SYNTEGRA CONSULTING

Cross Deep Court,
Heath Road,
Twickenham,
TW1 4AG

Energy Strategy Report

March 2023

Ref: 22-10334

TABLE OF CONTENTS

Quality Standards Control

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

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	15/03/2023	03/04/2023		
Prepared by	A. Grigoropoulos	A. Grigoropoulos		
Checked by	M. Standen	F. Bolton		
Authorised by	M. Standen	M. Standen		

Limitations

Syntegra Consulting Ltd ("SC") has prepared this report for the sole use of client in accordance with the agreement under which our services were performed. No other warranty, expressed or implied, is made as to the professional advice included in this report or any other services provided by SC.

The conclusions and recommendations contained in this report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by SC has not been independently verified by SC, unless otherwise stated in the report.

The methodology adopted and the sources of information used by SC in providing its services are outlined in this report. The work described in this report was undertaken in **Mar 2023** and is based on the conditions encountered and the information available during the said period of time. The scope of this report and the services are accordingly factually limited by these circumstances.

This renewable report and energy pre-assessment modelling were generated based on the provided drawings and building information assumptions. Although every effort has been made to provide accurate content within this report, SC makes no warranty or assumes no legal liability or responsibility for the accuracy or completeness of information contained in this report.

SC also wishes to make aware that this document is guidance only on energy strategy and should not be seen as a building design document. It is the responsibility of the appointed Building Services / Design Team to develop, select and implement appropriate energy efficiency measures to ensure compliance.

Where assessments of works or costs identified in this report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

SC disclaim any undertaking or obligation to advise any person of any change in any matter affecting the report, which may come or be brought to SC's attention after the date of the report.

Certain statements made in the report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. SC specifically does not guarantee or warrant any estimate or projections contained in this report.

Costs may vary outside the ranges quoted. Whilst cost estimates are provided for individual issues in this report, these are based upon information at the time which can be incomplete. Cost estimates for such issues may therefore vary from those provided. Where costs are supplied, these estimates should be considered in aggregate only. No reliance should be made in relation to any division of aggregate costs, including in relation to any issue, site or other subdivision.

No allowance has been made for changes in prices or exchange rates or changes in any other conditions which may result in price fluctuations in the future. Where assessments of works or costs necessary to achieve compliance have been made, these are based upon measures which, in SC's experience, could normally be negotiated with the relevant authorities under present legislation and enforcement practice, assuming a pro-active and reasonable approach by site management.

Forecast cost estimates do not include such costs associated with any negotiations, appeals or other non- technical actions associated with the agreement on measures to meet the requirements of the authorities, nor are potential business loss and interruption costs considered that may be incurred as part of any technical measures.

Copyright

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 **Cross Deep Court, Heath Road in Twickenham TW1 4AG.** The presented figures in this study are based on the most updated information provided by the design team (i.e. **the Architect**). The development will comprise of a **new-build 6 dwellings.** The overall analysis took into consideration the national building regulations (i.e. **Part L 1A**) 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 national 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 **Richmond** local 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 buildings (i.e. BER) 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.*
GLA Best Practice requirements (for new buildings)	*Major developments meet the carbon emission reduction requirements a **35%** carbon reduction against Building Regulations Part L.*	*The proposed scheme has achieved over **40%** carbon reduction.*
	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.*
London Borough of Richmond Local plans for climate change	*The council Local Plan will promote sustainable, high-quality design and construction and alternative energy supplies.*	*The project makes the best use of improved thermal performance fabric materials and has achieved the required carbon reductions.*

Table 1: 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 residential properties. The development building has been assessed using the best practice energy hierarchy strategies (i.e. GLA minimum 35% energy category improvement) which by default demonstrates Part L compliance.

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. • Energy efficient lighting fittings (i.e. LED). Further information could be found in the Be Lean Section.
BE CLEAN (Availability of CHP and communal heating systems)	• Analysis for local CHPs and communal heating systems been assessed. 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 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 2: Best practice Energy Hierarchy to achieve 35% reductions over Part L requirement.

	Domestic Unit (tCO_2/annum)
Notional TER	*4.778*
Baseline BER	*3.834*
Be-Lean BER *(10% reduction)*	*2.687*
Be-Clean BER	*2.687*
Be-Green BER *(35% reduction)*	*2.068*
CO_2 Shortfall *(tCO_2.annum)*	*2.068*
Net Zero offset Fund *(Shortfall*£95/tCO_2*30 years)*	***£5,893***

Table 3: Results summary

The table above explains the carbon emissions per each stage of the energy hierarchy and the final required carbon offset fund to be net-zero.

1.3 Assessment Results

1.1.1. Residential Flats

The new build residential dwellings has been simulated under four 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 fourth simulation analysed the carbon reductions after considering renewable technologies as an effective design measure to achieve the **35%** reductions beyond **Part L1A** requirements (i.e. Be Green).

Cross Place, Twickenham - Baseline scenario

Dwelling Name	DER	TER	DPER	TPER	DFEE	TFEE	Total Floor Area	Total Floor Area	394.89
Unit 01 - Baseline	9.44	12.65	70.39	66.66	53.2	50.1	84.55	Average DER	9.71
Unit 03 - Baseline	9.05	12.1	68.42	63.78	50.2	47.3	84.71	Average TER	12.1
Unit 02 - Baseline	9.6	11.32	75.69	60.64	46.8	44.5	61.3	Average DPER	75.01
Unit 04 - Baseline	10.92	12.76	85.09	69.27	56.8	53.3	51.52	Average TPER	64.6
Unit 05 - Baseline	10.07	12.57	78.12	67.29	53	51.1	60.99	Average DFEE	51.06
Unit 06 - Baseline	9.73	10.91	78.87	59.45	46	44	51.82	Average TFEE	48.4

Cross Place, Twickenham - Be Lean scenario

Dwelling Name	DER	TER	DPER	TPER	DFEE	TFEE	Total Floor Area	Total Floor Area	394.89
Unit 01 - Be Lean	6.37	12.65	66.81	66.66	49.9	50.1	84.55	Average DER	6.8
Unit 03 - Be Lean	6.16	12.1	64.71	63.78	46.7	47.3	84.71	Average TER	12.1
Unit 02 - Be Lean	6.88	11.32	72.5	60.64	43	44.5	61.3	Average DPER	71.58
Unit 04 - Be Lean	7.76	12.76	81.7	69.27	52.8	53.3	51.52	Average TPER	64.6
Unit 05 - Be Lean	7.09	12.57	74.58	67.29	49	51.1	60.99	Average DFEE	47.31
Unit 06 - Be Lean	7.19	10.91	75.93	59.45	41.7	44	51.82	Average TFEE	48.4

Cross Place, Twickenham - Be Green scenario

Dwelling Name	DER	TER	DPER	TPER	DFEE	TFEE	Total Floor Area	Total Floor Area	394.89
Unit 04 - Be Green	5.94	12.76	62.3	69.27	52.8	53.3	51.52	Average DER	5.24
Unit 05 - Be Green	5.45	12.57	57.19	67.29	49	51.1	60.99	Average TER	12.1
Unit 06 - Be Green	5.39	10.91	56.73	59.45	41.7	44	51.82	Average DPER	54.91
Unit 01 - Be Green	4.99	12.65	52.16	66.66	49.9	50.1	84.55	Average TPER	64.6
Unit 03 - Be Green	4.81	12.1	50.37	63.78	46.7	47.3	84.71	Average DFEE	47.31
Unit 02 - Be Green	5.23	11.32	54.97	60.64	43	44.5	61.3	Average TFEE	48.4

Image 1: Domestic Carbon Emissions after each stage of the proposed strategy

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 London Borough of Richmond for the residential redevelopment of Cross Deep Court, Heath Road in Twickenham, TW1 4AG (the Site), as shown within a red line drawing within the planning statement. Image 2 below display the site plan.

The site contains an existing four-storey corner-plot building, Cross Deep Court, located on the south Side of Heath Road and facing Cross Deep/King Street Parade to the east.

The proposal concerns two retail units within Cross Deep Court, Units 3 and 15. Unit 3 faces Cross Deep/King Street Parade to the east and comprises a ground floor pharmacy and an entrance to a gym, located on the upper floor(operated by Escape Fitness). Unit 15 fronts Heath Road to the north and comprises a ground and first floor retail unit and ancillary storage area (operated by Stevenson's sports shop). The upper levels from second floor and above are not covered by this application and are occupied by residential units.

This ESR provides Richmond 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. PL 1A TER)**. Furthermore, the report explains how to reach the required energy targets to achieve the required carbon reductions for the development.

The residential 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.

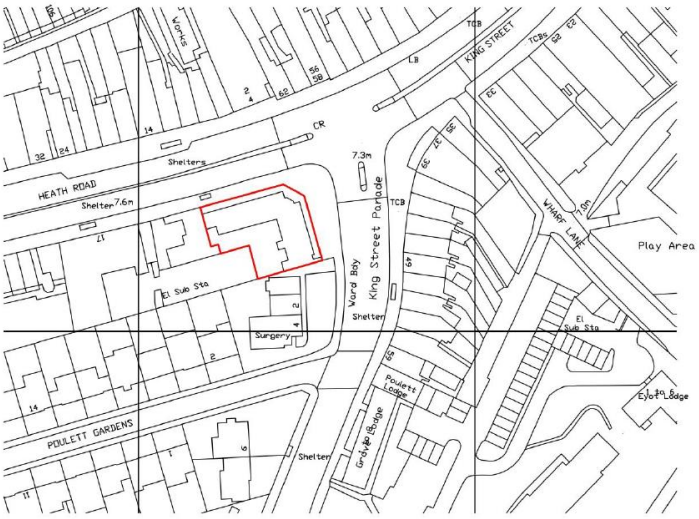

Image 2: Proposed development's site plan

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 The GLA Best Practice Energy Strategies for guidance only (e.g., London Plan 2021)

The London Plan 2021 prepared by The Mayor Of London came into force on 2nd March2021. Many London Boroughs have included the requirements below in their own local policiesand these are considered relevant to this report:

Policy GG 6 – Increasing efficiency and resilience; require that to help London become a more efficient and resilient city development must:

a) Seek to improve energy efficiency towards a low carbon circular economy, contributing towards London becoming a zero carbon city by 2030;

b) Ensure buildings and infrastructure are designed to adapt to climate change;

c) Create a safe and secure environment; and

d) Take an integrated and smart approach to the delivery of strategic and local infrastructure.

Policy SI 1 – Improving air quality; Development proposals should not lead to further deterioration of existing poor air quality or create new areas that exceed air quality limits.
Therefore, development must be air quality neutral and use design solutions to prevent exposure to existing air pollution. An air quality assessment should be submitted with major applications.

Policy SI 2 – Minimising Greenhouse Gas Emissions;

(A) Major developments should be net zero-carbon and to utilise the following energy hierarchy:

1) Be lean: Use less energy and manage demand during operation;
2) Be clean: exploit local energy resources (such as secondary heat) and supply efficiently and cleanly;
3) Be green: maximize opportunities for renewable energy by producing, storing and using renewable energy on-site.
4) Be Seen: Monitor, verify and report on energy performance.

(B) Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

(C) A minimum on-site reduction of at least 35% beyond Building Regulations Part L 2013 is required for major development. Residential development should achieve 10% through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:

1) Through a cash in lieu contribution to the Borough's carbon offset fund, and/or
2) Off-site provided that an alternative proposal is identified, and delivery is certain.

(D) Boroughs must establish and administer a carbon offset fund.

(E) Major development proposals should calculate and minimize unregulated emissions.

(F) Development proposals referrable to the Mayor should calculate emissions through a nationally recognized Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life cycle carbon emissions.

Policy SI 4 – Managing Heat Risk; Development proposals should minimize impacts on the urban heat island through design, layout, orientation, materials, and the incorporation of green infrastructure.

(A) Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the cooling hierarchy.

Policy SI 5 – Water infrastructure; Development proposals should:

1) Achieve a mains water consumption of 105 litres per person, per day.

2) Achieve BREEAM excellent standard for WAT 01 water category or equivalent (commercial development)

3) Incorporate measures such as smart metering, water saving and recycling measures to achieve a lower water consumption.

Policy SI 7 – Reducing waste and supporting the circular economy; referrable applications should aim to be net-zero waste and promote a circular economy during the construction and usage of the building. A circular economy statement should be prepared to support applications.

Policy SI 12 – Flood Risk Management; Strategic flood risk assessments should be used by developments to identify areas where flood risks exist and develop approaches to reduce these risks. Drainage should be designed to promote increased water efficiency, improve water quality, improve biodiversity, provide urban greening, amenity and recreation.

Policy G4 – Open Space – Developments should, where possible, create areas of publicly available open space, particularly in areas of deficiency, and resist the loss of protected open space in areas of deficiency.

Policy G5 – Urban Greening; Major development proposals should contribute to the greening of London by including urban greening.

(A) Boroughs should develop an urban greening factor (UGF) to identify the appropriate amount of urban greening required in new developments. In the interim, the mayor recommends a target score of 0.4 for developments that are predominantly residential.

(B) Existing green cover retained on site should count towards developments meeting the interim target scores set out in (A).

Policy G6 – Biodiversity And Access to Nature – Proposals should aim to establish a net biodiversity gain, and developments that reduce deficiencies in access to wildlife sites should be considered positively.

Policy G7 – Trees and Woodland – Wherever possible, existing trees of quality should be retained.

Policy T2 – Healthy Streets – Development proposals should show how the reduce the dominance of vehicles on London's streets, connect to local walking and cycling networks as well as public transport, and deliver improvements that support the ten healthy street indicators in line with TFL guidance:

1) Clean air

2) People feel relaxed
3) Things to do and see
4) People feel safe
5) People choose to walk, cycle, and use public transport
6) Not too noisy
7) Places to stop and rest
8) Shade and shelter
9) Easy to cross
10) Pedestrians from all walks of life

3.3 London Borough of Richmond Upon Thames

In July 2019, Richmond Council declared a Climate Emergency, committing to working towards becoming carbon neutral by 2030. Richmond published the Climate Emergency Strategy and the associated Action Plan. Reducing the borough's carbon emissions will require changes to the way we live and work, and changes from government and business. But change doesn't have to be a difficult, individual task; this is a unique opportunity to work together as a community to improve our quality of life and create a borough that's healthier, better to live in and fairer for everyone.

CLIMATE EMERGENCY STRATEGY GOAL: Become carbon neutral by 2030.

This Climate Emergency Strategy sets out six main areas of focus around climate change and sustainability, ensuring that we comply with current legislation, have a framework to set robust targets, have identified key actions we need deliver and have the resources in place to achieve these actions.

Richmond Council - Becoming carbon neutral as an organisation by 2030 – To reduce the energy demands from our estate, generate our own renewable energy, minimise waste and eliminate single use plastics from our operations. Key target is to become carbon neutral as an organisation by 2030.

Richmond legacy - Climate Change Mitigation and Energy Efficiency – to work with residents, communities, businesses and partners to engage, involve and support them in tackling the climate emergency. This will ensure Richmond is able to plan, measure and respond proactively to the effects of climate change and the implications of resource scarcity. Main goal is to create an environment where Richmond is able to be sustainable and low carbon by default.

Waste: Waste and Plastics and the Circular Economy –To reduce, reuse, recycle into everything Richmond does around waste by working with the residents, businesses and schools to reduce the overall amount of waste generated in the borough and will aim to be one of the top performing boroughs in London for recycling. Key target is to reduce the amount of waste generated in the borough.

Air: Improving Air Quality – To develop and deliver an ambitious air quality plan that will make a meaningful change to air quality in the borough with an emphasis on reducing air pollution particularly around schools and town centres. By 2024, the target is to have less polluting traffic on our roads, contributing to an improvement in air quality across the borough. Key target is to improve the air quality in the borough.

Nature: Green Infrastructure and Biodiversity – To improve and protect the biodiversity and ecology of the green spaces and protect them against the negative impacts of climate change. Key target is to plant more trees.

Water: Water Management and Flood Abatement – To ensure that development across Richmond addresses flood risks and promotes sustainable drainage. Key target is to be fully prepared for flooding.

Legislation and Policy

While there is no legislation that directly obliges local authorities to decrease their emissions or set a target for being carbon neutral, local authorities are plugged into a dense network of overlapping policy requirements and frameworks that require us to have due regard to and take action on preventing and adapting to climate change in areas around.
In the Clean Growth Strategy (2017), the government introduced a voluntary target for the wider public and higher education sectors in England. This target aims to reduce greenhouse gas emissions across these sectors by 30% by 2020 to 2021, compared to a 2009 to 2010 baseline.
This target is voluntary and there is no requirement to report on it. The Home Energy Conservation Act 1995 ('HECA') requires all local authorities in England to submit reports to the Secretary of State demonstrating what energy conservation measures they have adopted to improve the energy efficiency of residential accommodation within that area.

3.4 Meeting the challenge of climate change

One of the main challenges in any development is the ability to mitigate and adapt to the impact of climate change. In 2019 the government set out their ambition to reduce carbon emissions within the UK by 100%. As part of their declaration and response to the climate emergency both The Greater London Authority and The London Borough Of Richmond have set the more ambitious target to achieve this by 2030. Climate change will have an impact on the weather in the UK with winters becoming warmer and wetter with summers becoming warmer and drier. Designing buildings to mitigate and adapt to the impact of climate change will impact the design, construction and operation of all new buildings in the future. One of the NPPF's core planning principles is to include measures to mitigate and adapt to the effects of climate change in all new buildings as part of the planning process.

Reducing Embodied Carbon

Embodied carbon is the carbon used in the construction of a building. This includes carbon used during the extraction of raw materials, manufacture of goods, transportation of materials to site, installation and associated activities on site, maintenance and repair as well as the decommissioning and removal at the end of life of the building.

