



Sustainability Statement

North Street/Weldale Street, Reading

Client: Lochailort Thames Quarter

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Revision History

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1 Project Overview

1.1 Introduction

This sustainability study was prepared by Environmental Economics Ltd on behalf of Lochailort Thames Quarter. The report assesses measures to reduce the carbon emissions for the domestic housing on site through an improvement in materials and products used.

The address for the site is:

16 North Street
Reading
Berkshire
RG1 7DA

1.2 Description of Site

This report addresses a large domestic development being undertaken by Lochailort Thames Quarter, and does not include any further proposals for subsequent developments or non-residential parcels.

1.3 Policy Brief

The planning authority for this site is Reading Borough Council. The relevant conditions are as follows:

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

To meet these requirements: -

- A. All new housing is required to meet the most up to date Eco-homes (Code for sustainable homes) 'Very Good' as a minimum standard, and all new commercial developments are required to meet the most up to date BREEAM 'Very Good' as a minimum standard;*
- B. On developments of more than 10 dwellings or 1000m² of floor space, ensure that 50% of the provision meets the most up to date ECO-Homes (Code for Sustainable Homes) Excellent standards;*
- C. All new developments maximise the energy efficiency and energy conservation measures in their design layout and orientation to reduce overall energy demand;*

- D. All developments of more than 10 dwellings or 1000m² of floor space, to incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development;*
- E. All developments reduce mains water use and demonstrate that water conservation measures are incorporated so that predicted per capita consumption does not exceed the appropriate levels set out in the Code for Sustainable Home.*
- F. Developments incorporate sustainable urban drainage facilities and techniques as part of the layout of a development as appropriate and as advised by the Environment Agency, including minimising the size of impermeable areas so that peak run-off and annual water run-off is reduced where possible and in any case is no greater than the original conditions of the site. Particular care will be needed in areas of flood risk where different solutions may be required.*
- G. New buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other element;*
- H. Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measure such as solar shading, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, etc.;*
- I. Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets, designed with plants that carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and*
- J. All developments shall minimise the impact of surface water runoff from the development in the design of the drainage system.*
- K. Any development of more than 20 dwellings and/or non-residential development of over 1000m² shall consider the inclusion of a CHP plant, or biomass-fuelled heating scheme, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable or feasible for this form of energy provision.*
- L. Where there is existing decentralised energy provision including a CHP plant or district energy network present within the vicinity of an application site, further developments of over 10 dwellings or non-residential development of over 1000m² will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.*

Reason: To help mitigate and adapt to climate change and reduce greenhouse gas emissions in accordance with Core Strategy Policies CS.1 DM1 and DM2."

1.4 Policy CS.1 Sustainable Construction and Design

The policy will be promoted and implemented through the development control process in conjunction with policies contained within the ~Councils Development Control Document and the Councils Supplementary Planning Document on Sustainable Design and Construction.

1.4.1 Targets:

- *Increase in levels of new development achieving Eco-homes and BREEAM 'very good' and 'excellent' ratings to 100% by 2012*
- *Increase in the generation of energy from on-site renewable sources to 100% of major developments by 2012.*
- *50% of all minor and major applications to contain sustainable drainage systems bearing in mind that not all sites are suitable for the installation of sustainable drainage systems*

1.4.2 Indicators:

- *Renewable energy capacity installed by type from application details.*
- *Percentage of major developments achieving Eco-Homes and BREEAM 'Very good' and 'excellent' ratings.*
- *Number of planning applications that include sustainable drainage systems.*

1.5 Policy DM1: Adaptation to climate change

All developments will demonstrate how they been designed to incorporate measures to adapt to climate change.

1.5.1 Target:

The policy aims to ensure appropriate measure to adapt to climate change are incorporated within development. This policy will help improve the quality of life for those living, working, studying in and visiting the Borough, ensure new developments is accessible and sustainable and will meet the objectives of Reading Sustainable Community Strategy, which highlights the importance of environmental issues, climate change and sustainability.

1.5.2 Indicators:

The core strategy already includes a target and indicator for inclusion of sustainable drainage systems on 50% of schemes, which will continue to be monitored.

1.6 Policy DM2: Decentralised Energy

In meeting the most up to date Ecohomes or BREEAM standard, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source, including CHP.

1.6.1 Target:

The policy aims to provide a clear direction at to the types of sites and localities suitable for:

- 1) The introduction of decentralised energy, including CHP to the Borough*
- 2) Future connections to existing decentralised energy plants, thereby maximising opportunities for decentralised energy.*

This policy will help improve the quality of life for those living, workings, studying in and visiting the Borough, ensure new developments is accessible and sustainable and will meet the objectives of Reading Sustainable Community Strategy, which highlights the importance of environmental issues, climate change and sustainability.

1.7 Key Information

This section contains key information with regards to how this sustainability statement will progress the requirements of the building regulations and planning documents of Reading Borough Council.

1.7.1 Redacted/Altered Policy Points

1.7.1.1 Point A

It should be noted that the most recent version of Ecohomes – Code for Sustainable Homes – was withdrawn and is therefore no longer a requirement. The Code for Sustainable Homes manual can however be used as a guide to achieving sustainability as it sets out different performance standards that could be used to make a dwelling sustainable and energy efficient.

The North Street/Weldale Street development consists of 47 residential units and no non-residential units. This means that any BREEAM requirement does not apply to this build

Taking these points into account, point A in the policy brief is not relevant to this development.

1.7.1.2 Point B

As Code for Sustainable Homes is no longer applicable, this point is not relevant to this development. See section 1.7.1.1 Point A for more information as to why the Code for Sustainable Homes is no longer applicable.

1.7.1.3 Point D

It should be noted that due to recent changes to the building regulations, the requirement in Policy CS1 for the 'off-set to be at-least 20% of predicted carbon dioxide emissions' has now been superseded for both residential and non-residential developments.

This means that with regards to the policy brief in section 1.3, point D is now no-longer relevant.

1.7.1.4 Point E

Within new developments potable water consumption is governed by Approved Document G. The Code for Sustainable Homes has been withdrawn and so this is not relevant.

1.7.1.5 Point F

This policy is not relevant and the orientation of the individual dwellings cannot change as they are situated in an apartment block constrained by the existing site position.

1.7.1.6 Point L

There are no district heating or CHP fed heating networks in the local vicinity and therefore this point is not applicable to this development.

1.8 Targeted Policy Issues

The following points shall be contained in a sustainability appraisal in section 2.

1. *All new developments maximise the energy efficiency and energy conservation measures in their design layout and orientation to reduce overall energy demand;*
2. *All developments reduce mains water use and demonstrate that water conservation measures are incorporated so that predicted per capita consumption does not exceed the appropriate levels set out in the Code for Sustainable Homes or BREEAM Standards.*
3. *Developments incorporate sustainable urban drainage facilities and techniques as part of the layout of a development as appropriate and as advised by the Environment Agency, including minimising the size of impermeable areas so that peak run-off and annual water run-off is reduced where possible and in any case is no greater than the original conditions of the site. Particular care will be needed in areas of flood risk where different solutions may be required.*
4. *Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measure such as solar shading, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, etc.;*
5. *Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets, designed with plants that carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and*
6. *All developments shall minimise the impact of surface water runoff from the development in the design of the drainage system.*
7. *Any development of more than 20 dwellings and/or non-residential development of over 1000m² shall consider the inclusion of a CHP plant, or biomass-fuelled heating scheme, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable or feasible for this form of energy provision.*

2 Sustainability Appraisal

2.1 Summary

This section will discuss the sustainable design of the North Street/Weldale Street site. As mentioned above the Code for Sustainable homes criteria shall not be included in this section however, where relevant, the Code for Sustainable Homes manual shall be referred as guidance for sound performance data when attempting to achieve sustainable design and build.

2.2 Sustainable Design

The proposal is to erect 1 block of 47 new flats with parking, cycle storage and private space. The proposed building is to be of varying storeys of 2.5 to 4.5 storeys high.



Figure 1

This report will cover the following categories relating to the sustainable design of buildings to allow the design team to consider their inclusion during the detailed design stage:

- *Energy Efficiency and Energy Conservation*
- *Water Conservation*
- *Flood Risk*
- *Adaptation to climate change*
- *Surface Water*
- *Low Carbon Technologies*

2.3 Energy Efficiency and Energy Conservation Measures

2.3.1 Dwelling Emission Rate

In order to minimise the CO₂ emissions from the proposed build, it is suggested that a fabric first strategy be prioritised during the design process.

2.3.2 Energy Efficiency

To minimise heat loss and maximise the efficiency of the proposed build, the proposal could incorporate the following:

- Insulated roofs, walls and floors
- Double glazed windows
- Ventilation incorporated onto the design to avoid condensation
- Energy efficient lighting
- Natural daylight to all habitable rooms

The lower the heat loss factor for each individual element, the higher the efficiency of the build.

2.3.3 Energy Efficient White Good

This category is designed to encourage the use of energy efficient white goods with the intention of decreasing the appliance use related CO₂ emissions of the dwelling. The EU Energy Efficiency Labelling Scheme can be used as a source of information as the energy consumption of appliances. An appliance will have a higher rating the less energy it consumes. Some suggested ratings are as follows:

- A+ Fridges, Freezers and Fridge Freezers
- A rated dishwasher & washing machine
- B rated tumble dryer

2.3.4 Energy Display Devices

The introduction of smart metering into new build homes is a simple and cost effective solution, allowing the occupant to constantly monitor their own energy consumption. This provides them with the information necessary to make changes within their home which in turn will affect the carbon emissions across the whole site. See figure 2 for an example of a smart meter. Consideration for the inclusion of such a smart meter will be undertaken once detail design is underway and utility providers are consulted.



Figure 2

2.4 Water Conservation Measures

2.4.1 Water Consumption

To minimise the use of water, the proposal could incorporate the following:

- Water saving devices (dual flush /low flush toilets)
- Low flow rate water devices

By minimising the consumption of potable water in a dwelling, the amount of waste water is decreased. The intention is to decrease water usage by decreasing the amount of water consumed by household appliance, toilets, sinks and showers.

One way that Water consumption could be minimised is if each dwelling has a water consumption rate of less than/equal to 105l/p/day.

A Part G compliant water consumption assessment tool will be prepared to confirm the design potable water use as part of the building regulations submission.

2.5 Flood Risk

The proposed build is located in a low flood risk area. This can be seen in figure 3.

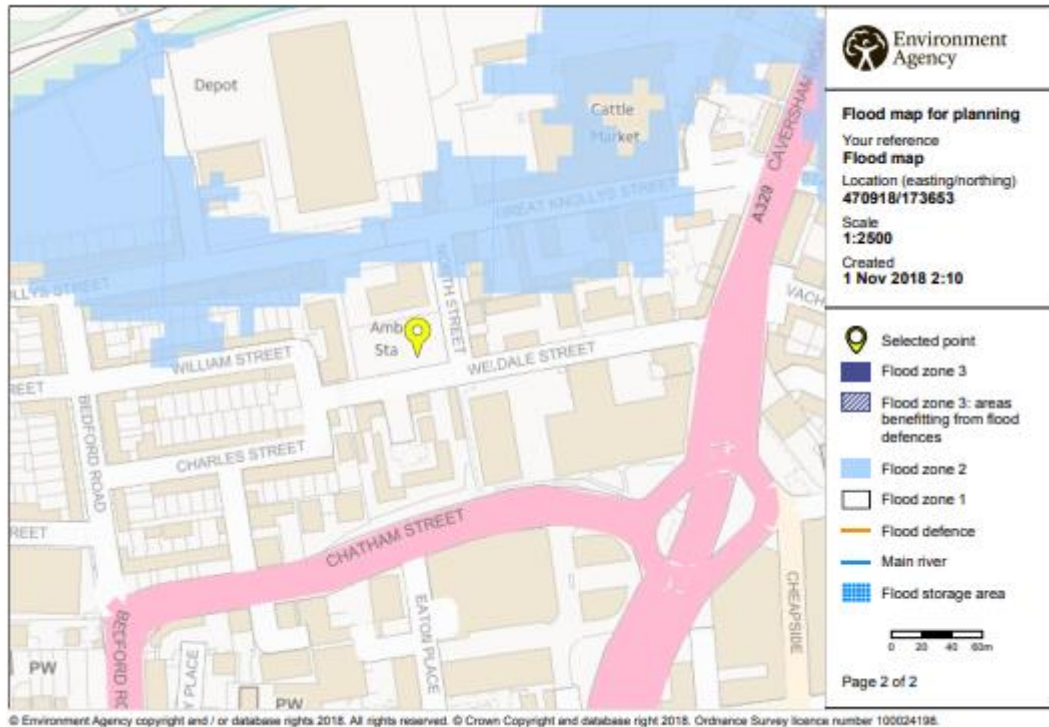


Figure 3

According to the Environment Agency, the site is located in a low flood risk area.

