.5	88.17	885.67	(219)
Space Cooling													
0	0	0	0	0	0	0	0	0	0	0	0		(221)
Annual totals								kWh/year		kWh/year			
Space heating fuel used, main system 1												534.41	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												885.67	(219)
Electricity for instantaneous electric shower(s)												0	(64a)
Space cooling fuel used												0	(221)
Electricity for pumps, fans and electric keep-hot													
Mechanical vent fans - balanced, extract or positive input from outside								0		0		176.35	(230a)
warm air heating system fans												0	(230b)
Heating circulation pump or water pump within warm air heating unit												0	(230c)
Oil boiler auxiliary (oil pump, flue fan, etc; excludes circulation pump)												0	(230d)
Gas boiler auxiliary (flue fan, etc; excludes circulation pump)												0	(230e)
Maintaining electric keep-hot facility for gas combi boiler												0	(230f)
Pump for solar water heating												0	(230g)
Pump for storage WWHRS												0	(230h)
Total electricity for the above												176.35	(231)
Electricity for lighting												126.57	(232)

Energy saving/generation technologies (Appendices M, N) - Energy used in dwelling

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234a)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235a)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235c)

Energy saving/generation technologies (Appendices M, N) - Energy exported

Electricity generated by PVs (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

0	0	0	0	0	0	0	0	0	0	0	0	0	(234b)

Electricity generated by hydro-electric generators

0	0	0	0	0	0	0	0	0	0	0	0	0	(235b)

Electricity used or net electricity generated by micro-CHP

0	0	0	0	0	0	0	0	0	0	0	0	0	(235d)

Appendix Q items: annual energy

Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved			0	(236a)
energy used			0	(237a)
Total delivered energy for all uses			1723	

10a. Fuel costs – Individual heating systems including micro-CHP

Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating - main system 1 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.12	(240a)
Low-rate fraction	0		88.12	(240b)
High-rate cost	0		0	(240c)
Low-rate cost	0		0	(240d)
Space heating - main system 1 cost (other fuel)	0		0	(240e)
Space heating - main system 2 (electric off-peak tariff				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.12	(241a)
Low-rate fraction	0		88.12	(241b)
High-rate cost	0		0	(241c)
Low-rate cost	0		0	(241d)
Space heating - main system 2 cost (other fuel)	0		0	(241e)
Space heating - secondary (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		88.12	(242a)

Low-rate fraction	0		88.12	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Space heating - secondary cost (other fuel)	0		0	(242e)
Water heating (electric off-peak tariff)				
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		0	(243)
Low-rate fraction	0		0	(242b)
High-rate cost	0		0	(242c)
Low-rate cost	0		0	(242d)
Water heating cost (other fuel)	0		146.05	(247)
(for a DHW-only heat network use (342a) or (342b) instead of (247)				
Energy For instantaneous electric shower(s)	0		0	(247a)
Space cooling	0		0	(248)
Pumps, fans And electric keep-hot	0		29.08	(249)
Energy For lighting	0		20.87	(250)
Additional standing charges	0		0	(251)
Energy saving/generation technologies	0		0	(252)
Appendix Q, <item 1 description>	Fuel	kWh/year		
energy saved Or generated	0		0	(253)
energy used	0		0	(254)
Total energy cost	0		284.12	(255)
11a. SAP rating – Individual heating systems including micro-CHP				
Energy cost deflator	0		0	(256)
Energy cost factor (ECF)	0		0	(257)
SAP rating	0		0	(258)

11a. SAP rating – Individual heating systems including micro-CHP

Energy cost deflator		0.36	(256)
Energy cost factor (ECF)		1.07	(257)
SAP rating		82.67	(258)

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

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			83.23	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			124.99	(264)
Energy for instantaneous electric shower(s)			0	(264a)

Space and water heating		0	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		24.46	(267)
Electricity for lighting		18.27	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO2, kg/year		250.95	(272)
Dwelling CO2 Emission Rate		4.95	(273)
EI rating		96	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissionsr kg CO2/year	
Space heating - main system 1			842.55	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1347.85	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			0	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			266.79	(281)
Electricity for lighting			194.14	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			2651.34	(286)
Dwelling PE Rate			52.35	(287)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Market Place - Commercial space (Be Lean)

As designed

Date: Tue Apr 11 14:36:11 2023

Administrative information

Building Details

Address: 13-16 MARKET PLACE, READING, RG21 2EG

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Certifier details

Name:

Telephone number:

Address: , ,

Foundation area [m^2]: 272.01

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	2.36	
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	1.99	
Target primary energy rate (TPER), kWh_{PE}/m^2.annum	25.87	
Building primary energy rate (BPER), kWh_{PE}/m^2.annum	21.91	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	First surface with maximum value
Walls*	0.26	0.18	0.18	BS000006:Surf[1]
Floors	0.18	0.15	0.15	BS000000:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.15	0.15	BS000000:Surf[1]
Windows** and roof windows	1.6	1.4	1.4	GR00000D:Surf[0]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check. *** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m^2K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	5

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- HVAC 1 - ASHP (heating only) + MVHR

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	2.5	-	0	-	0.85
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