Embodied carbon is a significant part of the carbon associated with the construction of a building. The requirements of the Building Regulations and Planning authorities for highly energy efficient buildings may increase material usage and increase the level of embodied carbon for a building.

As part of the planning submission a Whole Life Carbon Assessment (WLC) has not been undertaken. The assessment measures the carbon emissions associated with the proposed development over a period of 60 years from construction to end of life. In completing a whole life carbon assessment at this stage the building can be shaped to include sustainability and circular economy principles within the design.

Reducing Operational Carbon

National, regional and local planning policy focuses on the need to establish planning policies which create building having low operational carbon.

Recent updates to the Building Regulations support the reduction of energy demand through low carbon buildings.

The London plan requires new building to be net-zero operational. Developments are required to take all measures required to reduce the carbon emissions as much as possible with a minimum on-site reduction of 35% using measure such as fabric improvements, energy efficient systems and low carbon or renewable technologies.

Any shortfall in net-zero operational carbon are offset by a payment to the London Borough Of Richmond Carbon Offset Fund.

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.
    - Improved 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.

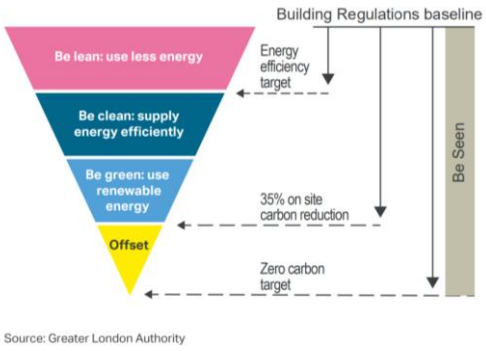

Image 3: GLA Energy Hierarchy

4.2 Modelling Strategy

The Government approved software **StromaSAP10,** has been utilised to carry out the project compliance simulations **(i.e., SAP)** 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**).

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	698-CDA-ZZ-00-DR-A-05-0002-Proposed Site Plan	PDF	*February 2023*
2	698-CDA-ZZ-00-DR-A-05-0101-Proposed Ground Floor Plan	PDF	*February 2023*
3	698-CDA-ZZ-00-DR-A-05-0103-Proposed First Floor Plan	PDF	*February 2023*
4	698-CDA-ZZ-XX-DR-A-00-0100-OS PLAN	PDF	*February 2023*
5	698-CDA-ZZ-ZZ-DR-A-05-0201-Proposed North Elevation	PDF	*February 2023*
6	698-CDA-ZZ-ZZ-DR-A-05-0203-Proposed East Elevation	PDF	*February 2023*
7	698-CDA-ZZ-ZZ-DR-A-05-0205-Proposed South Elevation	PDF	*February 2023*
8	698-CDA-ZZ-ZZ-DR-A-05-0207-Proposed West Elevation	PDF	*February 2023*

Table 3: Energy assessment document list

5. BASELINE - Target Emission Rate (TER) & Actual Dwelling Rate (DER)

The initial stage of the energy hierarchy is to establish a baseline. The baseline details the requirements to comply with the Building Regulations Part L 2021 and serves as a benchmark for all other stages.

The baseline regulated CO_2 emissions for the development are presented in the table below:

Model Name	CO_2 Emissions ($KgCO_2/m^2.annum$)	
	TER	DER
Domestic	*12.1*	*9.71*

Table 4: Regulated Energy Use and Carbon Emissions TER at Baseline

6. 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).

6.1 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.

The nearest weather station is in London, and this will be used for thermal and energy simulations.

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.

6.2 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.

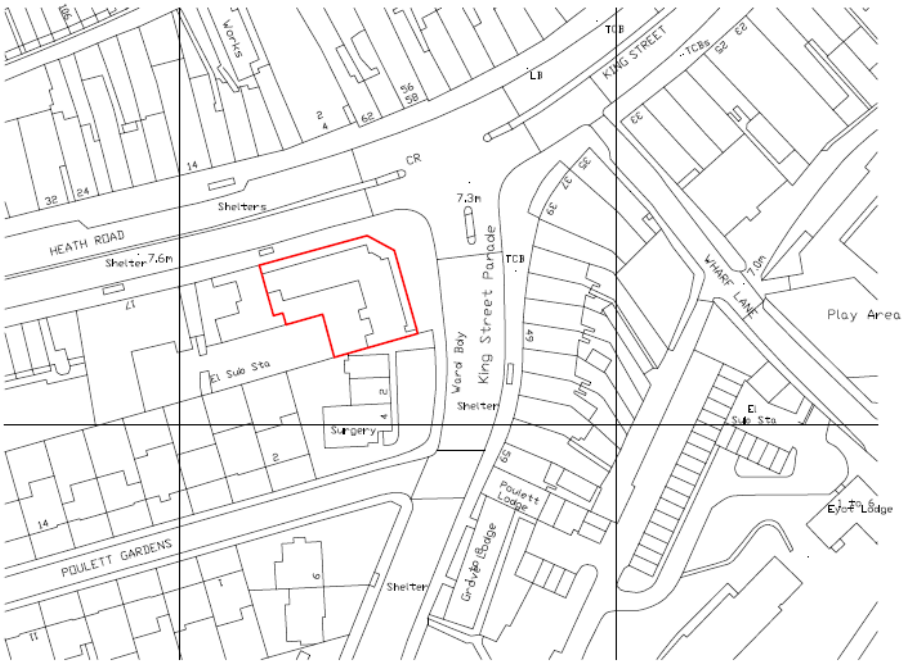

Image 4: Proposed Building site

6.3 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 5 below presents the different U-values used.

Building Type		**Domestic Residential flats**	
Category Specification		**Part L 1A Notional**	**Be-lean Improved values**
U-value *(W/m^2 K)*	*Wall*	*0.18*	*0.13*
	Window	*1.20*	*1.2*
	Floor	*0.13*	*0.11*
	Doors	*1.00*	*1.00*
Air Permeability *($m^3/h.m^2$ at 50 Pa)*		*5.00*	*5.00*

Table 5: Residential 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 loses 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.

6.4 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.

6.5 Ventilation strategy

A natural ventilation strategy will be adopted with extract fans in wet rooms; bathrooms, kitchens and utility rooms (if there is any). Therefore, lower energy consumption and CO_2 emissions due to avoiding mechanical ventilation.

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

❖ BE LEAN STAGE

Building Type	Notional TER ($KgCO_2/m^2.annum$)	DER at BE-LEAN ($KgCO_2/m^2.annum$)
Domestic flats	*12.1*	*6.8*

Table 6: 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.

7. 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.

7.1 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 **London Heat Map,** see image 5 below, as part of this assessment. The map identifies that the site is not located near to an existing or a proposed district heating network. The nearest proposed heat network is roughly 3,500 km away from the project site address. This has been demonstrated from the London Heat Map (http://www.londonheatmap.org.uk).

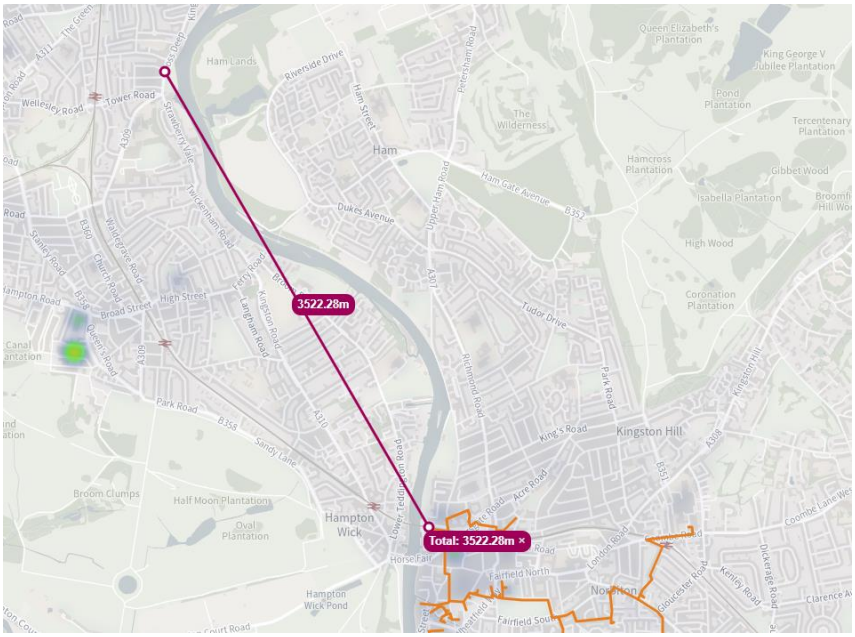

Image 5: London Heat Map near the site

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 loses shall be reduced through energy efficient design** during design development. It will include minimising duct lengths and adopting pipe configurations which minimise heat loss (e.g., twin pipes).
- ✓ Minimising 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.

8. 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 resource 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)** would be the most appropriate option in this development.

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 8: Feasibility Study of LZC Technologies

8.1 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 discounted 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 to the air.
C. Site doesn’t have an adequate storage space impacting layout and logistics arrangements.

8.2 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).

Please note that if ASHP technology is not viable then conventional boilers will be used which will not achieve the required CO2 reduction.

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	*12.1*	*5.24*	***56.69%***

Table 09: Regulated Carbon Reduction at Be-Green Stage

9. 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.

10. Conclusion

This report assesses the predicted energy performance and carbon dioxide emissions of the proposed development at **Cross Deep Court, Heath Road in Twickenham TW1 4AG.**

Based on the information provided by the design team, the study has been done on the **new build 6 residential dwellings**. 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 **40%** reductions 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.

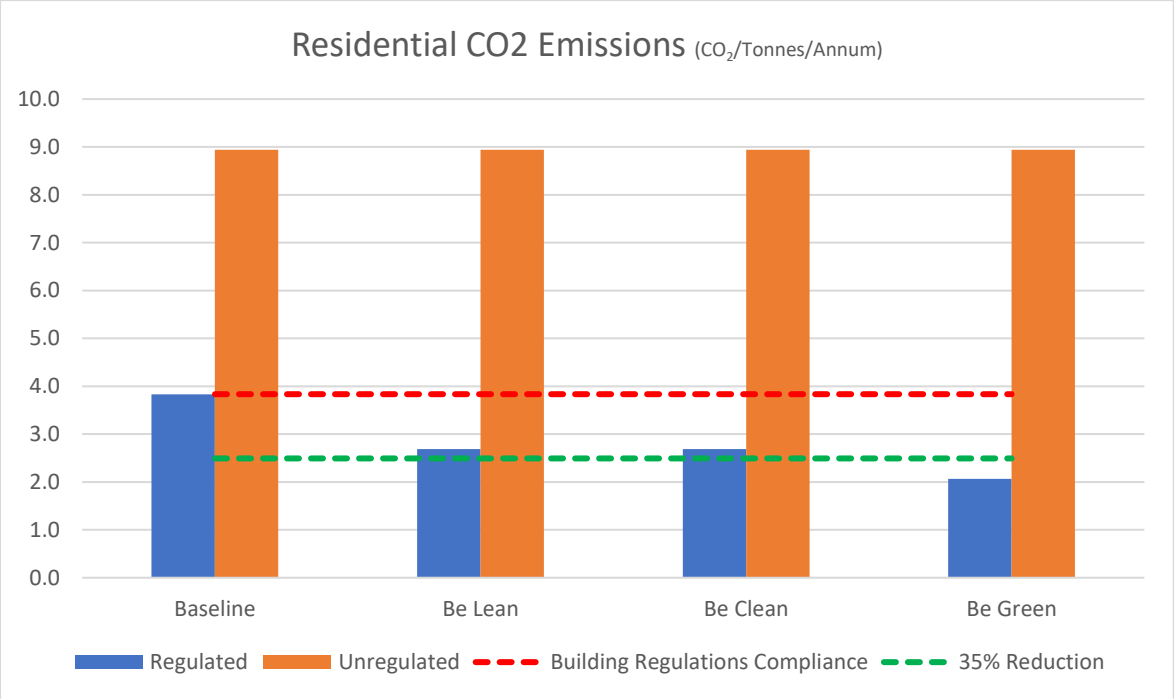

Chart 1: Carbon Emissions Reductions after each stage of the Energy Hierarchy

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	Baseline DER ($KgCO_2/m^2.annum$)	DER at BE-GREEN ($KgCO_2/m^2.annum$)	Carbon Savings at Be-Green
Domestic	*9.71*	*5.24*	***46.03%***

Table 10: Overall Regulated Carbon Reduction

Appendix – SAP Calculations

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.55 (1a)	x	3	(2a) =	253.65	(3a)
Total floor area TFA					84.55	(4)
Dwelling volume					253.65	(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	3	x	10 =	30	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.12	0.12	(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)	0.37	0.37	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.31	(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)

0.4	0.39	0.38	0.34	0.34	0.3	0.3	0.29	0.31	0.34	0.35	0.37	4.11	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

Effective air change rate from PCDB:

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	17.83		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	10.99	6341.25	(28b)
Basement wall	0	0	(29)
External wall	12.13	12807.9	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		169.63	(31)
Party Wall	0	9745.2	(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)	43.05	(33)
Heat capacity Cm = ∑(A x k)	28894.35	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	22.66	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	22.66	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	65.71	(37)

Ventilation heat loss calculated monthly

48.52	48.26	48.01	46.81	46.59	45.55	45.55	45.36	45.95	46.59	47.04	47.51	(38)

Heat transfer coefficient, W/K

114.23	113.97	113.72	112.53	112.31	111.27	111.27	111.08	111.67	112.31	112.76	113.23	(39)

Heat loss parameter (HLP), W/m²K

1.35	1.35	1.35	1.33	1.33	1.32	1.32	1.31	1.32	1.33	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	2.54	(42)

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

91.94	90.56	88.55	84.69	81.85	78.68	76.88	78.88	81.07	84.47	88.41	91.59	(42a)

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

30.4	29.95	29.31	28.14	27.26	26.29	25.76	26.39	27.08	28.12	29.32	30.3	(42b)

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

42.82	41.26	39.71	38.15	36.59	35.03	35.03	36.59	38.15	39.71	41.26	42.82	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	152.12	(43)

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

165.16	161.77	157.56	150.98	145.7	140	137.67	141.86	146.3	152.3	158.99	164.7	1823	(44)

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

261.57	230.36	242.17	206.69	196.14	172.15	166.51	175.65	180.4	206.67	226.51	257.89	2522.7	(45)

Distribution loss (46) = 0.15 x (45)

39.24	34.55	36.33	31	29.42	25.82	24.98	26.35	27.06	31	33.98	38.68	(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)

312.53 276.38 293.13 256 247.1 221.46 217.46 226.61 229.71 257.63 275.82 308.85 3122.7 (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)

312.53 276.38 293.13 256 247.1 221.46 217.46 226.61 229.71 257.63 275.82 308.85 3122.7 (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)]

99.71 88.1 93.26 81.05 77.96 69.57 68.1 71.14 72.31 81.46 87.64 98.49 (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

152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 (66)

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

35.82 31.81 25.87 19.59 14.64 12.36 13.36 17.36 23.3 29.59 34.53 36.81 (67)

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

341.32 344.87 335.94 316.94 292.95 270.41 255.35 251.81 260.73 279.74 303.72 326.26 (68)

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

52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8		(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

-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74		(71)

Water heating gains (Table 5)

134.02	131.1	125.35	112.57	104.78	96.62	91.54	95.62	100.43	109.49	121.73	132.38		(72)

Total internal gains

617.84	614.46	593.84	555.77	519.05	483.07	463.92	468.47	488.14	525.48	566.66	602.13		(73)

6. Solar gains

Solar gains in watts, calculated for each month

67.33	130.52	220.63	343.84	449.46	474.5	445.69	362.58	262.61	155.59	83.53	55.76		(83)

Total gains – internal and solar (watts)

685.17	744.98	814.47	899.62	968.51	957.57	909.61	831.05	750.76	681.07	650.19	657.89		(84)

7. Mean internal temperature (heating season)

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

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

0.99	0.99	0.98	0.94	0.85	0.68	0.52	0.59	0.83	0.96	0.99	0.99		(86)

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

19.5	19.66	19.96	20.37	20.72	20.93	20.98	20.97	20.82	20.37	19.87	19.47		(87)

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

19.8	19.8	19.81	19.82	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	0.99	0.97	0.92	0.79	0.58	0.39	0.45	0.75	0.94	0.98	0.99		(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.09	18.29	18.67	19.18	19.59	19.79	19.82	19.82	19.7	19.2	18.56	18.06		(90)

Living area fraction 0.44 (91)

Mean internal temperature (for the whole dwelling)

18.71	18.89	19.24	19.71	20.09	20.29	20.34	20.33	20.2	19.72	19.14	18.68		(92)

Adjusted mean internal temperature:

18.71	18.89	19.24	19.71	20.09	20.29	20.34	20.33	20.2	19.72	19.14	18.68		(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.96	0.92	0.81	0.62	0.45	0.51	0.78	0.94	0.98	0.99	(94)

Useful gains, mGm , W

676.85	731.18	785.59	824.55	781.05	596.46	409.11	424.95	582.69	640.06	637.37	651.12	(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

1646.41	1595.01	1448.69	1216.25	942.62	633.37	415.77	436.54	680.69	1023.89	1357.7	1639.9	(97)

Space heating requirement for each month

721.36	580.49	493.34	282.02	120.2	0	0	0	0	285.57	518.64	735.66	(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

721.36	580.49	493.34	282.02	120.2	0	0	0	0	285.57	518.64	735.66	(98c)

Space heating requirement in kWh/m²/year 44.2 (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 %),												170	(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	
424.33	341.47	290.2	165.9	70.71	0	0	0	0	167.98	305.08	432.74		(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				170	(216)
Efficiency of water heater													
170	170	170	170	170	170	170	170	170	170	170	170		(217)
Fuel for water heating													
183.84	162.58	172.43	150.59	145.36	130.27	127.92	133.3	135.13	151.55	162.25	181.67	1836.88	(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		2198.4	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		1836.88	(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	(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		86	(231)
Electricity for lighting		253.03	(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			4374.32	