The planning team have commissioned a detailed geotechnical report regarding more detailed analysis of the ground conditions. Once detailed design is underway the design team will need to refer to this report and undertake detailed analysis of Sustainable Urban Drainage Strategies in order to alleviate any resulting local issues.

2.6 Adaptation to Climate Change

2.6.1 Thermal Comfort

The phenomena of overheating in new build residential development is generally confined to single aspect apartments with large extents of south / south westerly facing glazing. This can result in significant solar gain with limited opportunity to expel the heat via ventilation.

The residential units at North Street/Weldale Street comprise a block of apartments, with the building height ranging from 2.5 storeys to 4.5 storeys. As seen by the indicative floor plan in appendix C, there are a small portion of single aspect south facing flats however, the development will be subject to an overheating check when the Part L 2012 SAP assessments are undertaken, which include an assessment of overheating risk.

2.6.2 Daylighting

In order to improve the quality of life of the future occupants, all habitable rooms (where applicable) shall benefit from natural lighting.

Good daylighting design is recommended for a number of reasons. Provision of natural light not only decreases the need to use energy to lighting but also can lead to an improvement in the quality of life of the occupant. All habitable rooms will benefit from tall glazed areas in order to increase daylight ingress.

A full daylight and sunlight assessment will be considered in order to inform the design process once planning is concluded.

2.7 Ecology

A Tree Survey has been commissioned to provide vital information on the maintenance of the site ecology. Some important notes from Stage A of the Tree Survey can be seen below:

- *The starting point of site layout design should be to avoid the RPA (root protection area), with protective measures taken (isolated cases) where this is not possible.*
- *Where intrusion with the RPA is unavoidable then its impact on the tree can be mitigated by specialist measures. These are detailed in the Tree Survey report.*
- *Replacement planting can ensure the continuity of tree cover where tree removal is unavoidable. Offsite provision may be considered in some circumstances but this will require negotiation with the local planning authority.*

For more information on the site ecology, please refer to Tree Survey report by others.

2.8 Low Carbon Technology

A Section on the feasibility of CHP is included in the Low and Zero Carbon technology Study in section 3.3.4.

2.9 Materials

2.9.1 Responsible Sourcing of Materials

This section relates to the management of a construction project from the point at which the materials for its components are sourced (for example harvested or mined) through manufacture and processing.

The BRE Green Guide is used to examine the environmental impact of the construction materials commonly used in generic buildings.

During detailed design the design team will endeavour to include construction elements rated as a minimum of "D", but with ambitions to achieve "A" or "A+".

2.10 Waste Management

2.10.1 Recycling

Reading Borough Council operate recycling, general waste and garden waste collections on alternating weeks, therefore there is a need for adequate space to store a sufficient amount of waste storage containers. The space should be accessible for all, with sufficient space to manoeuvre a wheelchair around, whilst keeping each necessary bin accessible.

The design team will provide recycling and landfill waste storage within the kitchen layout of each dwelling and appropriately sized communal storage within the project boundaries.

This provision will encourage recycling from the dwelling occupant by providing a means to recycle in each individual dwelling.

2.11 Sustainable Transport

2.11.1 Public Transport

The proposed build is located on the North/Weldale Street corner. As seen from figure 4, there are several bus stops and train stations nearby. This creates a number of sustainable alternatives for any future occupants.

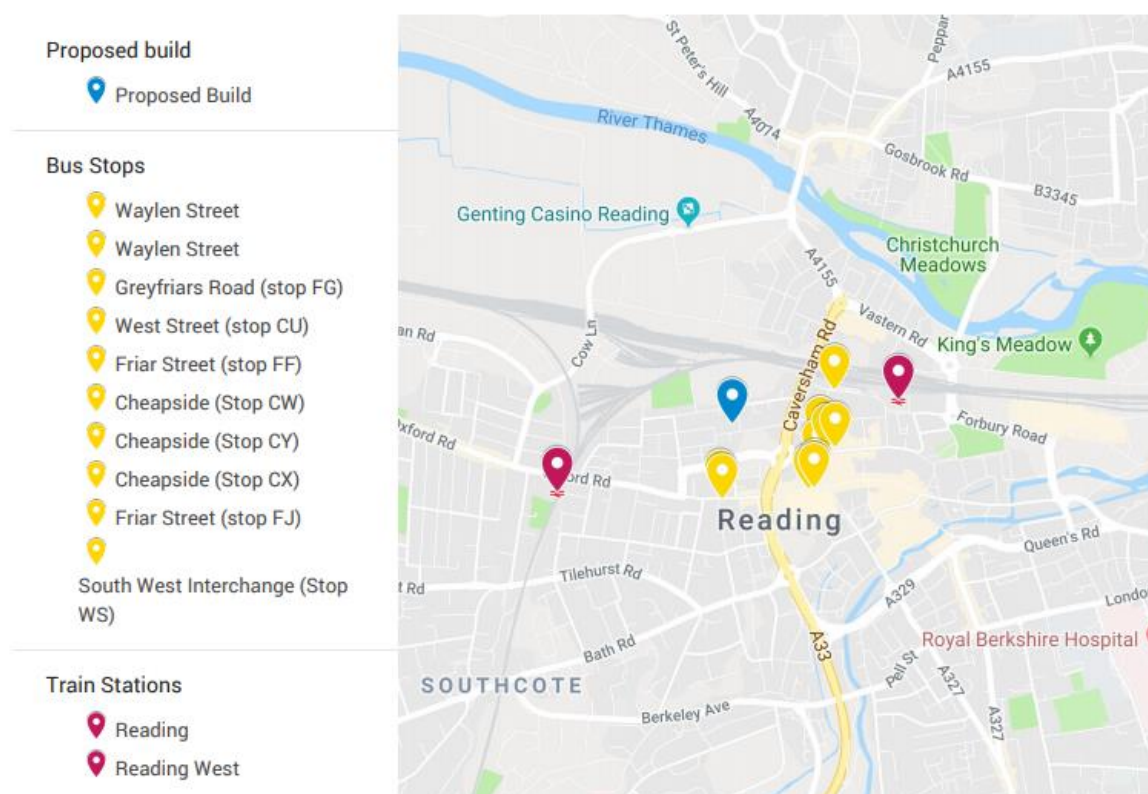


Figure 4

2.11.2 Cycle Storage

The overall aim of this section is to promote bicycles as a sustainable mode of transport, thereby decreasing the need for short car journeys which in turn translates to a decrease in CO₂ emissions associated with car usage.

The proposed build has accounted for up to 47 cycle spaces in the design. The increased capacity for cycle storage spaces is designed to encourage the use of sustainable transport in Reading Borough Council. Figure 5 is an example of where the cycle storage could be placed in context to the building (bottom left corner).

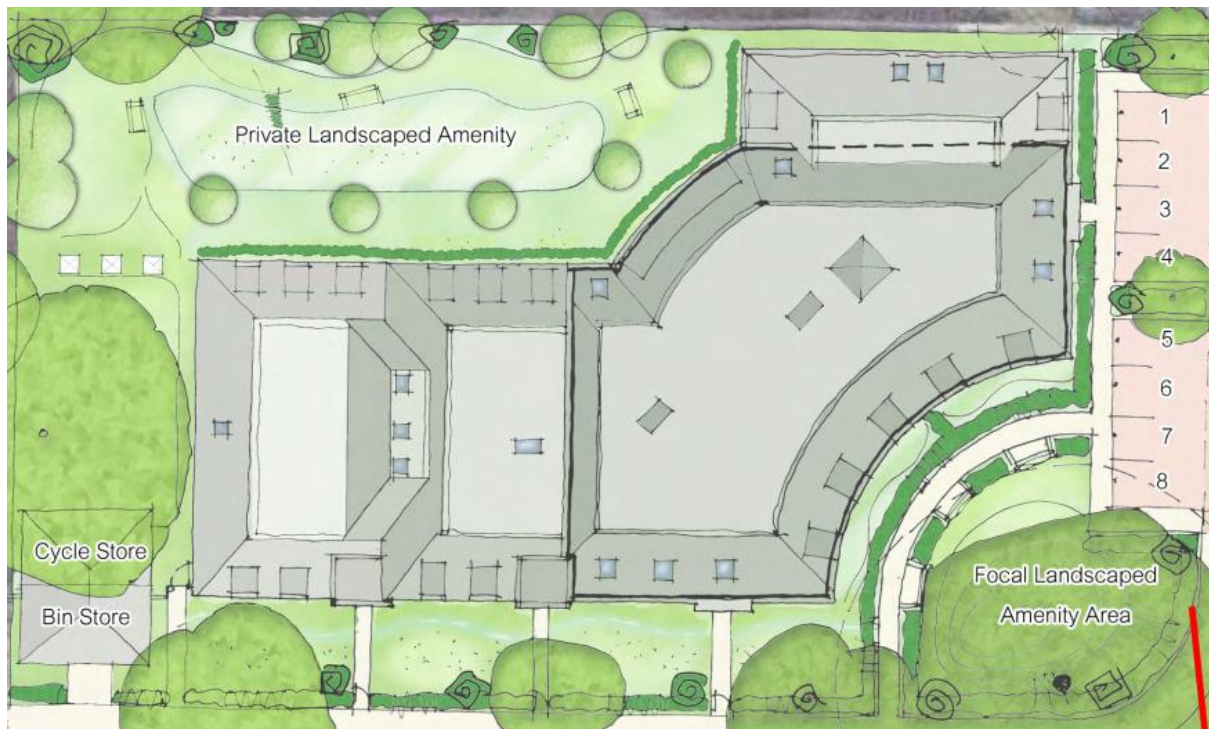


Figure 5

3 Energy Assessment

3.1 Assessment Methodology

Environmental Economics have modelled the proposed dwellings using NHER Plan Assessor software. The software provides a number of outputs which can be used to assess and compare the improvements from any number of build specifications in terms of:

- Building regulations compliance
- Energy usage per year (kWh/annum)
- Carbon emissions as a measure of building regulations compliance (kg CO₂/m²/year)
- Energy costs per year (£/annum)
- More detailed breakdowns by end use (space heating, water heating, cooking, lighting, appliances)
- Code for Sustainable Homes compliance
- Effective air change rate

Each of these outputs can be used in different ways to analyse the performance of the dwelling. The total regulated carbon emissions for each property is based upon:

- Space heating
- Water heating
- Electricity for pumps and fans
- Electricity for lighting

The total emission of carbon for the site is calculated for each of the models, and then the difference used to establish the level of improvement. In order to achieve this two representative apartment types have been modelled, Apartment Type C and Apartment Type F. These apartment types can be seen on the indicative floorplan in Appendix C.