2- HVAC 1 - ASHP (heating and cooling) + MVHR

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	2.5	5	0	-	0.85
Standard value	2.5*	5	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

1- DHW

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	2.8	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Zone-level mechanical ventilation, exhaust, and terminal units

ID	**System type in the Approved Documents**
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	**Zone**	**Standard**
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - WC	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - WC	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Core	-	-	-	1.1	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
Ground Floor - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Retail	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Retail	-	-	-	1.1	-	-	-	-	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
Basement - Store	120	-	-
Basement - Circulation	120	-	-
Basement - Circulation	120	-	-
Basement - Retail	120	-	-
Basement - Store	120	-	-
Basement - WC	120	-	-
Basement - WC	120	-	-
Basement - Circulation	120	-	-
Ground Floor - Core	120	-	-
Ground Floor - Circulation	120	-	-
Ground Floor - Retail	120	85	1.412
Ground Floor - Retail	120	85	1.412

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Ground Floor - Retail	NO (-85.6%)	NO
Ground Floor - Retail	NO (-5.7%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	808.1	808.1
External area [m^2]	760.9	760.9
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	3
Average conductance [W/K]	152.92	147.88
Average U-value [W/m^2K]	0.2	0.19
Alpha value* [%]	25.03	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**Retail/Financial and Professional Services**
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	0.73	0.98
Cooling	2.27	1.94
Auxiliary	3.07	2.21
Lighting	8.56	12.19
Hot water	0.29	0.26
Equipment*	11.24	11.24
TOTAL**	**14.92**	**17.58**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	35.04	42.11
Primary energy [kWh_{PE}/m^2]	21.91	25.87
Total emissions [kg/m^2]	1.99	2.36

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	7.8	63.5	0.9	5	3.1	2.33	3.55	2.5	5
	Notional	5.2	70.7	0.5	4.2	2.4	2.78	4.63	----	----
[ST] Central heating using water: radiators, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	11.4	0	1.4	0	7.7	2.23	0	2.5	0
	Notional	34.4	0	3.4	0	5.2	2.78	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Market Place - Commercial space (Be Green)

As designed

Date: Tue Apr 11 14:33:45 2023

Administrative information

Building Details

Address: 13-16 MARKET PLACE, READING, RG21 2EG

Certifier details

Name:

Telephone number:

Address: , ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m^2]: 272.01

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	2.36	
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	1.91	
Target primary energy rate (TPER), kWh_{PE}/m^2.annum	25.87	
Building primary energy rate (BPER), kWh_{PE}/m^2.annum	20.99	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	First surface with maximum value
Walls*	0.26	0.18	0.18	BS000006:Surf[1]
Floors	0.18	0.15	0.15	BS000000:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.15	0.15	BS000000:Surf[1]
Windows** and roof windows	1.6	1.4	1.4	GR00000D:Surf[0]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check. *** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m^2K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	5

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- HVAC 1 - ASHP (heating only) + MVHR

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3.5	-	0	-	0.85
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

2- HVAC 1 - ASHP (heating and cooling) + MVHR

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3.5	6	0	-	0.85
Standard value	2.5*	5	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

1- DHW

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	2.8	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Zone-level mechanical ventilation, exhaust, and terminal units

ID	**System type in the Approved Documents**
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	**Zone**	**Standard**
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - WC	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - WC	-	-	-	1.1	-	-	-	-	-	-	N/A
Basement - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Core	-	-	-	1.1	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
Ground Floor - Circulation	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Retail	-	-	-	1.1	-	-	-	-	-	-	N/A
Ground Floor - Retail	-	-	-	1.1	-	-	-	-	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
Basement - Store	120	-	-
Basement - Circulation	120	-	-
Basement - Circulation	120	-	-
Basement - Retail	120	-	-
Basement - Store	120	-	-
Basement - WC	120	-	-
Basement - WC	120	-	-
Basement - Circulation	120	-	-
Ground Floor - Core	120	-	-
Ground Floor - Circulation	120	-	-
Ground Floor - Retail	120	85	1.412
Ground Floor - Retail	120	85	1.412

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Ground Floor - Retail	NO (-85.6%)	NO
Ground Floor - Retail	NO (-5.7%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	808.1	808.1
External area [m^2]	760.9	760.9
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	3
Average conductance [W/K]	152.92	147.88
Average U-value [W/m^2K]	0.2	0.19
Alpha value* [%]	25.03	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**Retail/Financial and Professional Services**
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	0.48	0.98
Cooling	1.89	1.94
Auxiliary	3.07	2.21
Lighting	8.56	12.19
Hot water	0.29	0.26
Equipment*	11.24	11.24
TOTAL**	**14.29**	**17.58**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	35.04	42.11
Primary energy [kWh_{PE}/m^2]	20.99	25.87
Total emissions [kg/m^2]	1.91	2.36

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	7.8	63.5	0.6	4.1	3.1	3.5	4.26	3.5	6
	Notional	5.2	70.7	0.5	4.2	2.4	2.78	4.63	----	----
[ST] Central heating using water: radiators, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	11.4	0	0.9	0	7.7	3.5	0	3.5	0
	Notional	34.4	0	3.4	0	5.2	2.78	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type