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		80.02	(240a)
Low-rate fraction	0		80.02	(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		80.02	(241a)
Low-rate fraction	0		80.02	(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		80.02	(242a)

Low-rate fraction	0		80.02	(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		66.86	(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		14.18	(249)
Energy For lighting	0		41.73	(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		294.79	(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)		0.82	(257)
SAP rating		86.72	(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			461.66	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			259.05	(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		11.93	(267)
Electricity for lighting		36.52	(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		769.17	(272)
Dwelling CO2 Emission Rate		9.1	(273)
EI rating		92	(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			2484.2	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2794.77	(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			130.1	(281)
Electricity for lighting			388.11	(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			5797.17	(286)
Dwelling PE Rate			68.57	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.3	(1a) x	3	(2a) =	183.9	(3a)
Total floor area TFA					61.3	(4)
Dwelling volume					183.9	(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	3	x	10	=	30 (7a)
Number of passive vents	0	x	10	=	0 (7b)
Number of flueless gas fires	0	x	40	=	0 (7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.16	0.16	(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)	0.41	0.41	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.35	(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)

0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.4	0.41	4.61	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(25)

Effective air change rate from PCDB:

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(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	2.1		(26)
Windows	7.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.97	4597.5	(28b)
Basement wall	0	0	(29)
External wall	10.18	10742.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		126.83	(31)
Party Wall	0	9250.2	(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)	28.14	(33)
Heat capacity Cm = ∑(A x k)	24590.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.29	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.29	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	44.43	(37)

Ventilation heat loss calculated monthly

36.43	36.19	35.96	34.87	34.67	33.72	33.72	33.55	34.09	34.67	35.08	35.51	(38)

Heat transfer coefficient, W/K

80.85	80.62	80.39	79.3	79.09	78.15	78.15	77.97	78.51	79.09	79.51	79.94	(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	1.3	(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 2.02 (42)

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

79.83	78.63	76.88	73.54	71.07	68.31	66.75	68.49	70.39	73.34	76.76	79.52	(42a)

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

26.41	26.02	25.47	24.45	23.68	22.84	22.38	22.93	23.53	24.43	25.47	26.32	(42b)

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

37.16	35.8	34.45	33.1	31.75	30.4	30.4	31.75	33.1	34.45	35.8	37.16	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 132.07 (43)

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

143.39	140.45	136.8	131.09	126.5	121.55	119.53	123.17	127.02	132.23	138.04	143	1582.77 (44)

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

227.1	200	210.26	179.45	170.3	149.46	144.56	152.51	156.63	179.43	196.66	223.9	2190.26 (45)

Distribution loss (46) = 0.15 x (45)

34.07	30	31.54	26.92	25.54	22.42	21.68	22.88	23.49	26.91	29.5	33.59	(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	(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)

278.06 246.03 261.22 228.76 221.26 198.78 195.52 203.47 205.94 230.39 245.97 274.86 2790.26 (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)

278.06 246.03 261.22 228.76 221.26 198.78 195.52 203.47 205.94 230.39 245.97 274.86 2790.26 (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)]

88.25 78.01 82.65 72 69.36 62.03 60.81 63.45 64.41 72.4 77.72 87.19 (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

121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 (66)

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

29.19 25.93 21.08 15.96 11.93 10.07 10.88 14.15 18.99 24.11 28.14 30 (67)

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

263 265.73 258.86 244.22 225.73 208.36 196.76 194.03 200.91 215.55 234.03 251.4 (68)

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

	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	(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

	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	(71)

Water heating gains (Table 5)

	118.62	116.08	111.09	99.99	93.23	86.15	81.73	85.28	89.45	97.31	107.94	117.19	(72)

Total internal gains

	503.3	500.23	483.52	452.66	423.39	394.07	378.86	382.95	398.84	429.46	462.6	491.08	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	77.48	131.97	180.57	223.73	250.6	248.79	239.86	219.81	195.52	145.85	92.8	66.3	(83)

Total gains – internal and solar (watts)

	580.78	632.2	664.09	676.39	673.98	642.86	618.72	602.76	594.36	575.32	555.4	557.38	(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	0.85	0.71	0.54	0.57	0.78	0.93	0.98	0.99	(86)

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

	19.68	19.85	20.11	20.44	20.73	20.92	20.98	20.98	20.87	20.51	20.04	19.65	(87)

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

	19.83	19.83	19.83	19.85	19.85	19.86	19.86	19.86	19.86	19.85	19.84	19.84	(88)

Roof

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

	0.98	0.97	0.95	0.91	0.8	0.61	0.41	0.44	0.69	0.9	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.34	18.55	18.88	19.29	19.62	19.82	19.86	19.85	19.77	19.39	18.81	18.31	(90)

Living area fraction 0.58 (91)

Mean internal temperature (for the whole dwelling)

	19.12	19.31	19.6	19.96	20.27	20.46	20.51	20.51	20.41	20.04	19.53	19.09	(92)

Adjusted mean internal temperature:

	19.12	19.31	19.6	19.96	20.27	20.46	20.51	20.51	20.41	20.04	19.53	19.09	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.95	0.91	0.82	0.66	0.48	0.52	0.74	0.91	0.97	0.98	(94)

Useful gains, mGm , W

569.15	613.11	631.1	614.84	554.88	425.91	299.8	312.23	439.9	523.33	537.18	547.86	(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

1198.44	1161.48	1052.71	877.01	677.68	458.09	305.83	320.47	495.56	746.96	988.16	1190.6	(97)

Space heating requirement for each month

468.19	368.5	313.68	188.76	91.36	0	0	0	0	166.38	324.71	478.19	(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

468.19	368.5	313.68	188.76	91.36	0	0	0	0	166.38	324.71	478.19	(98c)

Space heating requirement in kWh/m²/year 39.15 (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 %),													170	(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	
275.4	216.77	184.52	111.04	53.74	0	0	0	0	97.87	191	281.29			(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					170	(216)
Efficiency of water heater														
170	170	170	170	170	170	170	170	170	170	170	170			(217)
Fuel for water heating														
163.57	144.72	153.66	134.57	130.15	116.93	115.01	119.69	121.14	135.52	144.69	161.68		1641.33	(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													1411.63	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1641.33	(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			0	(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													86	(231)
Electricity for lighting													206.2	(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			3345.16	

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		51.38	(240a)
Low-rate fraction	0		51.38	(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		51.38	(241a)
Low-rate fraction	0		51.38	(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		51.38	(242a)

Low-rate fraction	0		51.38	(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		59.74	(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		14.18	(249)
Energy For lighting	0		34	(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		251.31	(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		86.2	(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			296.44	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			231.37	(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		11.93	(267)
Electricity for lighting		29.76	(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		569.5	(272)
Dwelling CO2 Emission Rate		9.29	(273)
EI rating		93	(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			1595.14	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2496.84	(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			130.1	(281)
Electricity for lighting			316.27	(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			4538.35	(286)
Dwelling PE Rate			74.04	(287)

SAP WORKSHEET

Dwelling Reference: Unit 03
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.71 (1a)	x	3	(2a) =	254.13	(3a)
Total floor area TFA					84.71	(4)
Dwelling volume					254.13	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.08	0.08	(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)	0.33	0.33	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.25	(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)

0.32	0.32	0.31	0.28	0.27	0.24	0.24	0.24	0.25	0.27	0.29	0.3	3.34	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(24d)

Effective air change rate

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

Effective air change rate from PCDB:

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	12.97		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.97	4597.5	(28b)
Basement wall	0	0	(29)
External wall	14.54	15352	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		155.53	(31)
Party Wall	0	6274.8	(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)	37.59	(33)
Heat capacity Cm = ∑(A x k)	26224.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	21.94	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	21.94	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	59.52	(37)

Ventilation heat loss calculated monthly

46.35	46.18	46.01	45.22	45.08	44.39	44.39	44.26	44.65	45.08	45.38	45.69	(38)

Heat transfer coefficient, W/K

105.88	105.71	105.54	104.75	104.6	103.91	103.91	103.78	104.18	104.6	104.9	105.21	(39)

Heat loss parameter (HLP), W/m²K

1.25	1.25	1.25	1.24	1.23	1.23	1.23	1.23	1.23	1.23	1.24	1.24	(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	2.55	(42)

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

92	90.62	88.61	84.75	81.91	78.73	76.93	78.93	81.12	84.53	88.46	91.65	(42a)

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

30.42	29.97	29.33	28.16	27.28	26.3	25.78	26.41	27.1	28.14	29.34	30.32	(42b)

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

42.85	41.29	39.73	38.17	36.62	35.06	35.06	36.62	38.17	39.73	41.29	42.85	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	152.22	(43)

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

165.27	161.88	157.67	151.08	145.8	140.1	137.77	141.96	146.39	152.4	159.09	164.81	1824.2	(44)

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

261.74	230.51	242.33	206.82	196.27	172.26	166.62	175.77	180.52	206.8	226.66	258.06	2524.36	(45)

Distribution loss (46) = 0.15 x (45)

39.26	34.58	36.35	31.02	29.44	25.84	24.99	26.37	27.08	31.02	34	38.71	(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	(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)

312.7	276.54	293.29	256.14	247.23	221.58	217.57	226.73	229.83	257.76	275.97	309.02	3124.36	(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)

312.7	276.54	293.29	256.14	247.23	221.58	217.57	226.73	229.83	257.76	275.97	309.02	3124.36	(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)]

99.77	88.15	93.31	81.1	78	69.61	68.14	71.18	72.35	81.5	87.69	98.54	(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

152.77	152.77	152.77	152.77	152.77	152.77	152.77	152.77	152.77	152.77	152.77	152.77	(66)

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

38.2	33.93	27.59	20.89	15.61	13.18	14.24	18.51	24.85	31.55	36.83	39.26	(67)

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

341.79	345.34	336.4	317.38	293.36	270.78	255.7	252.16	261.09	280.12	304.14	326.71	(68)

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

	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	(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

	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	(71)

Water heating gains (Table 5)

	134.1	131.18	125.42	112.63	104.84	96.68	91.59	95.68	100.49	109.55	121.79	132.45	(72)

Total internal gains

	620.84	617.19	596.16	557.65	520.56	484.39	465.28	470.09	490.18	527.97	569.51	605.17	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	38.44	76.95	136.62	223.16	300.13	320.29	299.48	238.47	165.93	93.42	48.11	31.57	(83)

Total gains – internal and solar (watts)

	659.28	694.15	732.79	780.81	820.69	804.68	764.76	708.57	656.11	621.38	617.62	636.74	(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	0.98	0.96	0.89	0.74	0.58	0.64	0.86	0.97	0.99	0.99	(86)

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

	19.62	19.74	19.99	20.35	20.7	20.91	20.98	20.97	20.81	20.39	19.95	19.59	(87)

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

	19.88	19.88	19.88	19.89	19.89	19.9	19.9	19.9	19.9	19.89	19.89	19.89	(88)

Roof

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

	0.99	0.99	0.98	0.94	0.84	0.64	0.44	0.5	0.79	0.95	0.99	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.29	18.45	18.77	19.23	19.63	19.85	19.89	19.89	19.76	19.29	18.72	18.26	(90)

Living area fraction 0.36 (91)

Mean internal temperature (for the whole dwelling)

	18.77	18.91	19.21	19.63	20.01	20.23	20.28	20.27	20.13	19.68	19.16	18.74	(92)

Adjusted mean internal temperature:

	18.77	18.91	19.21	19.63	20.01	20.23	20.28	20.27	20.13	19.68	19.16	18.74	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.97	0.94	0.85	0.68	0.49	0.55	0.81	0.95	0.98	0.99	(94)

Useful gains, mGm , W

652.1	683.62	712.95	732.51	696.71	543.47	375.34	389.98	530.41	590.02	606.86	630.79	(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

1531.61	1481.03	1341.27	1123.93	869.25	584.85	382.46	402.03	628.68	949.94	1264.79	1529.28	(97)

Space heating requirement for each month

654.36	535.86	467.47	281.82	128.37	0	0	0	0	267.78	473.71	668.47	(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

654.36	535.86	467.47	281.82	128.37	0	0	0	0	267.78	473.71	668.47	(98c)

Space heating requirement in kWh/m²/year 41.06 (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 %),													170	(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	
384.92	315.21	274.98	165.78	75.51	0	0	0	0	157.52	278.65	393.22			(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					170	(216)
Efficiency of water heater														
170	170	170	170	170	170	170	170	170	170	170	170			(217)
Fuel for water heating														
183.94	162.67	172.52	150.67	145.43	130.34	127.99	133.37	135.2	151.63	162.34	181.77		1837.86	(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													2045.8	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1837.86	(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			0	(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													86	(231)
Electricity for lighting													269.83	(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			4239.49	

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		74.47	(240a)
Low-rate fraction	0		74.47	(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		74.47	(241a)
Low-rate fraction	0		74.47	(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		74.47	(242a)

Low-rate fraction	0		74.47	(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		66.9	(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		14.18	(249)
Energy For lighting	0		44.5	(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		292.04	(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)	0.81	(257)
SAP rating	86.86	(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			429.62	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			259.19	(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		11.93	(267)
Electricity for lighting		38.95	(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		739.68	(272)
Dwelling CO2 Emission Rate		8.73	(273)
EI rating		92	(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			2311.75	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2796.26	(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			130.1	(281)
Electricity for lighting			413.88	(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			5651.99	(286)
Dwelling PE Rate			66.72	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.52 (1a)	x	3	(2a) =	154.56	(3a)
Total floor area TFA					51.52	(4)
Dwelling volume					154.56	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.35	3.86	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	10.29		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.7	3864	(28b)
Basement wall	0	0	(29)
External wall	9.89	10442.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.57	(31)
Party Wall	0	8044.2	(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)	28.98	(33)
Heat capacity Cm = ∑(A x k)	22350.6	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.72	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.72	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	45.71	(37)

Ventilation heat loss calculated monthly

29.09	28.95	28.81	28.17	28.05	27.49	27.49	27.39	27.71	28.05	28.29	28.55	(38)

Heat transfer coefficient, W/K

74.8	74.66	74.52	73.88	73.76	73.2	73.2	73.1	73.42	73.76	74	74.26	(39)

Heat loss parameter (HLP), W/m²K

1.45	1.45	1.45	1.43	1.43	1.42	1.42	1.42	1.42	1.43	1.44	1.44	(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 1.73 (42)

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

73.3	72.2	70.59	67.52	65.25	62.73	61.29	62.88	64.63	67.34	70.48	73.02	(42a)

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

24.26	23.9	23.39	22.46	21.76	20.98	20.56	21.06	21.61	22.44	23.4	24.18	(42b)

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

34.1	32.86	31.62	30.38	29.14	27.9	27.9	29.14	30.38	31.62	32.86	34.1	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 121.27 (43)

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

131.66	128.96	125.61	120.36	116.15	111.61	109.75	113.09	116.62	121.41	126.74	131.3	1453.27 (44)

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

208.52	183.64	193.05	164.77	156.36	137.24	132.74	140.03	143.81	164.75	180.57	205.58	2011.05 (45)

Distribution loss (46) = 0.15 x (45)

31.28	27.55	28.96	24.72	23.45	20.59	19.91	21	21.57	24.71	27.08	30.84	(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	(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)

259.48 229.66 244.01 214.08 207.32 186.55 183.7 190.99 193.12 215.71 229.88 256.54 2611.05 (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)

259.48 229.66 244.01 214.08 207.32 186.55 183.7 190.99 193.12 215.71 229.88 256.54 2611.05 (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)]

82.07 72.57 76.93 67.11 64.73 57.96 56.87 59.3 60.15 67.52 72.37 81.1 (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

104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 (66)

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

22.1 19.63 15.97 12.09 9.04 7.63 8.24 10.71 14.38 18.26 21.31 22.72 (67)

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

225.64 227.98 222.08 209.52 193.67 178.76 168.81 166.47 172.37 184.93 200.78 215.69 (68)

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

47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	(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

-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	(71)

Water heating gains (Table 5)

110.31	107.99	103.4	93.21	87	80.5	76.44	79.7	83.54	90.75	100.51	109	(72)

Total internal gains

442.9	440.44	426.29	399.67	374.55	348.73	335.34	338.73	352.12	378.78	407.45	432.25	(73)

6. Solar gains

Solar gains in watts, calculated for each month

31	63.1	113.69	186.71	250.97	267.56	250.3	199.54	138.53	77.11	39.01	25.32	(83)

Total gains – internal and solar (watts)

473.9	503.54	539.98	586.37	625.52	616.29	585.63	538.26	490.65	455.89	446.45	457.56	(84)

7. Mean internal temperature (heating season)

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

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

0.99	0.98	0.97	0.93	0.84	0.69	0.53	0.59	0.82	0.95	0.98	0.99	(86)

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

19.46	19.61	19.9	20.32	20.69	20.91	20.98	20.96	20.8	20.34	19.83	19.43	(87)

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

19.72	19.73	19.73	19.74	19.74	19.75	19.75	19.75	19.74	19.74	19.74	19.73	(88)

Roof

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

0.99	0.98	0.96	0.91	0.79	0.58	0.39	0.45	0.74	0.93	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

17.99	18.17	18.55	19.06	19.48	19.7	19.74	19.74	19.61	19.1	18.47	17.95	(90)

Living area fraction 0.42 (91)

Mean internal temperature (for the whole dwelling)

18.61	18.78	19.12	19.59	19.99	20.21	20.26	20.26	20.11	19.63	19.05	18.58	(92)

Adjusted mean internal temperature:

18.61	18.78	19.12	19.59	19.99	20.21	20.26	20.26	20.11	19.63	19.05	18.58	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.96	0.91	0.8	0.62	0.45	0.51	0.76	0.93	0.97	0.98	(94)