The emissions calculation for the space and water heating, as well as the electricity for pumps, fans and lighting were all assessed using the Standard Assessment Procedure (SAP 2012) through version 6 of the NHER Plan Assessor software. SAP worksheets for all templates can be found Appendix E.

3.2 Designing buildings to cope with more extreme temperatures

3.2.1 Overheating Risk

The phenomena of overheating in new build residential development is generally confined to single aspect apartments with large extents of south / south westerly facing glazing. This can result in significant solar gain with limited opportunity to expel the heat via ventilation.

The residential units at North Street/Weldale Street are located in a block of flats, with the building height ranging from 2.5 storeys to 4.5 storeys. The proposed designs should be modelled using SAP 2012; this includes an assessment of overheating risk. By complying with current building regulations the flats should mitigate the risk of summer overheating.

3.3 Reducing energy demand through efficiency

3.3.1 Design Philosophy

Lochailort Thames Quarter has upgraded a number of elements from a standard build specification in order to improve energy efficiency across the development. The site adopts the good design principles endorsed and promoted by The Zero Carbon Hub, the construction industries' key advisors and partners with the Governments Communities and Local Government Department. This guidance follows the general good principles of energy efficiency as the industry moves towards zero carbon. The principles are illustrated in figure 6 below.

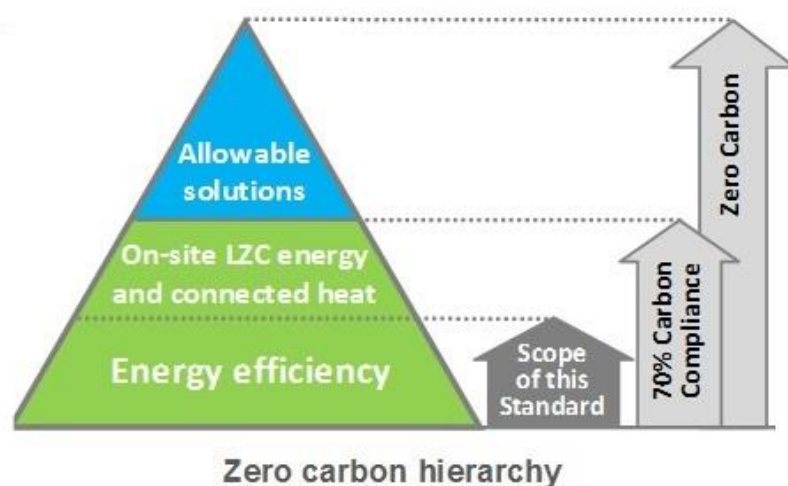


Figure 6

In order to reduce the residual carbon emissions a number of improvements were made to the standard material and product specification. These improvements include:

- *Upgraded heating and hot water controls*
- *Delayed start thermostat*
- *Design air permeability of 5.01m³/hr/m²*
- *Improved thermal bridging details*

3.3.2 Product Improvements

The systems used in a property to supply hot water and heating, as well as control it, are important to the overall energy demand of a property. The 2013 Building Regulations state that all systems and their controls must adhere to the minimum standards shown in Domestic Heating Compliance Guide.

For a mains gas fired system the minimum boiler efficiency required is 86%. The Developer intends to use high efficiency condensing boilers throughout the site for both combination and cylinder based systems. These boilers achieve a SAP 2012 rated efficiency of at least 89% and are recommended by the Energy Saving Trust.

Finally 100% Low-E lighting fixtures shall be fitted to all properties.

3.3.3 Fabric Improvements

The building fabric for all dwellings was improved from basic compliance with Part L1A 2013 to an enhanced specification. These fabric improvements reduce the space heating requirement upon a property. The improvements have been made through a combination of upgraded materials and increased insulation thicknesses. Enhanced glazing with a larger transmittance factor allowing for increased solar gains will also be used. These fabric improvements reduce the space heating requirement for a property. Changes to the U-Value of external elements are shown in table 1 below.

<i>Element</i>	<i>Minimum Standard</i>	<i>Potential Specification</i>	
-	<i>W/m²k</i>	<i>Description</i>	<i>W/m²k</i>
Walls	0.30	125mm Full Fill Cavity	0.23
Roof	0.20	400mm Mineral Wool Horizontal Ceiling, Loft Space	0.11
Floors	0.25	150mm TE Platinum	0.13 - 0.14
Doors	2.00	Timber Door	1.31
Glazing	2.00	Double glazed Low-E, u-PVC frame	1.41

Table 1

As improvements are made to the thermal conductivity of main elements, thermal bridging and air permeability becomes increasingly significant in the overall fabric performance. Lochailort Thames Quarter utilised Concrete Block Association (CBA) thermal bridging details, which achieve lower heat loss levels in comparison with standard practice.

As a result of following these junction details and focusing on build quality air permeability will also decrease. A target air pressure rating of 5.01m³/hr.m² has been set for all units on site which is a 50% improvement on the maximum allowable rating in the 2013 Building Regulations.

3.3.4 Low and Zero Carbon Technologies

3.3.4.1 Photovoltaic (PV) Cells

The efficiency of PV cells has improved rapidly over the last 15 years. This has made a previously uneconomical technology an increasingly viable solution to rising energy costs and demand. The cells can be produced in a variety of formats but are typically manufactured as a panel or a roof tile for domestic housing applications.

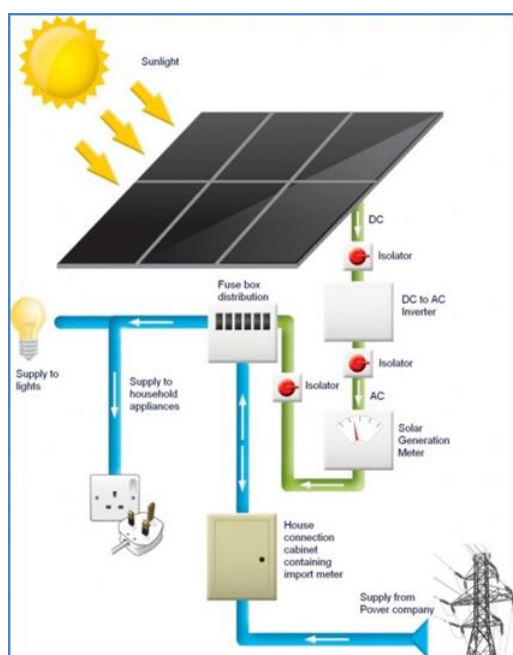


Figure 7

The PV system typically produces direct current (DC) which is then sent through an inverter to supply the house with electricity. If a greater amount of electricity is produced than used by the household, this extra can be sold back to the national grid, as can be seen in figure 7.

A PV cell is assessed on its peak power rating. This is tested by exposing the cell to the equivalent of full solar radiation and measuring the power output. The peak power is input into the NHER software as well as the physical attributes of the installation such as pitch, orientation and over-shading. A total energy saving per year can then be calculated through SAP for the PV installation. This is then offset against the electricity energy demand for the house.

3.3.4.2 Solar Hot Water (SHW)

SHW systems provide hot water to a household usually in conjunction with a conventional boiler and cylinder system. Because of this they are best suited to houses with a need for a cylinder hot water system rather than a combi boiler.

There are two main SHW systems; evacuated tubes and flat plate collectors. Evacuated tubes are more efficient at transferring solar irradiation to the fluid although flat plate collectors are considered to be better aesthetically and to install. An example of the latter can be seen in figure 8.



Figure 8

The final energy contribution to the household, calculated through SAP, is based on a number of factors:

- *Pitch, orientation and over-shading*
- *Heat absorption efficiency for the collector*
- *Average hot water usage of the dwelling*

The majority of the energy savings will be made in the hot water demand for the dwelling however, adding a SHW system will impact upon other energy demands.

3.3.4.3 Air Source Heat Pumps (ASHP)

ASHP provide heating and hot water to a home through thermal energy gathered from air outside the dwelling. Systems can be designed to work in conjunction with a boiler system but in the case of energy efficient new builds it is possible for an ASHP unit to provide 100% of the heating and hot water demand.



Figure 9

The thermal performance of the unit depends on the outside temperature as well as the unit's Coefficient of Performance. This is the ratio of thermal energy produced to energy used. A typical value for this would be around 3.5, meaning that for every 1kW of electricity consumed the unit would provide 3.5kW of thermal energy to the household. This efficiency leads to large carbon and energy savings for both space and water heating.

ASHP are assessed by their power output and the size of unit chosen depends on the demand from the household. An example external unit can be seen above in figure 9. The units with a larger power output can provide a larger amount of hotter water even in colder climates

3.3.4.4 Ground Source Heat Pumps (GSHP)

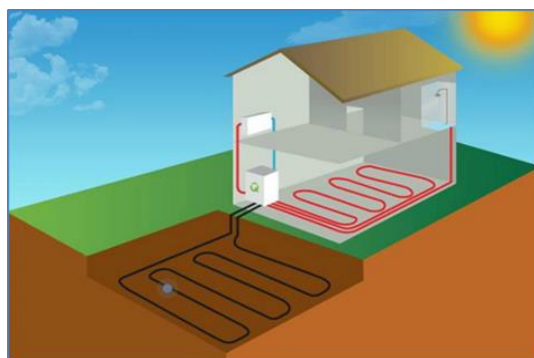


Figure 10

GSHP provide heating and hot water to a dwelling through geothermal effects. A GSHP system would offset the energy demand from the main space heating. There is, however, an additional electricity demand for the pump and control system. This would reduce energy savings from the installation.

GSHP are expensive to install and rely on having appropriate ground conditions and suitable space around the dwelling for the pipe looping. Energy savings are dependent upon the type of system being replaced and the way the system is operated by the homeowner. A typical system can be seen above in figure 10.

3.3.4.5 Biomass Heating Systems

Biomass heating systems burn fuels, considered carbon neutral, to heat the water required for a dwelling. There are a large variety of systems available and choice depends on the type of fuel to be burned and the level of automation.



The system would offset the energy demand from the hot water and main space heating. However, biomass systems typically require a large amount of maintenance and monitoring. An example system can be seen in figure 11.

The savings from such a system, in terms of CO₂ and money, depends upon what it is replacing. The savings are greatest when replacing an electrical hot water system but are considerably less for replacing mains gas.

3.3.4.6 Wind Turbines



Figure 12

Wind turbines provide electricity directly to a dwelling. They can be added to a property in two ways: pole mounted or building mounted. The pole mounted systems are free standing and therefore require enough space around them to allow for the construction and maintenance of the structure, as well as to allow for efficient operation. The building mounted systems have a lower power output but do not require additional structures, as can be seen in figure 12.

The energy produced from a wind turbine is heavily dependent upon the surrounding landscape. The energy saved will be offset against the electricity usage of the dwelling.

3.3.4.7 Combined Heat and Power (CHP)

Combined Heat and Power refers to a system that generates power locally, through combustion or steam turbines, and then utilise the waste heat from energy production to supplement a heating system. A typical set for a steam based CHP can be seen in figure 13.

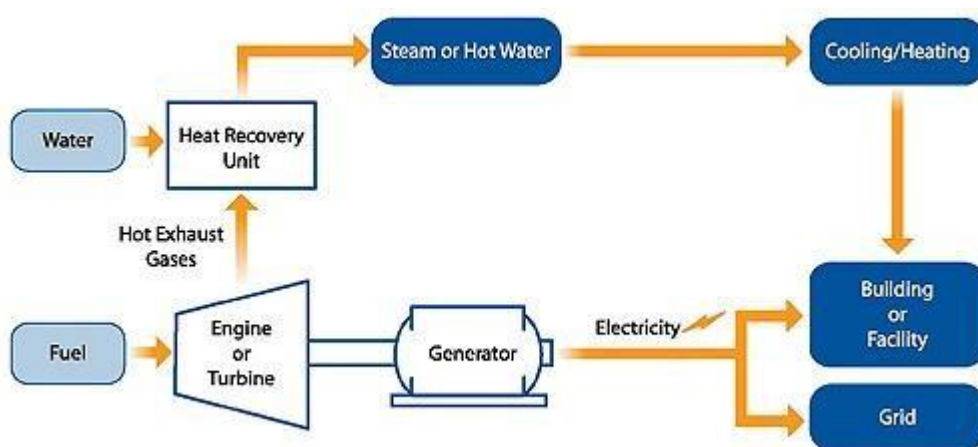


Figure 13

Such networks can be appropriate and desirable in situations where there is a large background demand for heat energy across a wide time period. In such cases the central plan benefits from a steady requirement for heat energy and as such can be sized with modular CHP/boiler plant. An example of such a development would be a mixed use development which includes leisure/commercial/hotels and domestic housing. In this example there would be a "base load" for heat energy which could justify the investment in an energy centre.

3.3.4.8 Comparison

SHW and PV can be incorporated into new build house designs. SHW has the potential to reduce the energy demand from hot water but is only relevant where properties are expected to include hot water cylinders due to design criteria. Where combination boilers are being adopted SHW is not relevant.

The product and installation cost make ASHP an expensive option. There is also a degree of uncertainty about the energy saving that can be obtained from the system as it requires diligent operation. The same can be said of GSHP, as well as the fact that additional extensive ground work is required in order to make use of the system.

Biomass hot water systems are more suited to the replacement of inefficient, carbon heavy systems such as electrical immersion heaters. The requirement of maintenance and monitoring makes it unsuitable for large scale new build developments

The density of the site is a major restriction on the potential energy that could be generated from wind turbines. Surrounding houses and the inner city location would restrict wind speeds. In order to obtain the energy savings required, larger, more expensive pole mounted systems would be required.

CHP can be a potential option for larger or mixed use developments, allowing the use of grid electric to be reduced and providing heat across the site. Potential drawbacks include the costs associated with distributing the energy and heat, as well as the difficulty of managing a system that will serve both privately owned dwellings and housing association stock.

When viewed from the perspective of the energy hierarchy, it can be seen that reducing energy demand through energy efficiency measures should be the first priority for any development. However if renewables or other further technologies are introduced, the need for higher fabric levels to achieve compliance will be reduced, leading to lower initial energy efficiency. This would be in contravention of the priorities as described by the energy hierarchy. It is therefore proposed that a "Fabric First" approach would be best suited in this instance.

3.3.5 “Fabric First” Approach

Although LZC technologies will have their part to play in the achieving low carbon efficient homes there are still a number of passive measures that can be implemented to achieve the same level of emissions reductions. Carbon emissions reductions achieved through energy efficiency measures have a number of advantages over the equivalent savings through LZC technologies:

- *Longer lifespans* – If the passive improvement measures are fully integrated into the building construction then the resulting carbon savings are secured for the lifetime of the dwelling, which is typically around 60 years. Most LZC technologies have a 25 year period of use before requiring replacement.
- *Lower maintenance* – There is little or no need to maintain fabric improvements in a property. This ensures future occupiers need not be responsible for the cost or upkeep of the upgrades. LZC technologies will require regular maintenance to ensure they are operating at their optimum performance levels. As soon as this is neglected, design predictions for carbon emissions will no longer be relevant.
- *Less dependency on occupier behaviour* – By adding a renewable technology to a property there is also the additional complication that comes with informing the occupier of their correct use. Many types of LZC require diligent operation in order to achieve the stated carbon savings. If this instruction is not effectively communicated or understood by the occupier, the carbon savings levels will fall below design levels.

This behavioural change, maintenance and replacement at end-of-life are beyond the control of both the council and Lochailort Thames Quarter, and the diminishing performance of the LZC technology is unavoidable. Therefore, a situation could easily be justified whereby the technology is only present and performing for its design life of 25 years, and with a diminishing efficiency.

The total potential carbon emissions are shown in Appendix A. As can be seen the carbon emission reductions exceeds the requirements of Part L1A 2013 by 2.6%, when utilising the proposed potential specification.

4 Conclusion

The following conditions have been addressed through measures as described:

- a) Energy Efficiency and Energy Conservation*
- b) Water Conservation*
- c) Flood Risk*
- d) Adaptation to climate change*
- e) Surface Water*
- f) Low Carbon Technologies*

By complying with Part F and Part L1A 2013, Lochailort Thames Quarter will have measures in place to mitigate the risk of overheating. The build specification used will reduce energy demand across the site, through the use of a good fabric specification and high efficiency services. Also measures will be taken to minimise water consumption by complying with Part G requirements and providing water butts to all dwellings.

Approved for Release

A handwritten signature in black ink, appearing to read 'S. Beasley', with a horizontal line drawn underneath the name.

Date: 09/11/2018

Appendix A

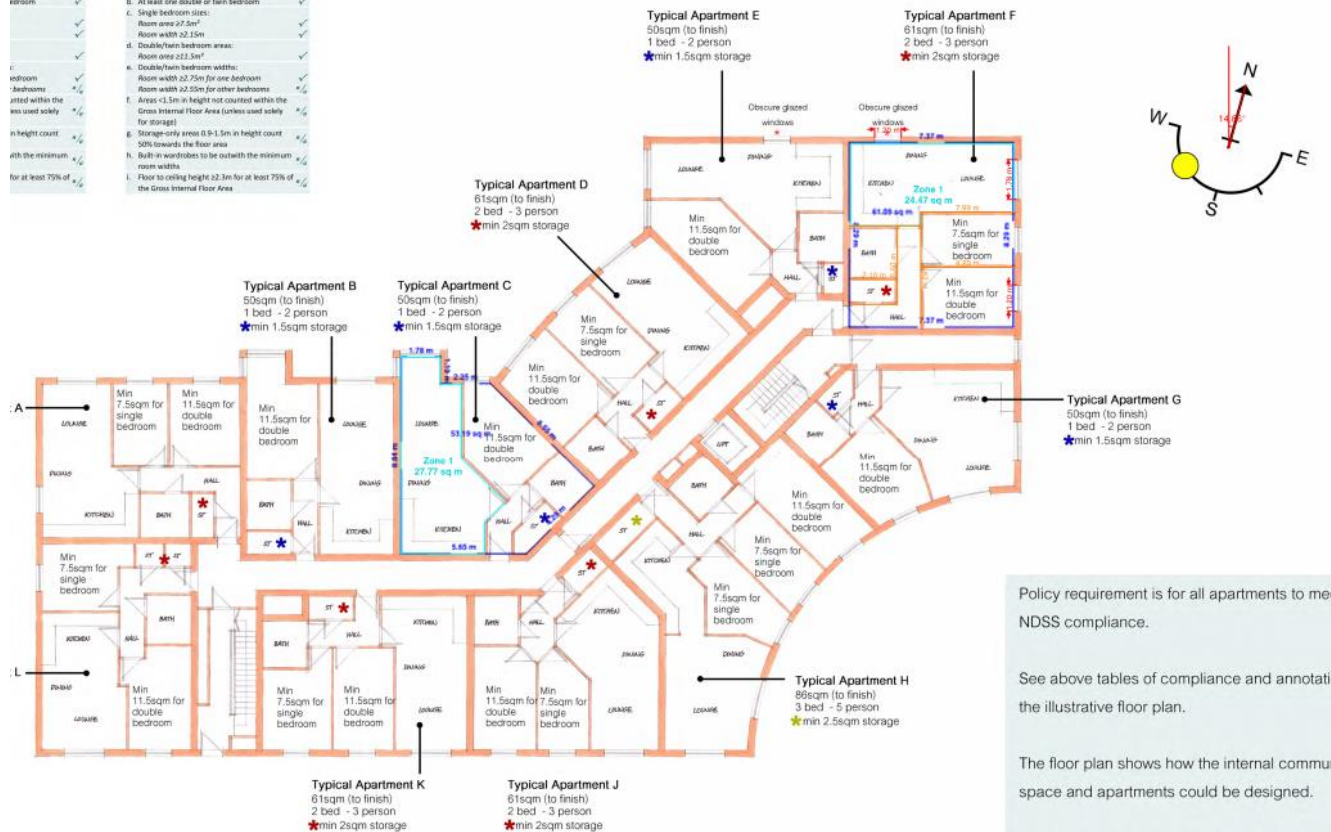
Client:	Lochailort Thames Quarter					
Project:	North Street/Weldale Street, Reading					
Report:	Carbon Emissions Reduction from Fabric and General Specification Improvements					
House Type/ Plot Number	Standard Regulatory Model CO ₂ Emissions Rate	Improved Model CO ₂ Emissions Rate	Improvement over Regulatory Model	SAP Floor Area	Number of Plots	Annual Carbon Emissions from Improved Model
-	kgCO ₂ /m ² .yr	kgCO ₂ /m ² .yr	%	m ²	-	kgCO ₂ /yr
Apartment C - GF	20.02	19.97	0.2%	53	3	3,187
Apartment C - FF	17.53	16.93	3.4%	53	8	7,206
Apartment C - TF	19.76	19.67	0.4%	53	2	2,093
Apartment F - GF	19.21	18.79	2.2%	61	8	9,172
Apartment F - FF	16.92	16.24	4.0%	61	19	18,818
Apartment F - TF	18.82	18.71	0.5%	61	7	7,991
Total Annual Carbon Emissions (kgCO ₂ /yr)						48,466
Floor Area Weighted Average Improvement (%)						
						2.6%
Notes						
#1: Calculated by SAP2012 to include total energy demand for space heating, hot water, lighting, pumps and fans.						

Appendix B



Appendix C

STANDARDS	NATIONALLY DESCRIBED SPACE STANDARDS
uk in Storage:	
✓	a. Gross Internal Floor Area & Built-in Storage:
✓	3-bed dwelling: 3 storey above 1st
✓	3-bed dwelling storage 22.5m ²
✓	b. At least one double or twin bedroom
✓	c. Single bedroom (dies):
✓	Room area 7.5m ²
✓	Room width 2.15m
✓	d. Double/twin bedroom area:
✓	Room area 21.5m ²
✓	e. Double/twin bedroom width:
✓	Room width 2.75m for one bedroom
✓	Room width 2.15m for other bedrooms
✓	f. Areas <1.5m in height not counted within the
✓	Gross Internal Floor Area (unless used solely
✓	for storage)
✓	g. Storage-only area 0.9-1.5m in height count
✓	50% towards the floor area
✓	h. Built-in wardrobes to be outwith the minimum
✓	room width
✓	i. Floor to ceiling height 2.1m for at least 75% of
✓	the Gross Internal Floor Area



Policy requirement is for all apartments to meet NDSS compliance.

See above tables of compliance and annotations to the illustrative floor plan.

The floor plan shows how the internal communal space and apartments could be designed.