Useful gains, mGm , W

465.07	490.7	516.31	532.09	500.3	383.16	262.95	273.12	375.04	422.37	433.76	450.11	(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

1070.46	1036.28	940.6	789.99	611.75	410.77	268.26	281.94	441.37	665.89	884.16	1067.79	(97)

Space heating requirement for each month

450.4	366.63	315.67	185.69	82.91	0	0	0	0	181.18	324.29	459.56	(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

450.4	366.63	315.67	185.69	82.91	0	0	0	0	181.18	324.29	459.56	(98c)

Space heating requirement in kWh/m²/year 45.93 (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 %),													170	(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	
264.94	215.66	185.69	109.23	48.77	0	0	0	0	106.58	190.76	270.33			(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					170	(216)
Efficiency of water heater														
170	170	170	170	170	170	170	170	170	170	170	170			(217)
Fuel for water heating														
152.63	135.1	143.54	125.93	121.96	109.74	108.06	112.35	113.6	126.89	135.22	150.91		1535.91	(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		1391.96	(211)
Space heating fuel used, main system 2		0	(213)
Space heating fuel used, secondary		0	(215)
Water heating fuel used		1535.91	(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	(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		86	(231)
Electricity for lighting		156.14	(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			3170.01	

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		50.67	(240a)
Low-rate fraction	0		50.67	(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		50.67	(241a)
Low-rate fraction	0		50.67	(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		50.67	(242a)

Low-rate fraction	0		50.67	(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		55.91	(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		14.18	(249)
Energy For lighting	0		25.75	(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		238.5	(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)		0.89	(257)
SAP rating		85.58	(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			292.31	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			216.44	(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		11.93	(267)
Electricity for lighting		22.54	(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		543.22	(272)
Dwelling CO2 Emission Rate		10.54	(273)
EI rating		92	(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			1572.91	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2336.23	(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			130.1	(281)
Electricity for lighting			239.49	(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			4278.73	(286)
Dwelling PE Rate			83.05	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	60.99 (1a)	x	3	(2a) =	182.97	(3a)
Total floor area TFA					60.99	(4)
Dwelling volume					182.97	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.11	0.11	(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)	0.36	0.36	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.28	(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)

0.36	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33	3.65	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

Effective air change rate

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

Effective air change rate from PCDB:

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	11.39		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	7.93	4574.25	(28b)
Basement wall	0	0	(29)
External wall	11.73	12380.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		138.2	(31)
Party Wall	0	7650	(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)	33.15	(33)
Heat capacity Cm = ∑(A x k)	24604.65	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.54	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.54	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	49.69	(37)

Ventilation heat loss calculated monthly

34	33.85	33.7	33.02	32.9	32.3	32.3	32.19	32.53	32.9	33.15	33.42	(38)

Heat transfer coefficient, W/K

83.68	83.54	83.39	82.71	82.58	81.99	81.99	81.88	82.22	82.58	82.84	83.11	(39)

Heat loss parameter (HLP), W/m²K

1.37	1.37	1.37	1.36	1.35	1.34	1.34	1.34	1.35	1.35	1.36	1.36	(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 2.01 (42)

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

79.63	78.43	76.69	73.35	70.89	68.14	66.58	68.31	70.21	73.16	76.57	79.32	(42a)

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

26.34	25.95	25.4	24.39	23.63	22.78	22.33	22.87	23.47	24.37	25.41	26.26	(42b)

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

37.06	35.71	34.37	33.02	31.67	30.32	30.32	31.67	33.02	34.37	35.71	37.06	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 131.74 (43)

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

143.04	140.1	136.46	130.76	126.19	121.25	119.23	122.86	126.7	131.9	137.69	142.64	1578.81 (44)

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

226.53	199.5	209.73	179	169.87	149.09	144.2	152.13	156.23	178.98	196.17	223.34	2184.78 (45)

Distribution loss (46) = 0.15 x (45)

33.98	29.93	31.46	26.85	25.48	22.36	21.63	22.82	23.43	26.85	29.42	33.5	(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)

277.49 245.53 260.69 228.32 220.83 198.41 195.16 203.08 205.55 229.94 245.48 274.3 2784.78 (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)

277.49 245.53 260.69 228.32 220.83 198.41 195.16 203.08 205.55 229.94 245.48 274.3 2784.78 (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)]

88.06 77.84 82.48 71.85 69.22 61.9 60.69 63.32 64.28 72.25 77.55 87 (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

120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 (66)

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

26.8 23.8 19.36 14.65 10.95 9.25 9.99 12.99 17.43 22.14 25.84 27.54 (67)

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

261.85 264.56 257.72 243.14 224.74 207.44 195.89 193.17 200.02 214.6 233 250.29 (68)

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

	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	(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

	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	(71)

Water heating gains (Table 5)

	118.36	115.83	110.85	99.79	93.04	85.97	81.57	85.11	89.27	97.11	107.71	116.94	(72)

Total internal gains

	499.26	496.46	480.18	449.84	420.99	391.92	376.71	380.53	395.98	426.1	458.81	487.03	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	34.31	69.84	125.83	206.64	277.77	296.13	277.03	220.85	153.32	85.35	43.17	28.02	(83)

Total gains – internal and solar (watts)

	533.57	566.29	606.01	656.48	698.76	688.06	653.73	601.38	549.31	511.45	501.98	515.05	(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)

	0.99	0.99	0.98	0.94	0.85	0.69	0.53	0.59	0.83	0.96	0.99	0.99	(86)

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

	19.53	19.67	19.95	20.35	20.71	20.92	20.98	20.97	20.81	20.37	19.89	19.5	(87)

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

	19.78	19.79	19.79	19.8	19.8	19.81	19.81	19.81	19.8	19.8	19.8	19.79	(88)

Roof

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

	0.99	0.98	0.97	0.92	0.8	0.59	0.4	0.46	0.75	0.94	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.12	18.3	18.66	19.15	19.56	19.76	19.8	19.8	19.67	19.19	18.58	18.08	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	18.58	18.75	19.08	19.55	19.94	20.14	20.19	20.18	20.05	19.58	19.01	18.55	(92)

Adjusted mean internal temperature:

	18.58	18.75	19.08	19.55	19.94	20.14	20.19	20.18	20.05	19.58	19.01	18.55	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.98	0.96	0.91	0.8	0.62	0.44	0.5	0.77	0.93	0.97	0.99	(94)

Useful gains, mGm , W

524.79	553.37	581.71	599.05	562	427.16	289.58	301.71	420.66	475.97	489.11	507.68	(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

1195.43	1157	1049.42	880.47	680.14	454.44	294.31	309.78	489.17	741.51	986.7	1192.86	(97)

Space heating requirement for each month

498.96	405.64	347.97	202.62	87.89	0	0	0	0	197.56	358.27	509.77	(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

498.96	405.64	347.97	202.62	87.89	0	0	0	0	197.56	358.27	509.77	(98c)

Space heating requirement in kWh/m²/year 42.77 (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 %),													170	(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	
293.51	238.61	204.69	119.19	51.7	0	0	0	0	116.21	210.75	299.87			(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					170	(216)
Efficiency of water heater														
170	170	170	170	170	170	170	170	170	170	170	170			(217)
Fuel for water heating														
163.23	144.43	153.35	134.3	129.9	116.71	114.8	119.46	120.91	135.26	144.4	161.35		1638.11	(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													1534.52	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1638.11	(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			0	(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													86	(231)
Electricity for lighting													189.31	(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			3447.94	

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		55.86	(240a)
Low-rate fraction	0		55.86	(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		55.86	(241a)
Low-rate fraction	0		55.86	(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		55.86	(242a)

Low-rate fraction	0		55.86	(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		59.63	(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		14.18	(249)
Energy For lighting	0		31.22	(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		252.88	(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)		0.86	(257)
SAP rating		86.08	(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			322.25	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			230.91	(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		11.93	(267)
Electricity for lighting		27.32	(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		592.41	(272)
Dwelling CO2 Emission Rate		9.71	(273)
EI rating		93	(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			1734.01	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2491.93	(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			130.1	(281)
Electricity for lighting			290.37	(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			4646.41	(286)
Dwelling PE Rate			76.18	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.82 (1a)	x	3	(2a) =	155.46	(3a)
Total floor area TFA					51.82	(4)
Dwelling volume					155.46	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34	3.85	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	5.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.74	3886.5	(28b)
Basement wall	0	0	(29)
External wall	10.49	11075.1	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.35	(31)
Party Wall	0	5482.8	(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)	25.21	(33)
Heat capacity Cm = ∑(A x k)	20444.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	12.8	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	12.8	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	38.01	(37)

Ventilation heat loss calculated monthly

29.24	29.1	28.97	28.32	28.2	27.64	27.64	27.54	27.86	28.2	28.45	28.7	(38)

Heat transfer coefficient, W/K

67.25	67.11	66.98	66.33	66.21	65.65	65.65	65.55	65.87	66.21	66.46	66.71	(39)

Heat loss parameter (HLP), W/m²K

1.3	1.3	1.29	1.28	1.28	1.27	1.27	1.26	1.27	1.28	1.28	1.29	(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 1.74 (42)

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

73.5	72.4	70.79	67.71	65.44	62.9	61.46	63.06	64.81	67.53	70.68	73.22	(42a)

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

24.33	23.97	23.46	22.52	21.82	21.04	20.62	21.12	21.67	22.51	23.46	24.25	(42b)

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

34.2	32.95	31.71	30.47	29.22	27.98	27.98	29.22	30.47	31.71	32.95	34.2	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 121.61 (43)

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

132.03	129.32	125.96	120.7	116.48	111.92	110.06	113.4	116.95	121.75	127.09	131.66	1457.31 (44)

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

209.1	184.15	193.59	165.23	156.8	137.62	133.11	140.42	144.21	165.21	181.07	206.15	2016.65 (45)

Distribution loss (46) = 0.15 x (45)

31.37	27.62	29.04	24.78	23.52	20.64	19.97	21.06	21.63	24.78	27.16	30.92	(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 (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)

260.06 230.18 244.55 214.54 207.76 186.93 184.06 191.38 193.53 216.17 230.38 257.11 2616.65 (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)

260.06 230.18 244.55 214.54 207.76 186.93 184.06 191.38 193.53 216.17 230.38 257.11 2616.65 (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)]

82.27 72.74 77.11 67.27 64.88 58.09 57 59.43 60.28 67.67 72.53 81.29 (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

104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 (66)

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

25.06 22.26 18.1 13.7 10.24 8.65 9.35 12.15 16.3 20.7 24.16 25.76 (67)

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

226.8 229.16 223.23 210.6 194.66 179.68 169.68 167.32 173.25 185.88 201.82 216.8 (68)

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

47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	(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

-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	(71)

Water heating gains (Table 5)

110.57	108.24	103.64	93.43	87.2	80.68	76.61	79.88	83.72	90.96	100.74	109.26	(72)

Total internal gains

447.52	444.74	430.05	402.81	377.19	351.09	337.71	341.43	355.36	382.62	411.8	436.89	(73)

6. Solar gains

Solar gains in watts, calculated for each month

57.8	98.45	134.7	166.91	186.95	185.6	178.93	163.98	145.86	108.81	69.23	49.46	(83)

Total gains – internal and solar (watts)

505.32	543.19	564.76	569.72	564.14	536.69	516.65	505.41	501.22	491.43	481.03	486.35	(84)

7. Mean internal temperature (heating season)

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

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

0.99	0.98	0.96	0.93	0.86	0.71	0.54	0.57	0.78	0.93	0.98	0.99	(86)

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

19.74	19.89	20.14	20.45	20.73	20.92	20.98	20.98	20.87	20.53	20.08	19.71	(87)

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

19.84	19.84	19.85	19.86	19.86	19.87	19.87	19.87	19.86	19.86	19.85	19.85	(88)

Roof

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

0.98	0.97	0.95	0.91	0.8	0.61	0.41	0.44	0.69	0.9	0.97	0.98	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.42	18.62	18.92	19.31	19.63	19.82	19.86	19.86	19.78	19.42	18.86	18.39	(90)

Living area fraction 0.45 (91)

Mean internal temperature (for the whole dwelling)

19.02	19.19	19.47	19.82	20.13	20.32	20.37	20.36	20.27	19.92	19.41	18.98	(92)

Adjusted mean internal temperature:

19.02	19.19	19.47	19.82	20.13	20.32	20.37	20.36	20.27	19.92	19.41	18.98	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.95	0.9	0.82	0.65	0.47	0.5	0.73	0.9	0.96	0.98	(94)

Useful gains, mGm , W

493.56	524.94	534.56	515.56	461.28	350.71	243.02	253.97	364.62	443.03	462.99	476.6	(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

989.67	959.09	868.75	724.56	558.05	375.34	247.26	259.78	406.54	616.95	818.22	986.06	(97)

Space heating requirement for each month

369.11	291.75	248.64	150.48	71.99	0	0	0	0	129.4	255.77	379.04	(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

369.11	291.75	248.64	150.48	71.99	0	0	0	0	129.4	255.77	379.04	(98c)

Space heating requirement in kWh/m²/year 36.59 (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 %),													170	(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	
217.12	171.62	146.26	88.52	42.35	0	0	0		0	76.12	150.45	222.97		(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					170	(216)
Efficiency of water heater														
170	170	170	170	170	170	170	170		170	170	170	170		(217)
Fuel for water heating														
152.98	135.4	143.85	126.2	122.21	109.96	108.27	112.57		113.84	127.16	135.52	151.24	1539.21	(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													1115.39	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1539.21	(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			0	(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													86	(231)
Electricity for lighting													177.03	(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			2917.64	

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		40.6	(240a)
Low-rate fraction	0		40.6	(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		40.6	(241a)
Low-rate fraction	0		40.6	(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		40.6	(242a)

Low-rate fraction	0		40.6	(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		56.03	(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		14.18	(249)
Energy For lighting	0		29.19	(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		232	(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)		0.86	(257)
SAP rating		86.02	(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			234.23	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			216.91	(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		11.93	(267)
Electricity for lighting		25.55	(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		488.62	(272)
Dwelling CO2 Emission Rate		9.43	(273)
EI rating		93	(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			1260.4	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2341.25	(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			130.1	(281)
Electricity for lighting			271.54	(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			4003.29	(286)
Dwelling PE Rate			77.25	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.55 (1a)	x	3	(2a) =	253.65	(3a)
Total floor area TFA					84.55	(4)
Dwelling volume					253.65	(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	3	x	10 =	30	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.12	0.12	(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)	0.37	0.37	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.31	(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)

0.4	0.39	0.38	0.34	0.34	0.3	0.3	0.29	0.31	0.34	0.35	0.37	4.11	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

Effective air change rate from PCDB:

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	17.83		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	9.3	6341.25	(28b)
Basement wall	0	0	(29)
External wall	8.76	12807.9	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		169.63	(31)
Party Wall	0	9745.2	(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)	37.99	(33)
Heat capacity Cm = ∑(A x k)	28894.35	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	22.66	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	22.66	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	60.65	(37)

Ventilation heat loss calculated monthly

48.52	48.26	48.01	46.81	46.59	45.55	45.55	45.36	45.95	46.59	47.04	47.51	(38)

Heat transfer coefficient, W/K

109.17	108.91	108.66	107.47	107.24	106.21	106.21	106.01	106.61	107.24	107.7	108.17	(39)

Heat loss parameter (HLP), W/m²K

1.29	1.29	1.29	1.27	1.27	1.26	1.26	1.25	1.26	1.27	1.27	1.28	(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)

91.94	90.56	88.55	84.69	81.85	78.68	76.88	78.88	81.07	84.47	88.41	91.59	(42a)

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

30.4	29.95	29.31	28.14	27.26	26.29	25.76	26.39	27.08	28.12	29.32	30.3	(42b)

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

42.82	41.26	39.71	38.15	36.59	35.03	35.03	36.59	38.15	39.71	41.26	42.82	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	152.12	(43)

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

165.16	161.77	157.56	150.98	145.7	140	137.67	141.86	146.3	152.3	158.99	164.7	1823 (44)

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

261.57	230.36	242.17	206.69	196.14	172.15	166.51	175.65	180.4	206.67	226.51	257.89	2522.7 (45)

Distribution loss (46) = 0.15 x (45)

39.24	34.55	36.33	31	29.42	25.82	24.98	26.35	27.06	31	33.98	38.68	(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)

287.69 253.94 268.28 231.96 222.26 197.42 192.62 201.77 205.67 232.78 251.78 284 2830.17 (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)

287.69 253.94 268.28 231.96 222.26 197.42 192.62 201.77 205.67 232.78 251.78 284 2830.17 (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)]

86.97 76.59 80.52 68.72 65.22 57.24 55.36 58.41 59.98 68.72 75.31 85.75 (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

152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 (66)

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

35.82 31.81 25.87 19.59 14.64 12.36 13.36 17.36 23.3 29.59 34.53 36.81 (67)

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

341.32 344.87 335.94 316.94 292.95 270.41 255.35 251.81 260.73 279.74 303.72 326.26 (68)

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

52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	(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

-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	(71)

Water heating gains (Table 5)

116.9	113.98	108.23	95.45	87.66	79.5	74.41	78.5	83.31	92.36	104.6	115.25	(72)

Total internal gains

597.72	594.33	573.72	535.65	498.93	465.95	446.8	451.35	471.02	505.36	546.53	582.01	(73)

6. Solar gains

Solar gains in watts, calculated for each month

67.33	130.52	220.63	343.84	449.46	474.5	445.69	362.58	262.61	155.59	83.53	55.76	(83)

Total gains – internal and solar (watts)

665.05	724.86	794.34	879.49	948.39	940.45	892.49	813.92	733.64	660.95	630.06	637.76	(84)

7. Mean internal temperature (heating season)

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

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

0.99	0.99	0.98	0.94	0.84	0.67	0.51	0.58	0.82	0.96	0.99	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)

19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(88)

Roof

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

0.99	0.99	0.97	0.92	0.79	0.57	0.39	0.45	0.74	0.94	0.99	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(90)

Living area fraction 0.44 (91)

Mean internal temperature (for the whole dwelling)

20.36	20.36	20.36	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.36	(92)

Adjusted mean internal temperature:

20.36	20.36	20.36	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.36	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.99	0.97	0.93	0.81	0.62	0.44	0.51	0.78	0.95	0.99	0.99	(94)

Useful gains, mGm , W

660.18	716.18	774.02	817.68	772.63	581.65	395.53	411.88	574.74	630	622.06	633.91	(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

1753.1	1683.74	1506.11	1232.33	929.61	613.18	400.77	421.35	668.57	1047.58	1428.67	1748.35	(97)

Space heating requirement for each month

813.13	650.2	544.67	298.55	116.79	0	0	0	0	310.68	580.76	829.14	(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

813.13	650.2	544.67	298.55	116.79	0	0	0	0	310.68	580.76	829.14	(98c)

Space heating requirement in kWh/m²/year 49.01 (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 %),												336.79	(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	
241.43	193.06	161.72	88.64	34.68	0	0	0	0	92.25	172.44	246.19		(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													
130.36	115.07	121.57	105.11	100.71	89.46	87.28	91.43	93.2	105.48	114.09	128.69	1282.45	(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												1230.4	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1282.45	(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		0	(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												0	(231)
Electricity for lighting												253.03	(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			2765.88	

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		202.89	(240a)
Low-rate fraction	0		202.89	(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		202.89	(241a)
Low-rate fraction	0		202.89	(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		202.89	(242a)

Low-rate fraction	0		202.89	(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		211.48	(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		0	(249)
Energy For lighting	0		41.73	(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		456.09	(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		79.46	(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			190.95	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			181.17	(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		0	(267)
Electricity for lighting		36.52	(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		408.64	(272)
Dwelling CO2 Emission Rate		4.83	(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			1937.36	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1952.36	(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			0	(281)
Electricity for lighting			388.11	(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			4277.84	(286)
Dwelling PE Rate			50.6	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.3	(1a) x	3	(2a) =	183.9	(3a)
Total floor area TFA					61.3	(4)
Dwelling volume					183.9	(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	3	x	10	=	30 (7a)
Number of passive vents	0	x	10	=	0 (7b)
Number of flueless gas fires	0	x	40	=	0 (7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.16	0.16	(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)	0.41	0.41	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.35	(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)

0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.4	0.41	4.61	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0		(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

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

Effective air change rate

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59		(25)

Effective air change rate from PCDB:

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59		(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	2.1		(26)
Windows	7.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.74	4597.5	(28b)
Basement wall	0	0	(29)
External wall	7.35	10742.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		126.83	(31)
Party Wall	0	9250.2	(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)	24.08	(33)
Heat capacity Cm = ∑(A x k)	24590.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.29	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.29	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	40.37	(37)

Ventilation heat loss calculated monthly

36.43	36.19	35.96	34.87	34.67	33.72	33.72	33.55	34.09	34.67	35.08	35.51	(38)

Heat transfer coefficient, W/K

76.8	76.56	76.33	75.25	75.04	74.09	74.09	73.92	74.46	75.04	75.45	75.88	(39)

Heat loss parameter (HLP), W/m²K

1.25	1.25	1.25	1.23	1.22	1.21	1.21	1.21	1.21	1.22	1.23	1.24	(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 2.02 (42)

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

79.83	78.63	76.88	73.54	71.07	68.31	66.75	68.49	70.39	73.34	76.76	79.52	(42a)

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

26.41	26.02	25.47	24.45	23.68	22.84	22.38	22.93	23.53	24.43	25.47	26.32	(42b)

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

37.16	35.8	34.45	33.1	31.75	30.4	30.4	31.75	33.1	34.45	35.8	37.16	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 132.07 (43)

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

143.39	140.45	136.8	131.09	126.5	121.55	119.53	123.17	127.02	132.23	138.04	143	1582.77 (44)

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

227.1	200	210.26	179.45	170.3	149.46	144.56	152.51	156.63	179.43	196.66	223.9	2190.26 (45)

Distribution loss (46) = 0.15 x (45)

34.07	30	31.54	26.92	25.54	22.42	21.68	22.88	23.49	26.91	29.5	33.59	(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)

253.22 223.59 236.37 204.72 196.41 174.74 170.68 178.62 181.9 205.55 221.93 250.02 2497.74 (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)

253.22 223.59 236.37 204.72 196.41 174.74 170.68 178.62 181.9 205.55 221.93 250.02 2497.74 (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)]

75.51 66.5 69.91 59.67 56.62 49.7 48.07 50.71 52.08 59.66 65.39 74.45 (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

121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 (66)

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

29.19 25.93 21.08 15.96 11.93 10.07 10.88 14.15 18.99 24.11 28.14 30 (67)

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

263 265.73 258.86 244.22 225.73 208.36 196.76 194.03 200.91 215.55 234.03 251.4 (68)

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

49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13		(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

-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73		(71)

Water heating gains (Table 5)

101.49	98.96	93.97	82.87	76.11	69.02	64.61	68.16	72.33	80.19	90.82	100.06		(72)

Total internal gains

483.18	480.11	463.4	432.54	403.26	376.95	361.74	365.82	381.72	409.34	442.48	470.95		(73)

6. Solar gains

Solar gains in watts, calculated for each month

77.48	131.97	180.57	223.73	250.6	248.79	239.86	219.81	195.52	145.85	92.8	66.3		(83)

Total gains – internal and solar (watts)

560.65	612.08	643.96	656.27	653.86	625.74	601.6	585.64	577.23	555.19	535.28	537.26		(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)

0.99	0.98	0.97	0.93	0.85	0.7	0.53	0.56	0.78	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)

19.88	19.88	19.88	19.9	19.9	19.91	19.91	19.92	19.91	19.9	19.9	19.89		(88)

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

0.98	0.98	0.95	0.91	0.8	0.6	0.4	0.44	0.69	0.91	0.97	0.99		(89)

Roof Mean internal temperature in the rest of dwelling T2

19.88	19.88	19.88	19.9	19.9	19.91	19.91	19.92	19.91	19.9	19.9	19.89		(90)

Living area fraction 0.58 (91)

Mean internal temperature (for the whole dwelling)

20.53	20.53	20.54	20.54	20.54	20.55	20.55	20.55	20.55	20.54	20.54	20.54		(92)

Adjusted mean internal temperature:

20.53	20.53	20.54	20.54	20.54	20.55	20.55	20.55	20.55	20.54	20.54	20.54		(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.96	0.92	0.83	0.66	0.48	0.51	0.74	0.92	0.98	0.99	(94)

Useful gains, mGm , W

553.34	599.07	619.36	605.11	544.73	413.18	287.84	300.15	429.37	512.98	522.91	531.43	(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

1246.73	1197.05	1071.4	875.99	663.58	440.71	292.53	306.69	479.97	746.13	1014.14	1239.81	(97)

Space heating requirement for each month

515.88	401.85	336.32	195.03	88.43	0	0	0	0	173.46	353.69	527.04	(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

515.88	401.85	336.32	195.03	88.43	0	0	0	0	173.46	353.69	527.04	(98c)

Space heating requirement in kWh/m²/year 42.28 (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 %),													328.62	(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	
156.98	122.28	102.34	59.35	26.91	0	0	0	0	52.78	107.63	160.38			(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					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														
114.74	101.32	107.11	92.77	89	79.18	77.34	80.94	82.42	93.14	100.56	113.29		1131.81	(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													788.66	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1131.81	(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			0	(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													0	(231)
Electricity for lighting													206.2	(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			2126.67	

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		130.05	(240a)
Low-rate fraction	0		130.05	(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		130.05	(241a)
Low-rate fraction	0		130.05	(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		130.05	(242a)

Low-rate fraction	0		130.05	(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		186.64	(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		0	(249)
Energy For lighting	0		34	(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		350.69	(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		80.75	(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			122.42	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			159.84	(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		0	(267)
Electricity for lighting		29.76	(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		312.02	(272)
Dwelling CO2 Emission Rate		5.09	(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			1241.9	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1722.86	(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			0	(281)
Electricity for lighting			316.27	(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			3281.03	(286)
Dwelling PE Rate			53.52	(287)

SAP WORKSHEET

Dwelling Reference: Unit 03
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.71 (1a)	x	3	(2a) =	254.13	(3a)
Total floor area TFA					84.71	(4)
Dwelling volume					254.13	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.08	0.08	(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)	0.33	0.33	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.25	(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)

0.32	0.32	0.31	0.28	0.27	0.24	0.24	0.24	0.25	0.27	0.29	0.3	3.34	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(24d)

Effective air change rate

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

Effective air change rate from PCDB:

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	12.97		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.74	4597.5	(28b)
Basement wall	0	0	(29)
External wall	10.5	15352	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		155.53	(31)
Party Wall	0	6274.8	(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)	32.32	(33)
Heat capacity Cm = ∑(A x k)	26224.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	21.94	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	21.94	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.26	(37)

Ventilation heat loss calculated monthly

46.35	46.18	46.01	45.22	45.08	44.39	44.39	44.26	44.65	45.08	45.38	45.69	(38)

Heat transfer coefficient, W/K

100.61	100.44	100.27	99.48	99.33	98.64	98.64	98.52	98.91	99.33	99.63	99.94	(39)

Heat loss parameter (HLP), W/m²K

1.19	1.19	1.18	1.17	1.17	1.16	1.16	1.16	1.17	1.17	1.18	1.18	(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 2.55 (42)

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

92	90.62	88.61	84.75	81.91	78.73	76.93	78.93	81.12	84.53	88.46	91.65	(42a)

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

30.42	29.97	29.33	28.16	27.28	26.3	25.78	26.41	27.1	28.14	29.34	30.32	(42b)

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

42.85	41.29	39.73	38.17	36.62	35.06	35.06	36.62	38.17	39.73	41.29	42.85	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 152.22 (43)

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

165.27	161.88	157.67	151.08	145.8	140.1	137.77	141.96	146.39	152.4	159.09	164.81	1824.2	(44)

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

261.74	230.51	242.33	206.82	196.27	172.26	166.62	175.77	180.52	206.8	226.66	258.06	2524.36	(45)

Distribution loss (46) = 0.15 x (45)

39.26	34.58	36.35	31.02	29.44	25.84	24.99	26.37	27.08	31.02	34	38.71	(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)

287.86 254.1 268.44 232.09 222.39 197.54 192.73 201.88 205.79 232.92 251.93 284.17 2831.84 (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)

287.86 254.1 268.44 232.09 222.39 197.54 192.73 201.88 205.79 232.92 251.93 284.17 2831.84 (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)]

87.03 76.64 80.57 68.77 65.26 57.28 55.4 58.44 60.02 68.76 75.36 85.8 (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

152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 (66)

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

38.2 33.93 27.59 20.89 15.61 13.18 14.24 18.51 24.85 31.55 36.83 39.26 (67)

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

341.79 345.34 336.4 317.38 293.36 270.78 255.7 252.16 261.09 280.12 304.14 326.71 (68)

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

52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	(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

-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	(71)

Water heating gains (Table 5)

116.98	114.05	108.3	95.51	87.72	79.55	74.46	78.55	83.36	92.42	104.67	115.33	(72)

Total internal gains

600.72	597.07	576.04	537.52	500.44	467.27	448.16	452.97	473.05	507.84	549.39	585.05	(73)

6. Solar gains

Solar gains in watts, calculated for each month

38.44	76.95	136.62	223.16	300.13	320.29	299.48	238.47	165.93	93.42	48.11	31.57	(83)

Total gains – internal and solar (watts)

639.15	674.02	712.66	760.69	800.57	787.56	747.64	691.44	638.99	601.26	597.49	616.61	(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	0.98	0.96	0.89	0.73	0.56	0.63	0.86	0.97	0.99	1	(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)

19.93	19.93	19.93	19.94	19.94	19.95	19.95	19.95	19.95	19.94	19.94	19.94	(88)

Roof

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

0.99	0.99	0.98	0.94	0.84	0.64	0.44	0.5	0.79	0.96	0.99	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.93	19.93	19.93	19.94	19.94	19.95	19.95	19.95	19.95	19.94	19.94	19.94	(90)

Living area fraction 0.36 (91)

Mean internal temperature (for the whole dwelling)

20.31	20.31	20.31	20.32	20.32	20.32	20.32	20.33	20.32	20.32	20.32	20.32	(92)

Adjusted mean internal temperature:

20.31	20.31	20.31	20.32	20.32	20.32	20.32	20.33	20.32	20.32	20.32	20.32	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.99	0.98	0.95	0.86	0.67	0.48	0.55	0.82	0.96	0.99	0.99	(94)

Useful gains, mGm , W

634.97	667.53	699.17	722.54	687.34	529.3	361.86	376.96	521.66	578.11	590.83	613.24	(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

1611.03	1548.12	1385.19	1136	856.26	564.67	367.39	386.69	615.49	965.53	1316.97	1610.76	(97)

Space heating requirement for each month

726.19	591.76	510.41	297.69	125.68	0	0	0	0	288.24	522.82	742.15	(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

726.19	591.76	510.41	297.69	125.68	0	0	0	0	288.24	522.82	742.15	(98c)

Space heating requirement in kWh/m²/year 44.92 (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 %),												336.78	(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	
215.63	175.71	151.56	88.39	37.32	0	0	0	0	85.59	155.24	220.37		(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													
130.44	115.14	121.64	105.17	100.77	89.51	87.33	91.48	93.25	105.54	114.16	128.77	1283.2	(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												1129.81	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1283.2	(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		0	(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												0	(231)
Electricity for lighting												269.83	(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			2682.85	

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		186.31	(240a)
Low-rate fraction	0		186.31	(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		186.31	(241a)
Low-rate fraction	0		186.31	(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		186.31	(242a)

Low-rate fraction	0		186.31	(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		211.6	(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		0	(249)
Energy For lighting	0		44.5	(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		442.4	(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)		1.23	(257)
SAP rating		80.1	(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			175.02	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			181.27	(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		0	(267)
Electricity for lighting		38.95	(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		395.24	(272)
Dwelling CO2 Emission Rate		4.67	(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			1777.79	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1953.51	(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			0	(281)
Electricity for lighting			413.88	(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			4145.19	(286)
Dwelling PE Rate			48.93	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.52 (1a)	x	3	(2a) =	154.56	(3a)
Total floor area TFA					51.52	(4)
Dwelling volume					154.56	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.35	3.86	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	10.29		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.67	3864	(28b)
Basement wall	0	0	(29)
External wall	7.14	10442.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.57	(31)
Party Wall	0	8044.2	(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)	25.21	(33)
Heat capacity Cm = ∑(A x k)	22350.6	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.72	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.72	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	41.93	(37)

Ventilation heat loss calculated monthly

29.09	28.95	28.81	28.17	28.05	27.49	27.49	27.39	27.71	28.05	28.29	28.55	(38)

Heat transfer coefficient, W/K

71.02	70.88	70.74	70.1	69.98	69.42	69.42	69.32	69.64	69.98	70.22	70.48	(39)

Heat loss parameter (HLP), W/m²K

1.38	1.38	1.37	1.36	1.36	1.35	1.35	1.35	1.35	1.36	1.36	1.37	(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	1.73	(42)

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

73.3	72.2	70.59	67.52	65.25	62.73	61.29	62.88	64.63	67.34	70.48	73.02	(42a)

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

24.26	23.9	23.39	22.46	21.76	20.98	20.56	21.06	21.61	22.44	23.4	24.18	(42b)

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

34.1	32.86	31.62	30.38	29.14	27.9	27.9	29.14	30.38	31.62	32.86	34.1	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	121.27	(43)

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

131.66	128.96	125.61	120.36	116.15	111.61	109.75	113.09	116.62	121.41	126.74	131.3	1453.27 (44)

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

208.52	183.64	193.05	164.77	156.36	137.24	132.74	140.03	143.81	164.75	180.57	205.58	2011.05 (45)

Distribution loss (46) = 0.15 x (45)

31.28	27.55	28.96	24.72	23.45	20.59	19.91	21	21.57	24.71	27.08	30.84	(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)

234.63 207.22 219.17 190.04 182.48 162.51 158.85 166.14 169.08 190.87 205.84 231.7 2318.53 (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)

234.63 207.22 219.17 190.04 182.48 162.51 158.85 166.14 169.08 190.87 205.84 231.7 2318.53 (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)]

69.33 61.06 64.19 54.79 51.99 45.63 44.13 46.56 47.82 54.78 60.04 68.36 (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

104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 (66)

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

22.1 19.63 15.97 12.09 9.04 7.63 8.24 10.71 14.38 18.26 21.31 22.72 (67)

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

225.64 227.98 222.08 209.52 193.67 178.76 168.81 166.47 172.37 184.93 200.78 215.69 (68)

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

47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	(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

-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	(71)

Water heating gains (Table 5)

93.19	90.86	86.28	76.09	69.88	63.38	59.32	62.58	66.41	73.63	83.39	91.88	(72)

Total internal gains

422.78	420.32	406.17	379.54	354.42	331.61	318.21	321.6	335	358.66	387.32	412.12	(73)

6. Solar gains

Solar gains in watts, calculated for each month

31	63.1	113.69	186.71	250.97	267.56	250.3	199.54	138.53	77.11	39.01	25.32	(83)

Total gains – internal and solar (watts)

453.78	483.42	519.86	566.25	605.39	599.17	568.51	521.14	473.53	435.77	426.33	437.44	(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	0.84	0.68	0.52	0.58	0.82	0.96	0.99	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)