This information is illustrative only at this outline

Appendix D



Appendix E

SAP Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	53.19 (1a) x	2.40 (2a) =	127.66 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 53.19 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	127.66 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	2 x 10 =	20 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)
		Air changes per hour
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20 ÷ (5) =	0.16 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>		
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.01 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41 (18)
Number of sides on which the dwelling is sheltered		2 (19)
Shelter factor	1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.35 (21)
Infiltration rate modified for monthly wind speed:		
	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	
Monthly average wind speed from Table U2	5.10 5.00 4.90 4.40 4.30 3.80 3.80 3.70 4.00 4.30 4.50 4.70	(22)
Wind factor (22)m ÷ 4	1.28 1.25 1.23 1.10 1.08 0.95 0.95 0.93 1.00 1.08 1.13 1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.44 0.43 0.42 0.38 0.37 0.33 0.33 0.32 0.35 0.37 0.39 0.41	(22b)
Calculate effective air change rate for the applicable case:		
If mechanical ventilation: air change rate through system		N/A (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h		N/A (23c)
d) natural ventilation or whole house positive input ventilation from loft		
	0.60 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.58 0.58	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)		
	0.60 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.58 0.58	(25)



3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			5.85	x 1.33	= 7.81		(27)						
Door			1.97	x 1.31	= 2.58		(26)						
Ground floor			53.19	x 0.13	= 6.91		(28a)						
External wall			9.53	x 0.23	= 2.19		(29a)						
External wall			21.89	x 0.26	= 5.69		(29a)						
Party wall			34.08	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			92.43				(31)						
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	25.19 (33)						
Heat capacity Cm = Σ(A x κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							10.10 (36)						
Total fabric heat loss						(33) + (36) =	35.29 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	25.16	25.01	24.85	24.12	23.98	23.34	23.34	23.22	23.59	23.98	24.26	24.55	(38)
Heat transfer coefficient, W/K (37)m + (38)m	60.45	60.29	60.14	59.40	59.26	58.63	58.63	58.51	58.87	59.26	59.54	59.83	
	Average = Σ(39)1...12/12 =											59.40 (39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.14	1.13	1.13	1.12	1.11	1.10	1.10	1.10	1.11	1.11	1.12	1.12	
	Average = Σ(40)1...12/12 =											1.12 (40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N												1.78	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												76.57	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	84.23	81.17	78.11	75.04	71.98	68.92	68.92	71.98	75.04	78.11	81.17	84.23		
												Σ(44)1...12 =	918.89	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	124.91	109.25	112.74	98.29	94.31	81.38	75.41	86.53	87.57	102.05	111.40	120.97		
												Σ(45)1...12 =	1204.80	(45)
Distribution loss 0.15 x (45)m	18.74	16.39	16.91	14.74	14.15	12.21	11.31	12.98	13.14	15.31	16.71	18.15	(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c	14.01	12.64	13.97	13.49	13.92	13.45	13.88	13.91	13.47	13.95	13.53	14.00	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m														

URN: Apartment C - GF version 1
 NHER Plan Assessor version 6.2.3
 SAP version 9.92

138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	(62)
--------	--------	--------	--------	--------	-------	-------	--------	--------	--------	--------	--------	------

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
------	------	------	------	------	------	------	------	------	------	------	------	------

Output from water heater for each month (kWh/month) (62)m + (63)m

138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	
$\Sigma(64)1...12 =$											1369.01	(64)

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

45.04	39.48	40.98	36.05	34.84	30.42	28.54	32.25	32.48	37.42	40.42	43.72	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Metabolic gains (Table 5)

107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

39.21	34.83	28.33	21.44	16.03	13.53	14.62	19.01	25.51	32.39	37.81	40.30	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

232.10	234.51	228.44	215.52	199.21	183.88	173.64	171.23	177.30	190.22	206.53	221.86	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	(69)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
------	------	------	------	------	------	------	------	------	------	------	------	------

Losses e.g. evaporation (Table 5)

-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	(71)
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Water heating gains (Table 5)

60.53	58.76	55.08	50.07	46.82	42.25	38.37	43.35	45.12	50.29	56.14	58.77	(72)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

418.02	414.27	398.02	373.21	348.24	325.84	312.80	319.76	334.10	359.08	386.66	407.11	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
North	0.77	4.17	10.63	x 0.9 x	0.72	x 0.70 =	15.49 (74)
West	0.77	1.68	19.64	x 0.9 x	0.72	x 0.70 =	11.52 (80)

Solar gains in watts $\Sigma(74)m...(82)m$

27.01	52.14	87.42	134.93	175.18	184.43	173.44	141.84	103.65	61.98	33.48	22.39	(83)
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Total gains - internal and solar (73)m + (83)m

445.03	466.41	485.44	508.14	523.42	510.27	486.24	461.60	437.75	421.07	420.13	429.50	(84)
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7. Mean internal temperature (heating season)

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

												21.00 (85)
--	--	--	--	--	--	--	--	--	--	--	--	------------

Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.99	0.98	0.94	0.86	0.69	0.52	0.57	0.81	0.95	0.98	0.99	(86)
------	------	------	------	------	------	------	------	------	------	------	------	------

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.99	20.10	20.30	20.58	20.82	20.96	20.99	20.99	20.90	20.62	20.26	19.97	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

19.97	19.97	19.98	19.99	19.99	20.00	20.00	20.00	20.00	19.99	19.99	19.98	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling n2,m

	0.99	0.98	0.97	0.92	0.81	0.60	0.41	0.45	0.73	0.93	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	18.66	18.81	19.09	19.50	19.81	19.97	20.00	20.00	19.92	19.56	19.06	18.63	(90)
Living area fraction											Living area ÷ (4) =	0.52	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	19.35	19.48	19.72	20.06	20.34	20.49	20.51	20.51	20.43	20.11	19.69	19.33	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	19.20	19.33	19.57	19.91	20.19	20.34	20.36	20.36	20.28	19.96	19.54	19.18	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m													
	0.99	0.98	0.97	0.92	0.82	0.63	0.45	0.50	0.75	0.93	0.98	0.99	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	438.66	457.11	468.61	468.86	429.42	322.06	218.71	228.58	329.38	391.07	409.92	424.25	(95)
Monthly average external temperature from Table U1													
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, L_m , W [(39)m x ((93)m - (96)m)]													
	900.86	869.88	785.93	653.90	503.00	336.23	220.71	231.82	364.03	554.71	740.54	896.33	(97)
Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$													
	343.88	277.38	236.09	133.23	54.74	0.00	0.00	0.00	0.00	121.74	238.04	351.23	
	$\Sigma(98)1...5, 10...12 =$												(98)
	1756.34												
Space heating requirement kWh/m ² /year													
	$(98) \div (4)$												(99)
	33.02												

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)	0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00 (202)
Fraction of space heat from main system 2	0.00	(202)
Fraction of total space heat from main system 1	(202) x [1 - (203)] =	1.00 (204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00 (205)
Efficiency of main system 1 (%)	90.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month													
	379.98	306.50	260.88	147.21	60.48	0.00	0.00	0.00	0.00	134.52	263.03	388.10	
	Σ(211)1...5, 10...12 =												(211)
	1940.71												

Water heating

Efficiency of water heater													
	89.56	89.50	89.36	89.01	88.35	87.30	87.30	87.30	87.30	88.91	89.37	89.59	(217)
Water heating fuel, kWh/month													
	155.12	136.19	141.80	125.57	122.50	108.62	102.28	115.05	115.74	130.47	139.78	150.66	
	Σ(219a)1...12 =												(219)
	1543.79												

Annual totals

Space heating fuel - main system 1	1940.71	
Water heating fuel	1543.79	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)
boiler flue fan	45.00	(230e)

Total electricity for the above, kWh/year				75.00	(231)
Electricity for lighting (Appendix L)				277.02	(232)
Total delivered energy for all uses			(211)...(221) + (231) + (232)...(237b) =	3836.51	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1940.71	x	3.48	x 0.01 =	67.54	(240)
Water heating	1543.79	x	3.48	x 0.01 =	53.72	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	277.02	x	13.19	x 0.01 =	36.54	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		287.69	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)				0.42	(256)
Energy cost factor (ECF)				1.23	(257)
SAP value				82.83	
SAP rating (section 13)				83	(258)
SAP band				B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	1940.71	x	0.216	=	419.19	(261)
Water heating	1543.79	x	0.216	=	333.46	(264)
Space and water heating			(261) + (262) + (263) + (264) =		752.65	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	277.02	x	0.519	=	143.77	(268)
Total CO ₂ , kg/year			(265)...(271) =		935.35	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		17.59	(273)
EI value					87.24	
EI rating (section 14)					87	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1940.71	x	1.22	=	2367.67	(261)
Water heating	1543.79	x	1.22	=	1883.42	(264)
Space and water heating			(261) + (262) + (263) + (264) =		4251.08	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	277.02	x	3.07	=	850.45	(268)
Primary energy kWh/year					5331.78	(272)
Dwelling primary energy rate kWh/m ² /year					100.24	(273)

SAP Worksheet

Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	53.19 (1a) x	2.40 (2a) =	127.66 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 53.19 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	127.66 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	2 x 10 =	20 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.16 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.01 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.41 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] =	0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) =	0.35 (21)
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Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.35	0.37	0.39	0.41
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Calculate effective air change rate for the applicable case:												
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If mechanical ventilation: air change rate through system	N/A (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A (23c)
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d) natural ventilation or whole house positive input ventilation from loft												
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			5.85	1.33	7.81		(27)						
Door			1.97	1.31	2.58		(26)						
External wall			9.53	0.23	2.19		(29a)						
External wall			21.89	0.26	5.69		(29a)						
Party wall			34.08	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			39.24				(31)						
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	18.27 (33)						
Heat capacity Cm = Σ(A x κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							5.61 (36)						
Total fabric heat loss						(33) + (36) =	23.89 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	25.16	25.01	24.85	24.12	23.98	23.34	23.34	23.22	23.59	23.98	24.26	24.55	(38)
Heat transfer coefficient, W/K (37)m + (38)m	49.05	48.89	48.74	48.00	47.87	47.23	47.23	47.11	47.47	47.87	48.14	48.43	
	Average = Σ(39)1...12/12 =											48.00 (39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.92	0.92	0.92	0.90	0.90	0.89	0.89	0.89	0.89	0.90	0.91	0.91	
	Average = Σ(40)1...12/12 =											0.90 (40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N													1.78	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36													76.57	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	84.23	81.17	78.11	75.04	71.98	68.92	68.92	71.98	75.04	78.11	81.17	84.23		
	Σ(44)1...12 =											918.89	(44)	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	124.91	109.25	112.74	98.29	94.31	81.38	75.41	86.53	87.57	102.05	111.40	120.97		
	Σ(45)1...12 =											1204.80	(45)	
Distribution loss 0.15 x (45)m	18.74	16.39	16.91	14.74	14.15	12.21	11.31	12.98	13.14	15.31	16.71	18.15	(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c	14.01	12.64	13.97	13.49	13.92	13.45	13.88	13.91	13.47	13.95	13.53	14.00	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	(62)	

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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	
$\Sigma(64)1...12 =$											1369.01	(64)

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

45.04	39.48	40.98	36.05	34.84	30.42	28.54	32.25	32.48	37.42	40.42	43.72	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	39.21	34.83	28.33	21.44	16.03	13.53	14.62	19.01	25.51	32.39	37.81	40.30	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	232.10	234.51	228.44	215.52	199.21	183.88	173.64	171.23	177.30	190.22	206.53	221.86	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	(71)
Water heating gains (Table 5)	60.53	58.76	55.08	50.07	46.82	42.25	38.37	43.35	45.12	50.29	56.14	58.77	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	418.02	414.27	398.02	373.21	348.24	325.84	312.80	319.76	334.10	359.08	386.66	407.11	(73)

6. Solar gains

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W		
North	0.77	x	4.17	x	10.63	x 0.9 x	0.72	x	0.70	=	15.49	(74)	
West	0.77	x	1.68	x	19.64	x 0.9 x	0.72	x	0.70	=	11.52	(80)	
Solar gains in watts Σ(74)m...(82)m													
	27.01	52.14	87.42	134.93	175.18	184.43	173.44	141.84	103.65	61.98	33.48	22.39	(83)
Total gains - internal and solar (73)m + (83)m													
	445.03	466.41	485.44	508.14	523.42	510.27	486.24	461.60	437.75	421.07	420.13	429.50	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00											(85)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.97	0.91	0.78	0.58	0.43	0.47	0.71	0.92	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.30	20.39	20.56	20.78	20.93	20.99	21.00	21.00	20.97	20.80	20.52	20.28	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	20.15	20.15	20.15	20.17	20.17	20.18	20.18	20.18	20.17	20.17	20.16	20.16	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.98	0.98	0.96	0.89	0.73	0.51	0.35	0.39	0.64	0.89	0.97	0.99	(89)