19.78	19.78	19.78	19.79	19.8	19.8	19.8	19.81	19.8	19.8	19.79	19.79	(88)

Roof

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

0.99	0.98	0.96	0.91	0.79	0.58	0.39	0.45	0.74	0.93	0.98	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.78	19.78	19.78	19.79	19.8	19.8	19.8	19.81	19.8	19.8	19.79	19.79	(90)

Living area fraction 0.42 (91)

Mean internal temperature (for the whole dwelling)

20.3	20.3	20.3	20.31	20.31	20.31	20.31	20.31	20.31	20.31	20.3	20.3	(92)

Adjusted mean internal temperature:

20.3	20.3	20.3	20.31	20.31	20.31	20.31	20.31	20.31	20.31	20.3	20.3	(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.98	0.97	0.92	0.81	0.62	0.45	0.51	0.78	0.94	0.98	0.99	(94)

Useful gains, mGm , W

448.75	475.62	503.85	523.43	492.18	372.45	253.37	263.82	367.84	411.5	418.65	433.3	(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

1136.08	1091.41	976.21	799.51	602.27	396.48	257.64	271.18	432.4	679.25	927.24	1134.82	(97)

Space heating requirement for each month

511.38	413.81	351.44	198.78	81.91	0	0	0	0	199.21	366.19	521.93	(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

511.38	413.81	351.44	198.78	81.91	0	0	0	0	199.21	366.19	521.93	(98c)

Space heating requirement in kWh/m²/year 51.33 (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 (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 %),													326.22	(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	
156.76	126.85	107.73	60.93	25.11	0	0	0	0	61.07	112.25	159.99			(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					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														
106.32	93.9	99.31	86.11	82.69	73.64	71.98	75.29	76.62	86.49	93.27	104.99		1050.61	(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													810.68	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1050.61	(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			0	(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													0	(231)
Electricity for lighting													156.14	(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			2017.42	

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		133.68	(240a)
Low-rate fraction	0		133.68	(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		133.68	(241a)
Low-rate fraction	0		133.68	(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		133.68	(242a)

Low-rate fraction	0		133.68	(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		173.24	(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		0	(249)
Energy For lighting	0		25.75	(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		332.67	(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)		1.24	(257)
SAP rating		79.89	(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			125.69	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			148.34	(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		0	(267)
Electricity for lighting		22.54	(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		296.57	(272)
Dwelling CO2 Emission Rate		5.76	(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			1276.03	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1599.14	(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			0	(281)
Electricity for lighting			239.49	(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			3114.66	(286)
Dwelling PE Rate			60.46	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	60.99 (1a)	x	3	(2a) =	182.97	(3a)
Total floor area TFA					60.99	(4)
Dwelling volume					182.97	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.11	0.11	(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)	0.36	0.36	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.28	(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)

0.36	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33	3.65	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

Effective air change rate

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

Effective air change rate from PCDB:

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	11.39		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.71	4574.25	(28b)
Basement wall	0	0	(29)
External wall	8.47	12380.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		138.2	(31)
Party Wall	0	7650	(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)	28.67	(33)
Heat capacity Cm = ∑(A x k)	24604.65	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.54	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.54	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	45.21	(37)

Ventilation heat loss calculated monthly

34	33.85	33.7	33.02	32.9	32.3	32.3	32.19	32.53	32.9	33.15	33.42	(38)

Heat transfer coefficient, W/K

79.21	79.06	78.91	78.23	78.11	77.51	77.51	77.4	77.74	78.11	78.36	78.63	(39)

Heat loss parameter (HLP), W/m²K

1.3	1.3	1.29	1.28	1.28	1.27	1.27	1.27	1.27	1.28	1.28	1.29	(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 2.01 (42)

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

79.63	78.43	76.69	73.35	70.89	68.14	66.58	68.31	70.21	73.16	76.57	79.32	(42a)

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

26.34	25.95	25.4	24.39	23.63	22.78	22.33	22.87	23.47	24.37	25.41	26.26	(42b)

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

37.06	35.71	34.37	33.02	31.67	30.32	30.32	31.67	33.02	34.37	35.71	37.06	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 131.74 (43)

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

143.04	140.1	136.46	130.76	126.19	121.25	119.23	122.86	126.7	131.9	137.69	142.64	1578.81 (44)

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

226.53	199.5	209.73	179	169.87	149.09	144.2	152.13	156.23	178.98	196.17	223.34	2184.78 (45)

Distribution loss (46) = 0.15 x (45)

33.98	29.93	31.46	26.85	25.48	22.36	21.63	22.82	23.43	26.85	29.42	33.5	(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)

252.65 223.09 235.84 204.27 195.99 174.36 170.32 178.24 181.51 205.1 221.44 249.46 2492.26 (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)

252.65 223.09 235.84 204.27 195.99 174.36 170.32 178.24 181.51 205.1 221.44 249.46 2492.26 (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)]

75.32 66.33 69.74 59.52 56.48 49.57 47.95 50.58 51.95 59.51 65.23 74.26 (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

120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 (66)

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

26.8 23.8 19.36 14.65 10.95 9.25 9.99 12.99 17.43 22.14 25.84 27.54 (67)

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

261.85 264.56 257.72 243.14 224.74 207.44 195.89 193.17 200.02 214.6 233 250.29 (68)

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

49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07		(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

-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38		(71)

Water heating gains (Table 5)

101.24	98.71	93.73	82.66	75.92	68.85	64.45	67.99	72.15	79.99	90.59	99.81		(72)

Total internal gains

479.14	476.33	460.06	429.71	400.87	374.8	359.59	363.41	378.86	405.98	438.68	466.91		(73)

6. Solar gains

Solar gains in watts, calculated for each month

34.31	69.84	125.83	206.64	277.77	296.13	277.03	220.85	153.32	85.35	43.17	28.02		(83)

Total gains – internal and solar (watts)

513.45	546.17	585.89	636.36	678.64	670.93	636.61	584.25	532.18	491.33	481.85	494.92		(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	0.98	0.94	0.85	0.68	0.52	0.58	0.83	0.96	0.99	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)

19.84	19.84	19.85	19.85	19.86	19.86	19.86	19.87	19.86	19.86	19.85	19.85		(88)

Roof

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

0.99	0.98	0.97	0.92	0.79	0.58	0.39	0.45	0.75	0.94	0.98	0.99		(89)

Roof

Mean internal temperature in the rest of dwelling T2

19.84	19.84	19.85	19.85	19.86	19.86	19.86	19.87	19.86	19.86	19.85	19.85		(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

20.22	20.23	20.23	20.23	20.23	20.24	20.24	20.24	20.24	20.23	20.23	20.23		(92)

Adjusted mean internal temperature:

20.22	20.23	20.23	20.23	20.23	20.24	20.24	20.24	20.24	20.23	20.23	20.23		(93)

8. Space heating requirement

Utilisation factor for gains,

0.99	0.99	0.97	0.93	0.81	0.62	0.44	0.5	0.77	0.95	0.98	0.99	(94)

Useful gains, mGm , W

508.38	538.22	569.21	590.23	552.7	414.21	278.43	290.75	412.31	465.08	473.95	490.79	(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

1261.3	1211.61	1083.22	886.58	666.53	437.08	282.05	297.21	477.08	752.45	1029.03	1260.41	(97)

Space heating requirement for each month

560.17	452.52	382.43	213.38	84.69	0	0	0	0	213.8	399.66	572.6	(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

560.17	452.52	382.43	213.38	84.69	0	0	0	0	213.8	399.66	572.6	(98c)

Space heating requirement in kWh/m²/year 47.21 (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 %),													329.88	(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	
169.81	137.17	115.93	64.68	25.67	0	0	0		0	64.81	121.15	173.58		(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														
114.48	101.09	106.87	92.56	88.81	79.01	77.18	80.77		82.25	92.94	100.34	113.04	1129.33	(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													872.8	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1129.33	(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			0	(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													0	(231)
Electricity for lighting													189.31	(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			2191.44	

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		143.93	(240a)
Low-rate fraction	0		143.93	(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		143.93	(241a)
Low-rate fraction	0		143.93	(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		143.93	(242a)

Low-rate fraction	0		143.93	(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		186.23	(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		0	(249)
Energy For lighting	0		31.22	(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		361.37	(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)		1.23	(257)
SAP rating		80.1	(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			135.4	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			159.49	(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		0	(267)
Electricity for lighting		27.32	(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		322.22	(272)
Dwelling CO2 Emission Rate		5.28	(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			1374.11	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1719.08	(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			0	(281)
Electricity for lighting			290.37	(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			3383.56	(286)
Dwelling PE Rate			55.48	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.82 (1a)	x	3	(2a) =	155.46	(3a)
Total floor area TFA					51.82	(4)
Dwelling volume					155.46	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34	3.85	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	5.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.7	3886.5	(28b)
Basement wall	0	0	(29)
External wall	7.58	11075.1	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.35	(31)
Party Wall	0	5482.8	(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)	21.26	(33)
Heat capacity Cm = ∑(A x k)	20444.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	12.8	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	12.8	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	34.06	(37)

Ventilation heat loss calculated monthly

29.24	29.1	28.97	28.32	28.2	27.64	27.64	27.54	27.86	28.2	28.45	28.7	(38)

Heat transfer coefficient, W/K

63.3	63.16	63.02	62.38	62.26	61.7	61.7	61.6	61.92	62.26	62.51	62.76	(39)

Heat loss parameter (HLP), W/m²K

1.22	1.22	1.22	1.2	1.2	1.19	1.19	1.19	1.19	1.2	1.21	1.21	(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 1.74 (42)

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

73.5	72.4	70.79	67.71	65.44	62.9	61.46	63.06	64.81	67.53	70.68	73.22	(42a)

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

24.33	23.97	23.46	22.52	21.82	21.04	20.62	21.12	21.67	22.51	23.46	24.25	(42b)

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

34.2	32.95	31.71	30.47	29.22	27.98	27.98	29.22	30.47	31.71	32.95	34.2	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 121.61 (43)

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

132.03	129.32	125.96	120.7	116.48	111.92	110.06	113.4	116.95	121.75	127.09	131.66	1457.31 (44)

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

209.1	184.15	193.59	165.23	156.8	137.62	133.11	140.42	144.21	165.21	181.07	206.15	2016.65 (45)

Distribution loss (46) = 0.15 x (45)

31.37	27.62	29.04	24.78	23.52	20.64	19.97	21.06	21.63	24.78	27.16	30.92	(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):	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)

235.21 207.74 219.71 190.5 182.91 162.89 159.22 166.53 169.48 191.32 206.34 232.27 2324.13 (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)

235.21 207.74 219.71 190.5 182.91 162.89 159.22 166.53 169.48 191.32 206.34 232.27 2324.13 (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)]

69.53 61.23 64.37 54.94 52.14 45.76 44.26 46.69 47.95 54.93 60.21 68.55 (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

104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 (66)

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

25.06 22.26 18.1 13.7 10.24 8.65 9.35 12.15 16.3 20.7 24.16 25.76 (67)

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

226.8 229.16 223.23 210.6 194.66 179.68 169.68 167.32 173.25 185.88 201.82 216.8 (68)

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

47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	(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

-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	(71)

Water heating gains (Table 5)

93.45	91.12	86.52	76.3	70.08	63.55	59.49	62.75	66.6	73.83	83.62	92.13	(72)

Total internal gains

427.4	424.61	409.93	382.69	357.06	333.97	320.59	324.31	338.24	362.5	391.68	416.77	(73)

6. Solar gains

Solar gains in watts, calculated for each month

57.8	98.45	134.7	166.91	186.95	185.6	178.93	163.98	145.86	108.81	69.23	49.46	(83)

Total gains – internal and solar (watts)

485.19	523.06	544.63	549.6	544.01	519.56	499.52	488.29	484.09	471.31	460.91	466.23	(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	0.93	0.85	0.7	0.53	0.56	0.77	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)

19.9	19.9	19.91	19.92	19.92	19.93	19.93	19.93	19.92	19.92	19.92	19.91	(88)

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

0.98	0.97	0.95	0.91	0.8	0.61	0.41	0.44	0.69	0.9	0.97	0.99	(89)

Roof Mean internal temperature in the rest of dwelling T2

19.9	19.9	19.91	19.92	19.92	19.93	19.93	19.93	19.92	19.92	19.92	19.91	(90)

Living area fraction 0.45 (91)

Mean internal temperature (for the whole dwelling)

20.4	20.4	20.4	20.4	20.41	20.41	20.41	20.41	20.41	20.41	20.4	20.4	(92)

Adjusted mean internal temperature:

20.4	20.4	20.4	20.4	20.41	20.41	20.41	20.41	20.41	20.41	20.4	20.4	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.98	0.96	0.92	0.83	0.65	0.46	0.5	0.73	0.92	0.97	0.99	(94)

Useful gains, mGm , W

477.82	510.7	522.23	504.87	450.25	338.1	231.96	242.67	353.63	432.08	448.69	460.29	(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

1018.95	978.88	875.99	717.69	542.04	358.53	235.12	247.1	390.62	610.53	831.55	1016.8	(97)

Space heating requirement for each month

402.6	314.62	263.2	153.23	68.29	0	0	0	0	132.77	275.66	414.04	(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

402.6	314.62	263.2	153.23	68.29	0	0	0	0	132.77	275.66	414.04	(98c)

Space heating requirement in kWh/m²/year 39.07 (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 %),												322	(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	
125.03	97.71	81.74	47.59	21.21	0	0	0	0	41.23	85.61	128.58		(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													
106.58	94.13	99.56	86.32	82.88	73.81	72.15	75.46	76.8	86.7	93.5	105.25	1053.14	(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												628.69	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1053.14	(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		0	(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												0	(231)
Electricity for lighting												177.03	(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												1858.87	

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		103.67	(240a)
Low-rate fraction	0		103.67	(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		103.67	(241a)
Low-rate fraction	0		103.67	(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		103.67	(242a)

Low-rate fraction	0		103.67	(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		173.66	(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		0	(249)
Energy For lighting	0		29.19	(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		306.53	(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)		1.14	(257)
SAP rating		81.52	(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			97.62	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			148.7	(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		0	(267)
Electricity for lighting		25.55	(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		271.87	(272)
Dwelling CO2 Emission Rate		5.25	(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			990.09	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			1603.01	(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			0	(281)
Electricity for lighting			271.54	(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			2864.64	(286)
Dwelling PE Rate			55.28	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.55 (1a)	x	3	(2a) =	253.65	(3a)
Total floor area TFA					84.55	(4)
Dwelling volume					253.65	(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	3	x	10 =	30	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.12	0.12	(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)	0.37	0.37	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.31	(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)

0.4	0.39	0.38	0.34	0.34	0.3	0.3	0.29	0.31	0.34	0.35	0.37	4.11	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

Effective air change rate from PCDB:

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	17.83		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	9.3	6341.25	(28b)
Basement wall	0	0	(29)
External wall	8.76	12807.9	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		169.63	(31)
Party Wall	0	9745.2	(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)	37.99	(33)
Heat capacity Cm = ∑(A x k)	28894.35	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	22.66	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	22.66	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	60.65	(37)

Ventilation heat loss calculated monthly

48.52	48.26	48.01	46.81	46.59	45.55	45.55	45.36	45.95	46.59	47.04	47.51	(38)

Heat transfer coefficient, W/K

109.17	108.91	108.66	107.47	107.24	106.21	106.21	106.01	106.61	107.24	107.7	108.17	(39)

Heat loss parameter (HLP), W/m²K

1.29	1.29	1.29	1.27	1.27	1.26	1.26	1.25	1.26	1.27	1.27	1.28	(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)

91.94	90.56	88.55	84.69	81.85	78.68	76.88	78.88	81.07	84.47	88.41	91.59	(42a)

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

30.4	29.95	29.31	28.14	27.26	26.29	25.76	26.39	27.08	28.12	29.32	30.3	(42b)

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

42.82	41.26	39.71	38.15	36.59	35.03	35.03	36.59	38.15	39.71	41.26	42.82	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	152.12	(43)

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

165.16	161.77	157.56	150.98	145.7	140	137.67	141.86	146.3	152.3	158.99	164.7	1823 (44)

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

261.57	230.36	242.17	206.69	196.14	172.15	166.51	175.65	180.4	206.67	226.51	257.89	2522.7 (45)

Distribution loss (46) = 0.15 x (45)

39.24	34.55	36.33	31	29.42	25.82	24.98	26.35	27.06	31	33.98	38.68	(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)

389.95 346.31 370.55 330.92 324.52 214.07 209.82 218.97 222.31 335.05 350.74 386.26 3699.47 (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)

389.95 346.31 370.55 330.92 324.52 214.07 209.82 218.97 222.31 335.05 350.74 386.26 3699.47 (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)]

189.67 169.36 183.22 168.11 167.92 90.77 90.01 93.06 93.52 171.42 174.7 188.45 (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

152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 152.61 (66)

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

35.82 31.81 25.87 19.59 14.64 12.36 13.36 17.36 23.3 29.59 34.53 36.81 (67)

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

341.32 344.87 335.94 316.94 292.95 270.41 255.35 251.81 260.73 279.74 303.72 326.26 (68)

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

	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	(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

	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	-101.74	(71)

Water heating gains (Table 5)

	254.94	252.02	246.27	233.49	225.7	126.07	120.99	125.07	129.88	230.4	242.64	253.29	(72)

Total internal gains

	738.76	735.37	714.76	676.69	639.97	512.52	493.37	497.92	517.59	646.4	687.57	723.05	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	67.33	130.52	220.63	343.84	449.46	474.5	445.69	362.58	262.61	155.59	83.53	55.76	(83)

Total gains – internal and solar (watts)

	806.09	865.9	935.38	1020.53	1089.43	987.02	939.06	860.5	780.21	801.99	771.1	778.8	(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	0.91	0.78	0.65	0.49	0.55	0.8	0.93	0.98	0.99	(86)

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

	19.73	19.88	20.16	20.53	20.82	20.95	20.99	20.98	20.86	20.54	20.08	19.7	(87)

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

	19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(88)

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

	0.98	0.97	0.95	0.88	0.72	0.55	0.37	0.42	0.71	0.9	0.97	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	18.41	18.6	18.96	19.41	19.73	19.85	19.87	19.87	19.78	19.43	18.86	18.38	(90)

Living area fraction 0.44 (91)

Mean internal temperature (for the whole dwelling)

	19	19.17	19.49	19.91	20.21	20.33	20.37	20.36	20.26	19.92	19.4	18.97	(92)

Adjusted mean internal temperature:

	19	19.17	19.49	19.91	20.21	20.33	20.37	20.36	20.26	19.92	19.4	18.97	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.94	0.88	0.74	0.59	0.42	0.48	0.75	0.9	0.96	0.98	(94)

Useful gains, mGm , W

788.63	838.76	882.65	895.73	809.95	583.1	395.79	412.52	582.07	722.05	743.56	764.09	(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

1604.33	1554.13	1411.63	1183.1	912.86	609.06	400.04	420.08	656.48	999.73	1324.8	1597.45	(97)

Space heating requirement for each month

606.88	480.73	393.57	206.91	76.57	0	0	0	0	206.6	418.49	620.02	(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

606.88	480.73	393.57	206.91	76.57	0	0	0	0	206.6	418.49	620.02	(98c)

Space heating requirement in kWh/m²/year 35.6 (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 %),													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	
242.85	192.37	157.49	82.8	30.64	0	0	0	0	82.67	167.46	248.11			(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					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														
222.7	197.78	211.62	188.99	185.34	122.25	119.83	125.05	126.96	191.35	200.31	220.6		2112.77	(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													1204.38	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													2112.77	(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			0	(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													0	(231)
Electricity for lighting													253.03	(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			3570.19	

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		198.6	(240a)
Low-rate fraction	0		198.6	(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		198.6	(241a)
Low-rate fraction	0		198.6	(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		198.6	(242a)

Low-rate fraction	0		198.6	(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		348.4	(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		0	(249)
Energy For lighting	0		41.73	(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		588.72	(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)	1.64	(257)
SAP rating	73.48	(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			187.31	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			301.51	(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		0	(267)
Electricity for lighting		36.52	(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		525.34	(272)
Dwelling CO2 Emission Rate		6.21	(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			1897.88	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3227.89	(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			0	(281)
Electricity for lighting			388.11	(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			5513.88	(286)
Dwelling PE Rate			65.21	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	61.3	(1a) x	3	(2a) =	183.9	(3a)
Total floor area TFA					61.3	(4)
Dwelling volume					183.9	(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	3	x	10	=	30 (7a)
Number of passive vents	0	x	10	=	0 (7b)
Number of flueless gas fires	0	x	40	=	0 (7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.16	0.16	(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)	0.41	0.41	(18)
Number of sides on which dwelling is sheltered	2	2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.35	(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)

0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.4	0.41	4.61	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0		(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

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

Effective air change rate

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59		(25)

Effective air change rate from PCDB:

0.6	0.6	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59		(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	2.1		(26)
Windows	7.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.74	4597.5	(28b)
Basement wall	0	0	(29)
External wall	7.35	10742.6	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		126.83	(31)
Party Wall	0	9250.2	(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)	24.08	(33)
Heat capacity Cm = ∑(A x k)	24590.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.29	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.29	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	40.37	(37)

Ventilation heat loss calculated monthly

36.43	36.19	35.96	34.87	34.67	33.72	33.72	33.55	34.09	34.67	35.08	35.51	(38)

Heat transfer coefficient, W/K

76.8	76.56	76.33	75.25	75.04	74.09	74.09	73.92	74.46	75.04	75.45	75.88	(39)

Heat loss parameter (HLP), W/m²K

1.25	1.25	1.25	1.23	1.22	1.21	1.21	1.21	1.21	1.22	1.23	1.24	(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 2.02 (42)

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

79.83	78.63	76.88	73.54	71.07	68.31	66.75	68.49	70.39	73.34	76.76	79.52	(42a)

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

26.41	26.02	25.47	24.45	23.68	22.84	22.38	22.93	23.53	24.43	25.47	26.32	(42b)

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

37.16	35.8	34.45	33.1	31.75	30.4	30.4	31.75	33.1	34.45	35.8	37.16	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 132.07 (43)

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

143.39	140.45	136.8	131.09	126.5	121.55	119.53	123.17	127.02	132.23	138.04	143	1582.77 (44)

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

227.1	200	210.26	179.45	170.3	149.46	144.56	152.51	156.63	179.43	196.66	223.9	2190.26 (45)

Distribution loss (46) = 0.15 x (45)

34.07	30	31.54	26.92	25.54	22.42	21.68	22.88	23.49	26.91	29.5	33.59	(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)

355.48 315.95 338.63 303.69 298.68 191.38 187.88 195.82 198.54 307.81 320.89 352.28 3367.03 (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)

355.48 315.95 338.63 303.69 298.68 191.38 187.88 195.82 198.54 307.81 320.89 352.28 3367.03 (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)]

178.21 159.26 172.61 159.06 159.33 83.23 82.72 85.36 85.61 162.36 164.78 177.15 (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

121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 121.09 (66)

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

29.19 25.93 21.08 15.96 11.93 10.07 10.88 14.15 18.99 24.11 28.14 30 (67)

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

263 265.73 258.86 244.22 225.73 208.36 196.76 194.03 200.91 215.55 234.03 251.4 (68)

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

49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13	49.13		(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

-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73	-80.73		(71)

Water heating gains (Table 5)

239.53	237	232.01	220.91	214.15	115.6	111.18	114.73	118.9	218.23	228.86	238.1		(72)

Total internal gains

624.22	621.15	604.44	573.58	544.3	423.52	408.31	412.4	428.29	550.38	583.52	611.99		(73)

6. Solar gains

Solar gains in watts, calculated for each month

77.48	131.97	180.57	223.73	250.6	248.79	239.86	219.81	195.52	145.85	92.8	66.3		(83)

Total gains – internal and solar (watts)

701.69	753.12	785	797.31	794.9	672.31	648.17	632.21	623.81	696.23	676.32	678.3		(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	0.93	0.88	0.77	0.66	0.49	0.53	0.74	0.87	0.95	0.98		(86)

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

19.97	20.12	20.36	20.64	20.85	20.95	20.99	20.99	20.91	20.7	20.3	19.95		(87)

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

19.88	19.88	19.88	19.9	19.9	19.91	19.91	19.92	19.91	19.9	19.9	19.89		(88)

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

0.96	0.95	0.91	0.84	0.71	0.57	0.38	0.41	0.65	0.83	0.94	0.97		(89)

Roof Mean internal temperature in the rest of dwelling T2

18.73	18.93	19.21	19.55	19.78	19.88	19.91	19.91	19.85	19.63	19.16	18.71		(90)

Living area fraction 0.58 (91)

Mean internal temperature (for the whole dwelling)

19.46	19.63	19.88	20.18	20.41	20.51	20.54	20.54	20.47	20.26	19.83	19.43		(92)

Adjusted mean internal temperature:

19.46	19.63	19.88	20.18	20.41	20.51	20.54	20.54	20.47	20.26	19.83	19.43		(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.94	0.91	0.85	0.74	0.62	0.45	0.48	0.7	0.84	0.94	0.97	(94)

Useful gains, mGm , W

674.27	711.53	717.56	679.07	586.21	416.7	288.54	301.17	436.07	587	632.88	654.79	(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

1163.96	1127.46	1021.42	849.13	653.39	437.6	291.98	305.95	474.23	724.56	960.37	1155.87	(97)

Space heating requirement for each month

364.33	279.51	226.07	122.44	49.98	0	0	0	0	102.34	235.79	372.8	(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

364.33	279.51	226.07	122.44	49.98	0	0	0	0	102.34	235.79	372.8	(98c)

Space heating requirement in kWh/m²/year 28.6 (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	
145.79	111.85	90.47	49	20	0	0	0	0	40.95	94.35	149.18			(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														
203.01	180.44	193.39	173.44	170.57	109.3	107.3	111.83	113.39	175.79	183.26	201.19		1922.92	(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													701.59	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1922.92	(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			0	(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													0	(231)
Electricity for lighting													206.2	(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			2830.7	

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		115.69	(240a)
Low-rate fraction	0		115.69	(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		115.69	(241a)
Low-rate fraction	0		115.69	(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		115.69	(242a)

Low-rate fraction	0		115.69	(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		317.09	(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		0	(249)
Energy For lighting	0		34	(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		466.78	(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)		1.58	(257)
SAP rating		74.37	(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			109.28	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			274.63	(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		0	(267)
Electricity for lighting		29.76	(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		413.67	(272)
Dwelling CO2 Emission Rate		6.75	(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			1106.17	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2938.64	(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			0	(281)
Electricity for lighting			316.27	(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			4361.08	(286)
Dwelling PE Rate			71.14	(287)

SAP WORKSHEET

Dwelling Reference: Unit 03
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	84.71 (1a)	x	3	(2a) =	254.13	(3a)
Total floor area TFA					84.71	(4)
Dwelling volume					254.13	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.08	0.08	(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)	0.33	0.33	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.25	(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)

0.32	0.32	0.31	0.28	0.27	0.24	0.24	0.24	0.25	0.27	0.29	0.3	3.34	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(24d)

Effective air change rate

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

Effective air change rate from PCDB:

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	12.97		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.74	4597.5	(28b)
Basement wall	0	0	(29)
External wall	10.5	15352	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		155.53	(31)
Party Wall	0	6274.8	(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)	32.32	(33)
Heat capacity Cm = ∑(A x k)	26224.3	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	21.94	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	21.94	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	54.26	(37)

Ventilation heat loss calculated monthly

46.35	46.18	46.01	45.22	45.08	44.39	44.39	44.26	44.65	45.08	45.38	45.69	(38)

Heat transfer coefficient, W/K

100.61	100.44	100.27	99.48	99.33	98.64	98.64	98.52	98.91	99.33	99.63	99.94	(39)

Heat loss parameter (HLP), W/m²K

1.19	1.19	1.18	1.17	1.17	1.16	1.16	1.16	1.17	1.17	1.18	1.18	(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 2.55 (42)

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

92	90.62	88.61	84.75	81.91	78.73	76.93	78.93	81.12	84.53	88.46	91.65	(42a)

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

30.42	29.97	29.33	28.16	27.28	26.3	25.78	26.41	27.1	28.14	29.34	30.32	(42b)

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

42.85	41.29	39.73	38.17	36.62	35.06	35.06	36.62	38.17	39.73	41.29	42.85	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 152.22 (43)

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

165.27	161.88	157.67	151.08	145.8	140.1	137.77	141.96	146.39	152.4	159.09	164.81	1824.2	(44)

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

261.74	230.51	242.33	206.82	196.27	172.26	166.62	175.77	180.52	206.8	226.66	258.06	2524.36	(45)

Distribution loss (46) = 0.15 x (45)

39.26	34.58	36.35	31.02	29.44	25.84	24.99	26.37	27.08	31.02	34	38.71	(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)

390.12 346.46 370.71 331.06 324.65 214.18 209.93 219.08 222.43 335.18 350.89 386.43 3701.13 (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)

390.12 346.46 370.71 331.06 324.65 214.18 209.93 219.08 222.43 335.18 350.89 386.43 3701.13 (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)]

189.73 169.41 183.28 168.16 167.96 90.81 90.05 93.09 93.55 171.46 174.75 188.51 (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

152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 152.77 (66)

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

38.2 33.93 27.59 20.89 15.61 13.18 14.24 18.51 24.85 31.55 36.83 39.26 (67)

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

341.79 345.34 336.4 317.38 293.36 270.78 255.7 252.16 261.09 280.12 304.14 326.71 (68)

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

	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	(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

	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	-101.85	(71)

Water heating gains (Table 5)

	255.02	252.09	246.34	233.55	225.76	126.13	121.04	125.13	129.94	230.46	242.71	253.37	(72)

Total internal gains

	741.76	738.11	717.08	678.56	641.48	513.84	494.73	499.54	519.63	648.88	690.43	726.09	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	38.44	76.95	136.62	223.16	300.13	320.29	299.48	238.47	165.93	93.42	48.11	31.57	(83)

Total gains – internal and solar (watts)

	780.19	815.06	853.7	901.73	941.61	834.13	794.21	738.02	685.56	742.3	738.53	757.65	(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	0.82	0.7	0.53	0.59	0.83	0.94	0.98	0.99	(86)

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

	19.86	19.97	20.21	20.54	20.81	20.94	20.99	20.98	20.86	20.57	20.17	19.83	(87)

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

	19.93	19.93	19.93	19.94	19.94	19.95	19.95	19.95	19.95	19.94	19.94	19.94	(88)

Roof

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

	0.98	0.98	0.96	0.9	0.77	0.61	0.41	0.47	0.75	0.91	0.97	0.99	(89)

Roof

Mean internal temperature in the rest of dwelling T2

	18.63	18.78	19.08	19.48	19.79	19.91	19.94	19.94	19.85	19.53	19.03	18.6	(90)

Living area fraction 0.36 (91)

Mean internal temperature (for the whole dwelling)

	19.07	19.21	19.48	19.86	20.16	20.28	20.32	20.31	20.21	19.91	19.44	19.04	(92)

Adjusted mean internal temperature:

	19.07	19.21	19.48	19.86	20.16	20.28	20.32	20.31	20.21	19.91	19.44	19.04	(93)

8. Space heating requirement

Utilisation factor for gains,

0.98	0.97	0.95	0.9	0.78	0.64	0.46	0.51	0.78	0.91	0.97	0.98	(94)

Useful gains, mGm , W

764.04	792.41	813.38	811.48	735.42	532.37	362.43	378.1	531.84	674.53	713.46	743.83	(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

1485.95	1436.99	1301.92	1090.07	839.86	560.39	366.69	385.5	604.17	924.33	1229.1	1483.28	(97)

Space heating requirement for each month

537.1	433.16	363.47	200.59	77.7	0	0	0	0	185.85	371.26	550.15	(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

537.1	433.16	363.47	200.59	77.7	0	0	0	0	185.85	371.26	550.15	(98c)

Space heating requirement in kWh/m²/year 32.1 (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	
214.93	173.33	145.45	80.27	31.09	0	0	0	0	74.37	148.56	220.15			(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														
222.8	197.87	211.71	189.07	185.41	122.32	119.89	125.12	127.03	191.42	200.4	220.69		2113.72	(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													1088.15	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													2113.72	(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			0	(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													0	(231)
Electricity for lighting													269.83	(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			3471.71	

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		179.44	(240a)
Low-rate fraction	0		179.44	(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		179.44	(241a)
Low-rate fraction	0		179.44	(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		179.44	(242a)

Low-rate fraction	0		179.44	(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		348.55	(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		0	(249)
Energy For lighting	0		44.5	(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		572.48	(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)		1.59	(257)
SAP rating		74.24	(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			169.03	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			301.64	(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		0	(267)
Electricity for lighting		38.95	(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		509.62	(272)
Dwelling CO2 Emission Rate		6.02	(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			1713.97	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3229.34	(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			0	(281)
Electricity for lighting			413.88	(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			5357.19	(286)
Dwelling PE Rate			63.24	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.52 (1a)	x	3	(2a) =	154.56	(3a)
Total floor area TFA					51.52	(4)
Dwelling volume					154.56	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.35	3.86	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	10.29		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.67	3864	(28b)
Basement wall	0	0	(29)
External wall	7.14	10442.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.57	(31)
Party Wall	0	8044.2	(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)	25.21	(33)
Heat capacity Cm = ∑(A x k)	22350.6	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.72	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.72	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	41.93	(37)

Ventilation heat loss calculated monthly

29.09	28.95	28.81	28.17	28.05	27.49	27.49	27.39	27.71	28.05	28.29	28.55	(38)

Heat transfer coefficient, W/K

71.02	70.88	70.74	70.1	69.98	69.42	69.42	69.32	69.64	69.98	70.22	70.48	(39)

Heat loss parameter (HLP), W/m²K

1.38	1.38	1.37	1.36	1.36	1.35	1.35	1.35	1.35	1.36	1.36	1.37	(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	1.73	(42)

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

73.3	72.2	70.59	67.52	65.25	62.73	61.29	62.88	64.63	67.34	70.48	73.02	(42a)

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

24.26	23.9	23.39	22.46	21.76	20.98	20.56	21.06	21.61	22.44	23.4	24.18	(42b)

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

34.1	32.86	31.62	30.38	29.14	27.9	27.9	29.14	30.38	31.62	32.86	34.1	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J)	121.27	(43)

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

131.66	128.96	125.61	120.36	116.15	111.61	109.75	113.09	116.62	121.41	126.74	131.3	1453.27 (44)

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

208.52	183.64	193.05	164.77	156.36	137.24	132.74	140.03	143.81	164.75	180.57	205.58	2011.05 (45)

Distribution loss (46) = 0.15 x (45)

31.28	27.55	28.96	24.72	23.45	20.59	19.91	21	21.57	24.71	27.08	30.84	(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)

336.9 299.59 321.43 289 284.74 179.15 176.05 183.34 185.73 293.13 304.8 333.96 3187.82 (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)

336.9 299.59 321.43 289 284.74 179.15 176.05 183.34 185.73 293.13 304.8 333.96 3187.82 (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)]

172.03 153.82 166.89 154.17 154.69 79.16 78.79 81.21 81.35 157.48 159.43 171.06 (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

104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 104.09 (66)

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

22.1 19.63 15.97 12.09 9.04 7.63 8.24 10.71 14.38 18.26 21.31 22.72 (67)