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

19.23	19.37	19.61	19.92	20.11	20.17	20.18	20.18	20.15	19.95	19.56	19.22	(90)
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Living area fraction

Living area ÷ (4) = 0.52 (91)

Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2

19.79	19.90	20.11	20.37	20.54	20.60	20.61	20.61	20.58	20.39	20.06	19.77	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.64	19.75	19.96	20.22	20.39	20.45	20.46	20.46	20.43	20.24	19.91	19.62	(93)
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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m	0.98	0.97	0.95	0.89	0.75	0.54	0.37	0.41	0.66	0.90	0.97	0.99	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m	437.14	454.36	462.24	450.64	390.09	273.43	181.87	190.64	290.65	377.35	406.45	423.07	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, L_m , W [(39)m x ((93)m - (96)m)]	752.50	726.23	655.78	543.35	415.87	276.26	182.12	191.10	300.50	461.43	616.92	746.97	(97)
Space heating requirement, kWh/month $0.024 \times ((97)m - (95)m) \times (41)m$	234.63	182.70	144.00	66.75	19.18	0.00	0.00	0.00	0.00	62.56	151.54	240.98	
	$\Sigma(98)1...5, 10...12 =$											1102.34	(98)
Space heating requirement kWh/m ² /year	$(98) \div (4) =$											20.72	(99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)	0.00	(201)
Fraction of space heat from main system(s)	$1 - (201) = 1.00$	(202)
Fraction of space heat from main system 2	0.00	(202)
Fraction of total space heat from main system 1	$(202) \times [1 - (203)] = 1.00$	(204)
Fraction of total space heat from main system 2	$(202) \times (203) = 0.00$	(205)
Efficiency of main system 1 (%)	90.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	259.26	201.88	159.12	73.76	21.19	0.00	0.00	0.00	0.00	69.12	167.45	266.28	
	$\Sigma(211)1...5, 10...12 = 1218.05$												(211)

Water heating

Efficiency of water heater	89.28	89.19	88.97	88.47	87.77	87.30	87.30	87.30	87.30	88.40	89.03	89.32	(217)
Water heating fuel, kWh/month	155.60	136.66	142.41	126.34	123.31	108.62	102.28	115.05	115.74	131.23	140.33	151.10	
	$\Sigma(219a)1...12 = 1548.67$												(219)

Annual totals

Space heating fuel - main system 1	1218.05	
Water heating fuel	1548.67	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)
boiler flue fan	45.00	(230e)
Total electricity for the above, kWh/year	75.00	(231)

Electricity for lighting (Appendix L)					277.02	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	3118.74	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1218.05	x	3.48	x 0.01 =	42.39	(240)
Water heating	1548.67	x	3.48	x 0.01 =	53.89	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	277.02	x	13.19	x 0.01 =	36.54	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	262.71	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.12	(257)
SAP value		84.32	
SAP rating (section 13)		84	(258)
SAP band		B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	1218.05	x	0.216	=	263.10	(261)
Water heating	1548.67	x	0.216	=	334.51	(264)
Space and water heating			(261) + (262) + (263) + (264) =		597.61	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	277.02	x	0.519	=	143.77	(268)
Total CO ₂ , kg/year			(265)...(271) =		780.31	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		14.67	(273)
EI value					89.35	
EI rating (section 14)					89	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1218.05	x	1.22	=	1486.02	(261)
Water heating	1548.67	x	1.22	=	1889.38	(264)
Space and water heating			(261) + (262) + (263) + (264) =		3375.40	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	277.02	x	3.07	=	850.45	(268)
Primary energy kWh/year					4456.09	(272)
Dwelling primary energy rate kWh/m ² /year					83.78	(273)

SAP Worksheet

Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	53.19 (1a)	2.40 (2a)	127.66 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 53.19 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	127.66 (5)

2. Ventilation rate

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

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) = 0.16 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.01 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.41 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
--	--------

Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.35 (21)
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Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.35	0.37	0.39	0.41
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Calculate effective air change rate for the applicable case:	
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If mechanical ventilation: air change rate through system	N/A (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A (23c)
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d) natural ventilation or whole house positive input ventilation from loft	
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	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			6.15	x 1.33	= 8.21		(27)						
Door			1.97	x 1.31	= 2.58		(26)						
External wall			9.23	x 0.23	= 2.12		(29a)						
External wall			21.89	x 0.26	= 5.69		(29a)						
Party wall			34.08	x 0.00	= 0.00		(32)						
Roof			53.19	x 0.11	= 5.85		(30)						
Total area of external elements ΣA, m ²			92.43				(31)						
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	24.45 (33)						
Heat capacity Cm = Σ(A x κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							10.03 (36)						
Total fabric heat loss						(33) + (36) =	34.48 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	25.16	25.01	24.85	24.12	23.98	23.34	23.34	23.22	23.59	23.98	24.26	24.55	(38)
Heat transfer coefficient, W/K (37)m + (38)m	59.64	59.48	59.33	58.60	58.46	57.82	57.82	57.70	58.07	58.46	58.74	59.03	
	Average = Σ(39)1...12/12 =											58.59 (39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.12	1.12	1.12	1.10	1.10	1.09	1.09	1.08	1.09	1.10	1.10	1.11	
	Average = Σ(40)1...12/12 =											1.10 (40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N													1.78	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36													76.57	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	84.23	81.17	78.11	75.04	71.98	68.92	68.92	71.98	75.04	78.11	81.17	84.23			
													Σ(44)1...12 =	918.89	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	124.91	109.25	112.74	98.29	94.31	81.38	75.41	86.53	87.57	102.05	111.40	120.97			
													Σ(45)1...12 =	1204.80	(45)
Distribution loss 0.15 x (45)m	18.74	16.39	16.91	14.74	14.15	12.21	11.31	12.98	13.14	15.31	16.71	18.15		(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		(56)	
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		(59)	
Combi loss for each month from Table 3a, 3b or 3c	14.01	12.64	13.97	13.49	13.92	13.45	13.88	13.91	13.47	13.95	13.53	14.00		(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m															

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138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	(62)
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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

138.92	121.89	126.70	111.78	108.23	94.83	89.29	100.44	101.04	116.00	124.93	134.97	
$\Sigma(64)1...12 =$											1369.01	(64)

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

45.04	39.48	40.98	36.05	34.84	30.42	28.54	32.25	32.48	37.42	40.42	43.72	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	107.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	38.79	34.45	28.02	21.21	15.86	13.39	14.46	18.80	25.23	32.04	37.40	39.87	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	232.10	234.51	228.44	215.52	199.21	183.88	173.64	171.23	177.30	190.22	206.53	221.86	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	47.49	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	-71.37	(71)
Water heating gains (Table 5)	60.53	58.76	55.08	50.07	46.82	42.25	38.37	43.35	45.12	50.29	56.14	58.77	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	417.60	413.89	397.71	372.98	348.06	325.69	312.64	319.55	333.83	358.73	386.24	406.67	(73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W							
North	0.77	4.47	10.63	x 0.9 x 0.72	x 0.70	= 16.60	(74)						
West	0.77	1.68	19.64	x 0.9 x 0.72	x 0.70	= 11.52	(80)						
Solar gains in watts Σ(74)m...(82)m													
	28.13	54.27	91.04	140.74	183.01	192.81	181.26	148.05	108.00	64.52	34.85	23.32	(83)
Total gains - internal and solar (73)m + (83)m													
	445.72	468.16	488.75	513.72	531.07	518.50	493.91	467.60	441.82	423.25	421.09	429.99	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00											(85)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.99	0.98	0.94	0.85	0.67	0.51	0.55	0.80	0.95	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.02	20.12	20.32	20.60	20.83	20.96	20.99	20.99	20.91	20.63	20.28	20.00	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.98	19.99	19.99	20.00	20.00	20.01	20.01	20.01	20.01	20.00	20.00	19.99	(88)
Utilisation factor for gains for rest of dwelling n2,m													

	0.99	0.98	0.97	0.92	0.80	0.59	0.40	0.44	0.72	0.93	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	18.70	18.85	19.14	19.54	19.84	19.99	20.01	20.01	19.94	19.59	19.10	18.67	(90)
Living area fraction											Living area ÷ (4) =	0.52	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	19.38	19.51	19.75	20.09	20.36	20.50	20.52	20.52	20.45	20.13	19.71	19.36	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	19.23	19.36	19.60	19.94	20.21	20.35	20.37	20.37	20.30	19.98	19.56	19.21	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m													
	0.99	0.98	0.96	0.92	0.81	0.62	0.44	0.48	0.74	0.93	0.98	0.99	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	439.24	458.58	471.10	471.79	430.36	319.98	216.40	226.29	328.30	391.98	410.63	424.66	(95)
Monthly average external temperature from Table U1													
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, L_m , W [(39)m x ((93)m - (96)m)]													
	890.71	860.18	777.34	646.81	497.42	332.22	218.07	229.05	359.82	548.51	732.14	886.09	(97)
Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m													
	335.90	269.88	227.84	126.02	49.89	0.00	0.00	0.00	0.00	116.46	231.49	343.30	
	$\Sigma(98)1...5, 10...12 =$												(98)
	1700.78												
Space heating requirement kWh/m ² /year													
	$(98) \div (4)$												(99)
	31.98												

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)

0.00

(201)

Fraction of space heat from main system(s)

1 - (201) =

1.00

(202)

Fraction of space heat from main system 2

0.00

(202)

Fraction of total space heat from main system 1

(202) x [1 - (203)] =

1.00

(204)

Fraction of total space heat from main system 2

(202) x (203) =

0.00

(205)

Efficiency of main system 1 (%)

90.50

(206)

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

Space heating fuel (main system 1), kWh/month

371.16

298.21

251.76

139.24

55.13

0.00

0.00

0.00

0.00

128.69

255.79

379.33

Σ(211)1...5, 10...12 =

1879.31

(211)

Water heating

Efficiency of water heater

89.54

89.48

89.33

88.97

88.29

87.30

87.30

87.30

87.30

88.87

89.35

89.57

(217)

Water heating fuel, kWh/month

155.15

136.22

141.84

125.64

122.59

108.62

102.28

115.05

115.74

130.52

139.82

150.68

Σ(219a)1...12 =

1544.14

(219)

Annual totals

Space heating fuel - main system 1

1879.31

Water heating fuel

1544.14

Electricity for pumps, fans and electric keep-hot (Table 4f)

central heating pump or water pump within warm air heating unit

30.00

(230c)

boiler flue fan

45.00

(230e)

Total electricity for the above, kWh/year					75.00	(231)
Electricity for lighting (Appendix L)					274.00	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	3772.46	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1879.31	x	3.48	x 0.01 =	65.40	(240)
Water heating	1544.14	x	3.48	x 0.01 =	53.74	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	274.00	x	13.19	x 0.01 =	36.14	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	285.17	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.22	(257)
SAP value					82.98	
SAP rating (section 13)					83	(258)
SAP band					B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	1879.31	x	0.216	=	405.93	(261)
Water heating	1544.14	x	0.216	=	333.54	(264)
Space and water heating				(261) + (262) + (263) + (264) =	739.47	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	274.00	x	0.519	=	142.21	(268)
Total CO ₂ , kg/year				(265)...(271) =	920.60	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	17.31	(273)
EI value					87.44	
EI rating (section 14)					87	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1879.31	x	1.22	=	2292.76	(261)
Water heating	1544.14	x	1.22	=	1883.86	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4176.62	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	274.00	x	3.07	=	841.19	(268)
Primary energy kWh/year					5248.05	(272)
Dwelling primary energy rate kWh/m ² /year					98.67	(273)