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

225.64 227.98 222.08 209.52 193.67 178.76 168.81 166.47 172.37 184.93 200.78 215.69 (68)

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

47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	47.14	(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

-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	-69.4	(71)

Water heating gains (Table 5)

231.23	228.9	224.32	214.13	207.92	109.95	105.89	109.15	112.99	211.67	221.43	229.92	(72)

Total internal gains

563.82	561.36	547.21	520.58	495.46	378.18	364.79	368.18	381.57	499.7	528.36	553.16	(73)

6. Solar gains

Solar gains in watts, calculated for each month

31	63.1	113.69	186.71	250.97	267.56	250.3	199.54	138.53	77.11	39.01	25.32	(83)

Total gains – internal and solar (watts)

594.82	624.46	660.9	707.29	746.43	645.74	615.08	567.71	520.1	576.81	567.37	578.48	(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	0.97	0.94	0.88	0.76	0.64	0.49	0.54	0.78	0.9	0.96	0.98	(86)

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

19.79	19.93	20.19	20.55	20.83	20.94	20.99	20.98	20.85	20.58	20.14	19.76	(87)

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

19.78	19.78	19.78	19.79	19.8	19.8	19.8	19.81	19.8	19.8	19.79	19.79	(88)

Roof

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

0.97	0.96	0.92	0.84	0.69	0.54	0.36	0.41	0.69	0.86	0.95	0.97	(89)

Roof

Mean internal temperature in the rest of dwelling T2

18.44	18.61	18.94	19.37	19.66	19.77	19.8	19.8	19.71	19.41	18.88	18.41	(90)

Living area fraction 0.42 (91)

Mean internal temperature (for the whole dwelling)

19.01	19.17	19.47	19.87	20.15	20.27	20.3	20.3	20.19	19.91	19.41	18.98	(92)

Adjusted mean internal temperature:

19.01	19.17	19.47	19.87	20.15	20.27	20.3	20.3	20.19	19.91	19.41	18.98	(93)

8. Space heating requirement

Utilisation factor for gains,

0.96	0.95	0.92	0.85	0.71	0.58	0.41	0.47	0.72	0.86	0.94	0.96	(94)

Useful gains, mGm , W

571.69	592.96	607.75	599.22	530.11	375.08	253.91	264.89	376.76	496.58	533.25	558.12	(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

1044.68	1011.18	917.72	768.84	591.68	393.38	257.06	270.22	424.21	651.22	864.59	1041.83	(97)

Space heating requirement for each month

351.9	281.04	230.61	122.12	45.81	0	0	0	0	115.05	238.57	359.89	(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

351.9	281.04	230.61	122.12	45.81	0	0	0	0	115.05	238.57	359.89	(98c)

Space heating requirement in kWh/m²/year 33.87 (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	
140.82	112.46	92.28	48.87	18.33	0	0	0	0	46.04	95.46	144.01		(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													
192.4	171.1	183.57	165.05	162.62	102.31	100.54	104.71	106.07	167.41	174.07	190.72	1820.57	(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												698.28	(211)
Space heating fuel used, main system 2												0	(213)
Space heating fuel used, secondary												0	(215)
Water heating fuel used												1820.57	(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		0	(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												0	(231)
Electricity for lighting												156.14	(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			2674.99	

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		115.15	(240a)
Low-rate fraction	0		115.15	(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		115.15	(241a)
Low-rate fraction	0		115.15	(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		115.15	(242a)

Low-rate fraction	0		115.15	(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		300.21	(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		0	(249)
Energy For lighting	0		25.75	(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		441.11	(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)		1.65	(257)
SAP rating		73.33	(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			108.62	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			260.14	(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		0	(267)
Electricity for lighting		22.54	(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		391.3	(272)
Dwelling CO2 Emission Rate		7.6	(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			1100.44	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2782.71	(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			0	(281)
Electricity for lighting			239.49	(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			4122.64	(286)
Dwelling PE Rate			80.02	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	60.99 (1a)	x	3	(2a) =	182.97	(3a)
Total floor area TFA					60.99	(4)
Dwelling volume					182.97	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.11	0.11	(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)	0.36	0.36	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.28	(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)

0.36	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33	3.65	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

Effective air change rate

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

Effective air change rate from PCDB:

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	11.39		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	6.71	4574.25	(28b)
Basement wall	0	0	(29)
External wall	8.47	12380.4	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		138.2	(31)
Party Wall	0	7650	(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)	28.67	(33)
Heat capacity Cm = ∑(A x k)	24604.65	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	16.54	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	16.54	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	45.21	(37)

Ventilation heat loss calculated monthly

34	33.85	33.7	33.02	32.9	32.3	32.3	32.19	32.53	32.9	33.15	33.42	(38)

Heat transfer coefficient, W/K

79.21	79.06	78.91	78.23	78.11	77.51	77.51	77.4	77.74	78.11	78.36	78.63	(39)

Heat loss parameter (HLP), W/m²K

1.3	1.3	1.29	1.28	1.28	1.27	1.27	1.27	1.27	1.28	1.28	1.29	(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 2.01 (42)

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

79.63	78.43	76.69	73.35	70.89	68.14	66.58	68.31	70.21	73.16	76.57	79.32	(42a)

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

26.34	25.95	25.4	24.39	23.63	22.78	22.33	22.87	23.47	24.37	25.41	26.26	(42b)

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

37.06	35.71	34.37	33.02	31.67	30.32	30.32	31.67	33.02	34.37	35.71	37.06	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 131.74 (43)

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

143.04	140.1	136.46	130.76	126.19	121.25	119.23	122.86	126.7	131.9	137.69	142.64	1578.81 (44)

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

226.53	199.5	209.73	179	169.87	149.09	144.2	152.13	156.23	178.98	196.17	223.34	2184.78 (45)

Distribution loss (46) = 0.15 x (45)

33.98	29.93	31.46	26.85	25.48	22.36	21.63	22.82	23.43	26.85	29.42	33.5	(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)

354.91 315.45 338.11 303.24 298.25 191.01 187.52 195.44 198.15 307.36 320.4 351.72 3361.55 (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)

354.91 315.45 338.11 303.24 298.25 191.01 187.52 195.44 198.15 307.36 320.4 351.72 3361.55 (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)]

178.02 159.1 172.44 158.91 159.18 83.11 82.6 85.23 85.48 162.21 164.61 176.96 (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

120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 120.57 (66)

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

26.8 23.8 19.36 14.65 10.95 9.25 9.99 12.99 17.43 22.14 25.84 27.54 (67)

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

261.85 264.56 257.72 243.14 224.74 207.44 195.89 193.17 200.02 214.6 233 250.29 (68)

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

	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	49.07	(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

	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	-80.38	(71)

Water heating gains (Table 5)

	239.28	236.75	231.77	220.7	213.96	115.42	111.02	114.56	118.72	218.03	228.63	237.85	(72)

Total internal gains

	620.18	617.37	601.1	570.75	541.91	421.37	406.16	409.98	425.43	547.02	579.72	607.95	(73)

6. Solar gains

Solar gains in watts, calculated for each month

	34.31	69.84	125.83	206.64	277.77	296.13	277.03	220.85	153.32	85.35	43.17	28.02	(83)

Total gains – internal and solar (watts)

	654.49	687.21	726.93	777.4	819.68	717.51	683.18	630.83	578.76	632.37	622.89	635.96	(84)

7. Mean internal temperature (heating season)

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

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

	0.98	0.97	0.95	0.89	0.77	0.65	0.49	0.55	0.79	0.91	0.97	0.98	(86)

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

	19.83	19.96	20.22	20.57	20.84	20.95	20.99	20.98	20.86	20.59	20.16	19.81	(87)

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

	19.84	19.84	19.85	19.85	19.86	19.86	19.86	19.87	19.86	19.86	19.85	19.85	(88)

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

	0.97	0.96	0.94	0.86	0.71	0.55	0.37	0.42	0.7	0.87	0.95	0.98	(89)

Roof Mean internal temperature in the rest of dwelling T2

	18.54	18.7	19.02	19.44	19.73	19.83	19.86	19.86	19.77	19.48	18.96	18.51	(90)

Living area fraction 0.33 (91)

Mean internal temperature (for the whole dwelling)

	18.96	19.12	19.42	19.81	20.09	20.2	20.23	20.23	20.13	19.85	19.36	18.94	(92)

Adjusted mean internal temperature:

	18.96	19.12	19.42	19.81	20.09	20.2	20.23	20.23	20.13	19.85	19.36	18.94	(93)

8. Space heating requirement

Utilisation factor for gains,

0.97	0.96	0.93	0.86	0.72	0.58	0.41	0.46	0.73	0.87	0.95	0.97	(94)

Useful gains, mGm , W

632.77	657.11	674.68	666.89	590.05	416.48	278.85	291.62	420.58	551.29	590.19	617.04	(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

1161.56	1124.11	1019.61	853.56	655.52	434.16	281.57	296.38	468.94	722.14	960.57	1158.76	(97)

Space heating requirement for each month

393.42	313.83	256.63	134.4	48.71	0	0	0	0	127.11	266.68	403.04	(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

393.42	313.83	256.63	134.4	48.71	0	0	0	0	127.11	266.68	403.04	(98c)

Space heating requirement in kWh/m²/year 31.87 (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	
157.43	125.58	102.69	53.78	19.49	0	0	0	0	50.86	106.71	161.28			(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														
202.69	180.16	193.09	173.18	170.33	109.08	107.09	111.62	113.16	175.53	182.98	200.87		1919.79	(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													777.83	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1919.79	(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			0	(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													0	(231)
Electricity for lighting													189.31	(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			2886.93	

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		128.26	(240a)
Low-rate fraction	0		128.26	(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		128.26	(241a)
Low-rate fraction	0		128.26	(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		128.26	(242a)

Low-rate fraction	0		128.26	(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		316.57	(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		0	(249)
Energy For lighting	0		31.22	(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		476.06	(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)		1.62	(257)
SAP rating		73.79	(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			121.05	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			274.18	(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		0	(267)
Electricity for lighting		27.32	(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		422.56	(272)
Dwelling CO2 Emission Rate		6.93	(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			1225.99	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2933.87	(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			0	(281)
Electricity for lighting			290.37	(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			4450.24	(286)
Dwelling PE Rate			72.97	(287)

SAP WORKSHEET

Dwelling Reference: Unit 02
Dwelling Type: Existing Dwelling
EN5 5SU

1. Overall dwelling dimensions

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground Floor	51.82 (1a)	x	3	(2a) =	155.46	(3a)
Total floor area TFA					51.82	(4)
Dwelling volume					155.46	(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	2	x	10 =	20	(7a)
Number of passive vents	0	x	10 =	0	(7b)
Number of flueless gas fires	0	x	40 =	0	(7c)

Air changes per hour

Number of storeys in the dwelling (ns)	0.13	0.13	(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)	0.38	0.38	(18)
Number of sides on which dwelling is sheltered	3	3	(19)
Shelter factor		0.78	(20)
Infiltration rate incorporating shelter factor		0.29	(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)

0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34	3.85	(22b)

Calculate effective air change rate for the applicable case:

0	(23a)
0	(23b)
0	(23c)

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

0	0	0	0	0	0	0	0	0	0	0	0	(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

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

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

Effective air change rate from PCDB:

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

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	2.1		(26)
Windows	5.89		(27)
Roof window	0		(27a)
Basement floor	0	0	(28)
Ground floor	0	0	(28a)
Exposed floor	5.7	3886.5	(28b)
Basement wall	0	0	(29)
External wall	7.58	11075.1	(29a)
Roof	0	0	(30)
Total area of external elements ∑A, m²		117.35	(31)
Party Wall	0	5482.8	(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)	21.26	(33)
Heat capacity Cm = ∑(A x k)	20444.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	(35)
Linear Thermal bridges: ∑ (L x Ψ) calculated using Appendix K	12.8	(36)
Point Thermal bridges: ∑χ (W/K) if significant point thermal bridge present and values available	12.8	(36a)
Total fabric heat loss H = ∑(A × U) + ∑(L × Ψ) +∑χ	34.06	(37)

Ventilation heat loss calculated monthly

29.24	29.1	28.97	28.32	28.2	27.64	27.64	27.54	27.86	28.2	28.45	28.7	(38)

Heat transfer coefficient, W/K

63.3	63.16	63.02	62.38	62.26	61.7	61.7	61.6	61.92	62.26	62.51	62.76	(39)

Heat loss parameter (HLP), W/m²K

1.22	1.22	1.22	1.2	1.2	1.19	1.19	1.19	1.19	1.2	1.21	1.21	(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 1.74 (42)

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

73.5	72.4	70.79	67.71	65.44	62.9	61.46	63.06	64.81	67.53	70.68	73.22	(42a)

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

24.33	23.97	23.46	22.52	21.82	21.04	20.62	21.12	21.67	22.51	23.46	24.25	(42b)

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

34.2	32.95	31.71	30.47	29.22	27.98	27.98	29.22	30.47	31.71	32.95	34.2	(42c)

Annual average hot water usage in litres per day Vd,average (from Appendix J) 121.61 (43)

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

132.03	129.32	125.96	120.7	116.48	111.92	110.06	113.4	116.95	121.75	127.09	131.66	1457.31 (44)

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

209.1	184.15	193.59	165.23	156.8	137.62	133.11	140.42	144.21	165.21	181.07	206.15	2016.65 (45)

Distribution loss (46) = 0.15 x (45)

31.37	27.62	29.04	24.78	23.52	20.64	19.97	21.06	21.63	24.78	27.16	30.92	(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)

337.48 300.1 321.97 289.46 285.18 179.53 176.42 183.73 186.13 293.59 305.31 334.53 3193.42 (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)

337.48 300.1 321.97 289.46 285.18 179.53 176.42 183.73 186.13 293.59 305.31 334.53 3193.42 (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)]

172.23 153.99 167.07 154.33 154.84 79.29 78.91 81.34 81.48 157.63 159.59 171.25 (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

104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 104.63 (66)

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

25.06 22.26 18.1 13.7 10.24 8.65 9.35 12.15 16.3 20.7 24.16 25.76 (67)

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

226.8 229.16 223.23 210.6 194.66 179.68 169.68 167.32 173.25 185.88 201.82 216.8 (68)

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

47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	47.21	(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

-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	-69.75	(71)

Water heating gains (Table 5)

231.49	229.16	224.56	214.34	208.12	110.13	106.06	109.33	113.17	211.87	221.66	230.17	(72)

Total internal gains

568.44	565.65	550.97	523.73	498.1	380.54	367.16	370.88	384.81	503.54	532.72	557.81	(73)

6. Solar gains

Solar gains in watts, calculated for each month

57.8	98.45	134.7	166.91	186.95	185.6	178.93	163.98	145.86	108.81	69.23	49.46	(83)

Total gains – internal and solar (watts)

626.23	664.1	685.67	690.64	685.05	566.14	546.1	534.86	530.67	612.35	601.95	607.27	(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	0.86	0.75	0.66	0.49	0.52	0.73	0.85	0.94	0.97	(86)

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

20.08	20.21	20.43	20.68	20.87	20.95	20.99	20.99	20.92	20.74	20.38	20.05	(87)

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

19.9	19.9	19.91	19.92	19.92	19.93	19.93	19.93	19.92	19.92	19.92	19.91	(88)

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

0.96	0.94	0.9	0.83	0.69	0.56	0.37	0.4	0.64	0.81	0.92	0.96	(89)

Roof Mean internal temperature in the rest of dwelling T2

18.88	19.05	19.31	19.61	19.82	19.9	19.92	19.92	19.87	19.69	19.27	18.85	(90)

Living area fraction 0.45 (91)

Mean internal temperature (for the whole dwelling)

19.42	19.58	19.81	20.09	20.29	20.37	20.4	20.4	20.34	20.16	19.77	19.39	(92)

Adjusted mean internal temperature:

19.42	19.58	19.81	20.09	20.29	20.37	20.4	20.4	20.34	20.16	19.77	19.39	(93)

8. Space heating requirement

Utilisation factor for gains,

0.95	0.93	0.9	0.83	0.71	0.6	0.43	0.46	0.68	0.82	0.92	0.96	(94)

Useful gains, mGm , W

595.19	619.65	616.87	575.55	488.81	341.6	232.59	243.58	360.04	500.51	553.98	580.28	(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

957.1	926.91	839.08	698.1	534.95	356.29	234.76	246.61	386.57	595.48	791.98	953.39	(97)

Space heating requirement for each month

269.26	206.48	165.33	88.24	34.33	0	0	0	0	70.66	171.35	277.6	(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

269.26	206.48	165.33	88.24	34.33	0	0	0	0	70.66	171.35	277.6	(98c)

Space heating requirement in kWh/m²/year 24.76 (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 %),													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	
107.75	82.62	66.16	35.31	13.74	0	0	0	0	28.27	68.57	111.08			(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					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														
192.73	171.39	183.88	165.31	162.87	102.53	100.75	104.93	106.3	167.67	174.36	191.05		1823.77	(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													513.5	(211)
Space heating fuel used, main system 2													0	(213)
Space heating fuel used, secondary													0	(215)
Water heating fuel used													1823.77	(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			0	(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													0	(231)
Electricity for lighting													177.03	(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			2514.31	

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		84.68	(240a)
Low-rate fraction	0		84.68	(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		84.68	(241a)
Low-rate fraction	0		84.68	(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		84.68	(242a)

Low-rate fraction	0		84.68	(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		300.74	(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		0	(249)
Energy For lighting	0		29.19	(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		414.61	(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)		1.54	(257)
SAP rating		75.01	(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			80.07	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			260.59	(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		0	(267)
Electricity for lighting		25.55	(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		366.21	(272)
Dwelling CO2 Emission Rate		7.07	(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			809.95	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			2787.59	(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			0	(281)
Electricity for lighting			271.54	(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			3869.08	(286)
Dwelling PE Rate			74.66	(287)