SAP Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	61.00 (1a) x	2.40 (2a) =	146.40 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 61.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	146.40 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	2 x 10 =	20 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20 ÷ (5) =	0.14 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area		5.01 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.39 (18)
Number of sides on which the dwelling is sheltered		2 (19)
Shelter factor	1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.33 (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.42	0.41	0.40	0.36	0.35	0.31	0.31	0.30	0.33	0.35	0.37	0.39
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system

N/A (23a)

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

N/A (23c)

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

0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			8.31	1.33	11.09		(27)						
Door			1.97	1.31	2.58		(26)						
Ground floor			61.00	0.14	8.54		(28a)						
External wall			29.27	0.23	6.73		(29a)						
External wall			15.72	0.26	4.09		(29a)						
Party wall			19.90	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			116.27				(31)						
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	33.03	(33)						
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						10.03	(36)						
Total fabric heat loss					(33) + (36) =	43.06	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	28.41	28.24	28.08	27.32	27.18	26.52	26.52	26.39	26.77	27.18	27.47	27.77	(38)
Heat transfer coefficient, W/K (37)m + (38)m	71.47	71.30	71.14	70.38	70.24	69.58	69.58	69.45	69.83	70.24	70.53	70.83	
	Average = Σ(39)1...12/12 =											70.38	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.17	1.17	1.17	1.15	1.15	1.14	1.14	1.14	1.14	1.15	1.16	1.16	
	Average = Σ(40)1...12/12 =											1.15	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N												2.01	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												81.93	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	90.13	86.85	83.57	80.29	77.02	73.74	73.74	77.02	80.29	83.57	86.85	90.13		
												Σ(44)1...12 =	983.18	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	133.65	116.89	120.62	105.16	100.91	87.07	80.69	92.59	93.70	109.19	119.19	129.44		
												Σ(45)1...12 =	1289.11	(45)
Distribution loss 0.15 x (45)m	20.05	17.53	18.09	15.77	15.14	13.06	12.10	13.89	14.05	16.38	17.88	19.42	(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c	14.05	12.67	14.00	13.52	13.94	13.47	13.90	13.93	13.49	13.98	13.56	14.04	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m														

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 NHER Plan Assessor version 6.2.3
 SAP version 9.92

147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	(62)
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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	
$\Sigma(64)1...12 =$											1453.64	(64)

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

47.95	42.03	43.61	38.35	37.04	32.32	30.30	34.27	34.53	39.80	43.02	46.55	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	(66)

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

42.21	37.49	30.49	23.08	17.25	14.57	15.74	20.46	27.46	34.86	40.69	43.38	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

261.88	264.60	257.75	243.17	224.77	207.47	195.92	193.20	200.05	214.63	233.03	250.33	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Cooking gains (calculated in Appendix L, equation L15 or L15a), 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)
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Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
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Losses e.g. evaporation (Table 5)

-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	(71)
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Water heating gains (Table 5)

64.45	62.55	58.61	53.26	49.78	44.89	40.73	46.06	47.95	53.50	59.75	62.56	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

460.80	456.90	439.11	411.77	384.07	359.19	344.65	351.98	367.73	395.25	425.74	448.53	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
East	0.77	6.69	19.64	x 0.9 x	0.74	x 0.70 =	47.17 (76)
North	0.77	1.62	10.63	x 0.9 x	0.74	x 0.70 =	6.18 (74)

Solar gains in watts $\Sigma(74)m... (82)m$

53.35	104.09	172.03	253.87	315.05	324.54	308.12	261.82	200.87	123.55	66.44	43.94	(83)
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Total gains - internal and solar (73)m + (83)m

514.15	560.99	611.15	665.64	699.11	683.73	652.77	613.80	568.60	518.80	492.18	492.48	(84)
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7. Mean internal temperature (heating season)

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

												21.00	(85)
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.99	0.97	0.92	0.80	0.62	0.46	0.51	0.76	0.94	0.98	0.99	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.95	20.09	20.33	20.63	20.86	20.97	20.99	20.99	20.92	20.63	20.24	19.92	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.94	19.94	19.95	19.96	19.96	19.97	19.97	19.97	19.96	19.96	19.96	19.95	(88)
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Utilisation factor for gains for rest of dwelling n2,m

	0.99	0.98	0.96	0.89	0.75	0.53	0.36	0.40	0.68	0.92	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	18.57	18.77	19.11	19.54	19.83	19.95	19.97	19.97	19.91	19.55	19.00	18.54	(90)
Living area fraction											Living area ÷ (4) =	0.38	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	19.09	19.27	19.57	19.95	20.22	20.33	20.35	20.35	20.29	19.96	19.47	19.06	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	18.94	19.12	19.42	19.80	20.07	20.18	20.20	20.20	20.14	19.81	19.32	18.91	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
	0.98	0.98	0.95	0.89	0.75	0.55	0.38	0.43	0.69	0.91	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	506.29	547.28	581.62	590.35	527.34	378.63	249.54	262.02	392.91	472.57	478.91	486.22	(95)
Monthly average external temperature from Table U1													
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x ((93)m - (96)m)]													
	1046.52	1013.71	919.16	767.27	587.80	388.57	250.77	264.14	421.80	646.54	861.49	1041.93	(97)
Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m													
	401.93	313.45	251.13	127.38	44.99	0.00	0.00	0.00	0.00	129.43	275.46	413.45	
											Σ(98)1...5, 10...12 =	1957.22	(98)
Space heating requirement kWh/m ² /year											(98) ÷ (4) =	32.09	(99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)

0.00

(201)

Fraction of space heat from main system(s)

1 - (201) =

1.00

(202)

Fraction of space heat from main system 2

0.00

(202)

Fraction of total space heat from main system 1

(202) x [1 - (203)] =

1.00

(204)

Fraction of total space heat from main system 2

(202) x (203) =

0.00

(205)

Efficiency of main system 1 (%)

90.50

(206)

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

Space heating fuel (main system 1), kWh/month

444.12

346.35

277.49

140.76

49.71

0.00

0.00

0.00

0.00

143.02

304.38

456.85

Σ(211)1...5, 10...12 =

2162.67

(211)

Water heating

Efficiency of water heater

89.62

89.54

89.36

88.93

88.18

87.30

87.30

87.30

87.30

88.91

89.43

89.65

(217)

Water heating fuel, kWh/month

164.81

144.70

150.66

133.45

130.25

115.17

108.35

122.01

122.78

138.53

148.44

160.03

Σ(219a)1...12 =

1639.17

(219)

Annual totals

Space heating fuel - main system 1

2162.67

Water heating fuel

1639.17

Electricity for pumps, fans and electric keep-hot (Table 4f)

central heating pump or water pump within warm air heating unit

30.00

(230c)

boiler flue fan

45.00

(230e)

Total electricity for the above, kWh/year					75.00	(231)
Electricity for lighting (Appendix L)					298.14	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	4174.99	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2162.67	x	3.48	x 0.01 =	75.26	(240)
Water heating	1639.17	x	3.48	x 0.01 =	57.04	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	298.14	x	13.19	x 0.01 =	39.32	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	301.52	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.19	(257)
SAP value					83.33	
SAP rating (section 13)					83	(258)
SAP band					B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	2162.67	x	0.216	=	467.14	(261)
Water heating	1639.17	x	0.216	=	354.06	(264)
Space and water heating				(261) + (262) + (263) + (264) =	821.20	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	298.14	x	0.519	=	154.74	(268)
Total CO ₂ , kg/year				(265)...(271) =	1014.86	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	16.64	(273)
EI value					87.17	
EI rating (section 14)					87	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2162.67	x	1.22	=	2638.46	(261)
Water heating	1639.17	x	1.22	=	1999.79	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4638.25	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	298.14	x	3.07	=	915.29	(268)
Primary energy kWh/year					5783.80	(272)
Dwelling primary energy rate kWh/m ² /year					94.82	(273)

SAP Worksheet

Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	61.00 (1a) x	2.40 (2a) =	146.40 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 61.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	146.40 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	2 x 10 =	20 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.14 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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

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

Number of sides on which the dwelling is sheltered

Shelter factor

Infiltration rate incorporating shelter factor

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Wind factor (22)m ÷ 4

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

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system

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

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

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

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



3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			7.26	1.33	9.69		(27)						
Door			1.97	1.31	2.58		(26)						
External wall			30.32	0.23	6.97		(29a)						
External wall			15.72	0.26	4.09		(29a)						
Party wall			19.90	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			55.27				(31)						
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	23.33 (33)						
Heat capacity Cm = Σ(A x κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							6.32 (36)						
Total fabric heat loss						(33) + (36) =	29.65 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	28.41	28.24	28.08	27.32	27.18	26.52	26.52	26.39	26.77	27.18	27.47	27.77	(38)
Heat transfer coefficient, W/K (37)m + (38)m	58.06	57.89	57.73	56.97	56.83	56.17	56.17	56.04	56.42	56.83	57.11	57.42	
	Average = Σ(39)1...12/12 =												56.97 (39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.95	0.95	0.95	0.93	0.93	0.92	0.92	0.92	0.92	0.93	0.94	0.94	
	Average = Σ(40)1...12/12 =												0.93 (40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N													2.01 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36													81.93 (43)
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	90.13	86.85	83.57	80.29	77.02	73.74	73.74	77.02	80.29	83.57	86.85	90.13	
Σ(44)1...12 =													983.18 (44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)													
	133.65	116.89	120.62	105.16	100.91	87.07	80.69	92.59	93.70	109.19	119.19	129.44	
Σ(45)1...12 =													1289.11 (45)
Distribution loss 0.15 x (45)m													
	20.05	17.53	18.09	15.77	15.14	13.06	12.10	13.89	14.05	16.38	17.88	19.42	(46)
Water storage loss calculated for each month (55) x (41)m													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c													
	14.05	12.67	14.00	13.52	13.94	13.47	13.90	13.93	13.49	13.98	13.56	14.04	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
	147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	
$\Sigma(64)1...12 =$											1453.64	(64)

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

47.95	42.03	43.61	38.35	37.04	32.32	30.30	34.27	34.53	39.80	43.02	46.55	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	43.49	38.62	31.41	23.78	17.78	15.01	16.22	21.08	28.29	35.92	41.93	44.69	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	261.88	264.60	257.75	243.17	224.77	207.47	195.92	193.20	200.05	214.63	233.03	250.33	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), 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)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	(71)
Water heating gains (Table 5)	64.45	62.55	58.61	53.26	49.78	44.89	40.73	46.06	47.95	53.50	59.75	62.56	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	462.08	458.04	440.04	412.48	384.59	359.63	345.13	352.60	368.56	396.31	426.97	449.85	(73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W							
East	0.77	x 5.64	x 19.64	x 0.9 x 0.72	x 0.70	= 38.69	(76)						
North	0.77	x 1.62	x 10.63	x 0.9 x 0.72	x 0.70	= 6.02	(74)						
Solar gains in watts $\Sigma(74)m...(82)m$													
	44.71	87.18	144.18	213.16	265.06	273.31	259.37	220.02	168.45	103.49	55.66	36.83	(83)
Total gains - internal and solar (73)m + (83)m													
	506.79	545.22	584.22	625.64	649.65	632.95	604.50	572.63	537.01	499.80	482.64	486.68	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00											(85)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.96	0.89	0.76	0.56	0.41	0.45	0.69	0.92	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.25	20.37	20.56	20.79	20.94	20.99	21.00	21.00	20.97	20.79	20.49	20.23	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	20.12	20.13	20.13	20.14	20.14	20.15	20.15	20.15	20.15	20.14	20.14	20.13	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.95	0.87	0.70	0.49	0.33	0.37	0.62	0.89	0.97	0.99	(89)

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

19.14	19.31	19.58	19.91	20.09	20.14	20.15	20.15	20.13	19.91	19.49	19.12	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

Living area ÷ (4) = 0.38 (91)

Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2

19.56	19.71	19.95	20.24	20.41	20.46	20.47	20.47	20.45	20.24	19.87	19.54	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.41	19.56	19.80	20.09	20.26	20.31	20.32	20.32	20.30	20.09	19.72	19.39	(93)
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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m	0.98	0.97	0.94	0.86	0.71	0.50	0.35	0.38	0.63	0.89	0.97	0.99	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m	498.02	530.02	551.31	540.69	461.30	318.29	208.72	219.31	339.82	443.34	466.95	479.74	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, L_m , W [(39)m x [(93)m - (96)m]]	877.36	848.57	767.92	637.57	486.34	320.95	208.95	219.73	349.56	539.40	720.56	871.92	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	282.23	214.07	161.16	69.75	18.63	0.00	0.00	0.00	0.00	71.47	182.59	291.78	
	$\Sigma(98)1...5, 10...12 =$											1291.68	(98)
Space heating requirement kWh/m ² /year	$(98) \div (4) =$											21.18	(99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)	0.00	(201)
Fraction of space heat from main system(s)	1 - (201) = 1.00	(202)
Fraction of space heat from main system 2	0.00	(202)
Fraction of total space heat from main system 1	(202) x [1 - (203)] = 1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) = 0.00	(205)
Efficiency of main system 1 (%)	90.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	311.85	236.54	178.07	77.07	20.58	0.00	0.00	0.00	0.00	78.97	201.76	322.41	
	Σ(211)1...5, 10...12 = 1427.27												(211)

Water heating

Efficiency of water heater	89.37	89.27	89.01	88.46	87.73	87.30	87.30	87.30	87.30	88.45	89.12	89.42	(217)
Water heating fuel, kWh/month	165.26	145.14	151.24	134.16	130.91	115.17	108.35	122.01	122.78	139.25	148.95	160.45	
	Σ(219a)1...12 = 1643.67												(219)

Annual totals

Space heating fuel - main system 1	1427.27	
Water heating fuel	1643.67	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)
boiler flue fan	45.00	(230e)
Total electricity for the above, kWh/year	75.00	(231)

Electricity for lighting (Appendix L)					307.19	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	3453.13	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1427.27	x	3.48	x 0.01 =	49.67	(240)
Water heating	1643.67	x	3.48	x 0.01 =	57.20	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	307.19	x	13.19	x 0.01 =	40.52	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	277.28	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.10	(257)
SAP value		84.67	
SAP rating (section 13)		85	(258)
SAP band		B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	1427.27	x	0.216	=	308.29	(261)
Water heating	1643.67	x	0.216	=	355.03	(264)
Space and water heating				(261) + (262) + (263) + (264) =	663.32	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	307.19	x	0.519	=	159.43	(268)
Total CO ₂ , kg/year				(265)...(271) =	861.68	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	14.13	(273)
EI value					89.11	
EI rating (section 14)					89	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1427.27	x	1.22	=	1741.27	(261)
Water heating	1643.67	x	1.22	=	2005.28	(264)
Space and water heating				(261) + (262) + (263) + (264) =	3746.55	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	307.19	x	3.07	=	943.07	(268)
Primary energy kWh/year					4919.87	(272)
Dwelling primary energy rate kWh/m ² /year					80.65	(273)

SAP Worksheet

Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Marek Chmel	Assessor number	10256
Client		Last modified	08/11/2018
Address	Plot North Street, Weldale Street, Reading, RG12		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	61.00 (1a) x	2.40 (2a) =	146.40 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 61.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	146.40 (5)

2. Ventilation rate

		m ³ per hour
Number of chimneys	0 x 40 =	0 (6a)
Number of open flues	0 x 20 =	0 (6b)
Number of intermittent fans	2 x 10 =	20 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.14 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.01 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.39 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] =	0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) =	0.33 (21)
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Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.42	0.41	0.40	0.36	0.35	0.31	0.31	0.30	0.33	0.35	0.37	0.39
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Calculate effective air change rate for the applicable case:												
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If mechanical ventilation: air change rate through system	N/A (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A (23c)
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d) natural ventilation or whole house positive input ventilation from loft												
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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	0.59	0.58	0.58	0.57	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Window			7.53	x 1.33	= 10.05		(27)						
Door			1.97	x 1.31	= 2.58		(26)						
External wall			30.05	x 0.23	= 6.91		(29a)						
External wall			15.72	x 0.26	= 4.09		(29a)						
Party wall			19.90	x 0.00	= 0.00		(32)						
Roof			61.00	x 0.11	= 6.71		(30)						
Total area of external elements ΣA, m ²			116.27				(31)						
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	30.34 (33)						
Heat capacity Cm = Σ(A x κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							10.86 (36)						
Total fabric heat loss						(33) + (36) =	41.20 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	28.41	28.24	28.08	27.32	27.18	26.52	26.52	26.39	26.77	27.18	27.47	27.77	(38)
Heat transfer coefficient, W/K (37)m + (38)m	69.61	69.44	69.28	68.52	68.38	67.72	67.72	67.59	67.97	68.38	68.67	68.97	
	Average = Σ(39)1...12/12 =											68.52 (39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.14	1.14	1.14	1.12	1.12	1.11	1.11	1.11	1.11	1.12	1.13	1.13	
	Average = Σ(40)1...12/12 =											1.12 (40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N												2.01	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												81.93	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	90.13	86.85	83.57	80.29	77.02	73.74	73.74	77.02	80.29	83.57	86.85	90.13		
												Σ(44)1...12 =	983.18	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	133.65	116.89	120.62	105.16	100.91	87.07	80.69	92.59	93.70	109.19	119.19	129.44		
												Σ(45)1...12 =	1289.11	(45)
Distribution loss 0.15 x (45)m	20.05	17.53	18.09	15.77	15.14	13.06	12.10	13.89	14.05	16.38	17.88	19.42	(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c	14.05	12.67	14.00	13.52	13.94	13.47	13.90	13.93	13.49	13.98	13.56	14.04	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m														

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 SAP version 9.92

147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	(62)
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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

147.70	129.56	134.62	118.68	114.85	100.54	94.59	106.52	107.19	123.17	132.75	143.47	
$\Sigma(64)1...12 =$											1453.64	(64)

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

47.95	42.03	43.61	38.35	37.04	32.32	30.30	34.27	34.53	39.80	43.02	46.55	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	120.59	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

43.14	38.31	31.16	23.59	17.63	14.89	16.09	20.91	28.06	35.63	41.59	44.33	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

261.88	264.60	257.75	243.17	224.77	207.47	195.92	193.20	200.05	214.63	233.03	250.33	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), 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)
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Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
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Losses e.g. evaporation (Table 5)

-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	-80.39	(71)
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Water heating gains (Table 5)

64.45	62.55	58.61	53.26	49.78	44.89	40.73	46.06	47.95	53.50	59.75	62.56	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

461.73	457.73	439.79	412.28	384.45	359.51	345.00	352.43	368.33	396.02	426.64	449.49	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
East	0.77	x 5.85	x 19.64	x 0.9 x 0.72	x 0.70	= 40.13	(76)
North	0.77	x 1.68	x 10.63	x 0.9 x 0.72	x 0.70	= 6.24	(74)

Solar gains in watts $\Sigma(74)m...(82)m$

46.37	90.43	149.54	221.10	274.92	283.48	269.02	228.21	174.72	107.34	57.73	38.20	(83)
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Total gains - internal and solar (73)m + (83)m

508.10	548.15	589.33	633.38	659.37	642.99	614.02	580.64	543.05	503.36	484.37	487.69	(84)
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7. Mean internal temperature (heating season)

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

												21.00	(85)
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.99	0.97	0.93	0.82	0.64	0.48	0.53	0.77	0.94	0.98	0.99	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.98	20.11	20.33	20.63	20.85	20.97	20.99	20.99	20.92	20.63	20.26	19.96	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.97	19.97	19.97	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.98	19.98	(88)
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Utilisation factor for gains for rest of dwelling n2,m

	0.99	0.98	0.96	0.90	0.77	0.55	0.37	0.42	0.69	0.92	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	18.64	18.82	19.14	19.56	19.85	19.97	19.99	19.99	19.93	19.58	19.05	18.61	(90)
Living area fraction											Living area ÷ (4) =	0.38	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	19.15	19.31	19.59	19.96	20.23	20.35	20.37	20.37	20.30	19.98	19.51	19.12	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	19.00	19.16	19.44	19.81	20.08	20.20	20.22	20.22	20.15	19.83	19.36	18.97	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m													
	0.99	0.98	0.96	0.90	0.77	0.57	0.40	0.44	0.70	0.92	0.97	0.99	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	500.57	535.57	563.31	568.44	509.61	368.60	243.82	255.93	382.40	460.76	471.74	481.66	(95)
Monthly average external temperature from Table U1													
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, L_m , W [(39)m x ((93)m - (96)m)]													
	1023.02	990.07	896.67	747.55	572.82	379.14	245.10	258.10	411.56	630.96	841.69	1018.46	(97)
Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$													
	388.71	305.42	248.03	128.96	47.03	0.00	0.00	0.00	0.00	126.63	266.36	399.38	
	$\Sigma(98)1...5, 10...12 =$										1910.52	(98)	
Space heating requirement kWh/m ² /year	$(98) \div (4) =$										31.32	(99)	

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)	0.00	(201)
Fraction of space heat from main system(s)	1 - (201) = 1.00	(202)
Fraction of space heat from main system 2	0.00	(202)
Fraction of total space heat from main system 1	(202) x [1 - (203)] = 1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) = 0.00	(205)
Efficiency of main system 1 (%)	90.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month												
	429.51	337.48	274.06	142.50	51.96	0.00	0.00	0.00	0.00	139.93	294.32	441.30
	Σ(211)1...5, 10...12 =										2111.07	(211)

Water heating

Efficiency of water heater													
	89.60	89.52	89.35	88.94	88.21	87.30	87.30	87.30	87.30	88.89	89.41	89.63	(217)
Water heating fuel, kWh/month													
	164.85	144.73	150.67	133.44	130.21	115.17	108.35	122.01	122.78	138.56	148.48	160.07	
	Σ(219a)1...12 =										1639.31	(219)	

Annual totals

Space heating fuel - main system 1	2111.07	
Water heating fuel	1639.31	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)
boiler flue fan	45.00	(230e)

Total electricity for the above, kWh/year					75.00	(231)
Electricity for lighting (Appendix L)					304.71	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	4130.09	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2111.07	x	3.48	x 0.01 =	73.47	(240)
Water heating	1639.31	x	3.48	x 0.01 =	57.05	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	304.71	x	13.19	x 0.01 =	40.19	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	300.60	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.19	(257)
SAP value					83.38	
SAP rating (section 13)					83	(258)
SAP band					B	

12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	2111.07	x	0.216	=	455.99	(261)
Water heating	1639.31	x	0.216	=	354.09	(264)
Space and water heating				(261) + (262) + (263) + (264) =	810.08	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	304.71	x	0.519	=	158.15	(268)
Total CO ₂ , kg/year				(265)...(271) =	1007.15	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	16.51	(273)
EI value					87.27	
EI rating (section 14)					87	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2111.07	x	1.22	=	2575.50	(261)
Water heating	1639.31	x	1.22	=	1999.95	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4575.46	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	304.71	x	3.07	=	935.47	(268)
Primary energy kWh/year					5741.18	(272)
Dwelling primary energy rate kWh/m ² /year					94.12	(273)