Energy Strategy Report

BioPark, Broadwater Road, Welwyn Garden City, AL7 3AX

Prepared by: Stroma Built Environment Ltd

On behalf of: EDC Ltd *Dec 2020*

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Contents

1. Executive Summary

The following Energy Assessment has been prepared to support the planning application for the proposed development known as Broadwater Gardens at Broadwater Road, Welwyn Garden City. It has been written to provide a a sustainable solution for the proposed site in accordance with Welwyn Hatfield Borough Local Plan. Broadwater Road West Supplementary Planning Document Section 7 Core National Indicator 2 requires all new developments in the Broadwater Road West development area, to achieve a site target of at least 10% of their energy requirements from decentralised and renewable or low-carbon sources. Draft Policy SADM 13 requires that all major development proposals must demonstrate that they have sought to maximise opportunities for renewable and low carbon sources of energy supply where consistent with other Local Plan policies.

The proposed development concerns the demolition of existing buildings and construction of residential units (Use Class C3) and community hub (Use Class E/F.2), with public realm and open space, landscaping, access, associated car and cycle parking, refuse and recycling storage and supporting infrastructure.

A fabric first approach to energy efficiency has been specified in order to minimise demand and create inherent efficiency. Using the proposed specifications, the energy efficiency measures alone can be shown to bring the development in line with the *Building Regulations Part L: Conservation of Fuel and Power*.

There are currently no existing district heating networks within the vicinity of the development. However, for the flats an on-site heat network has been proposed due to the size and density of the development. The community heating system shall consist of a single energy centre, consisting of gas boilers, and shall be designed in such a way as to allow for efficient connection to a future district scheme, should one become available. The townhouses are proposed to have standalone boilers, as due to their locality they will not be connected to the energy centre. The extra length in pipework will mean extra losses, therefore making connection infeasible.

Integration of renewable or low carbon energy sources have been investigated, and the proposals include a PV arrays totalling 76kWp across the flats. It is considered that the ‘Shell Only’ commercial unit will most likely be fitted with Air Source Heat Pump technology due to this being the standard approach for units of this type.

The above measures reduce carbon emissions by 12.84% in the case of dwellings, and 13.86% in the case of non-dwellings, when compared to the building regulations baseline scenario. The proposed renewables alone, reduce the carbon emission by more than 10%.

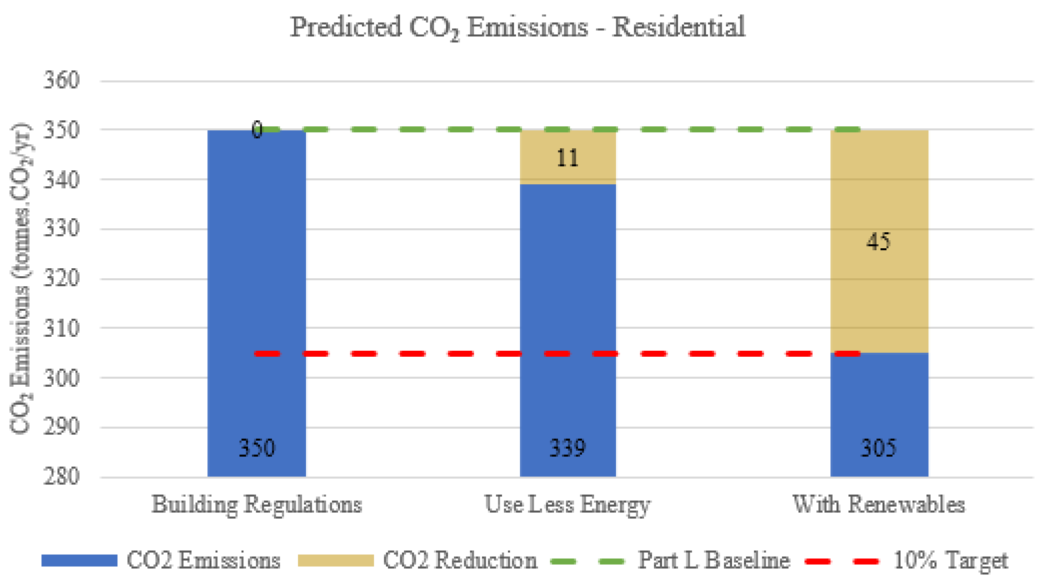
It is important to note that the ‘Shell Only’ nature of the commercial elements are such that we need to make assumptions for the future fit out specification. Therefore the improvement in non-dwellings emissions are shown to be possible, and cannot be confirmed as the future services are entirely unknown at this stage.

The following tables and graph detail the site carbon emissions results.

Residential

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)
Building Regulations	350
Use Less Energy	339
With Renewables	305

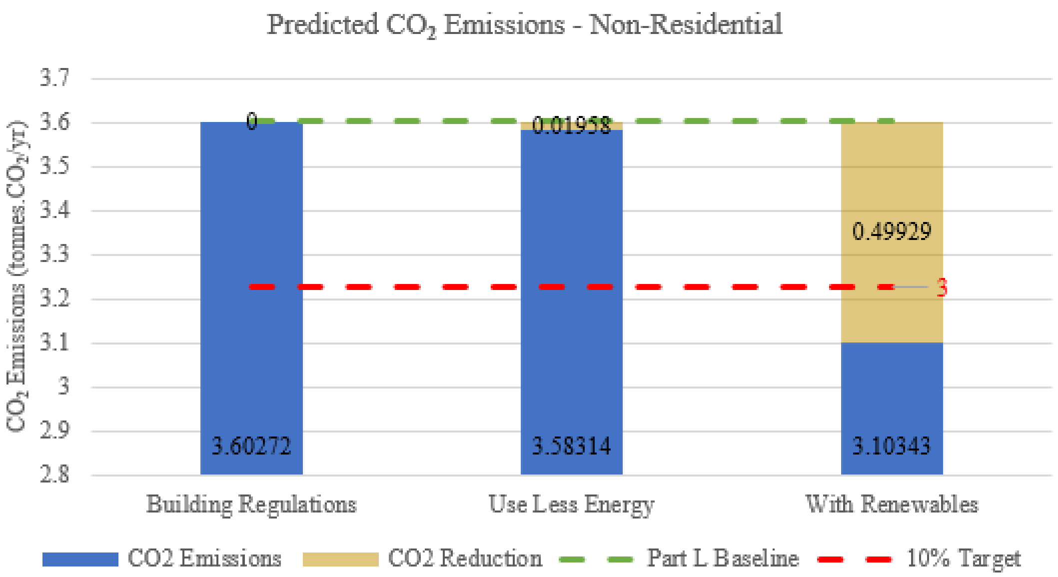
Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Use Less Energy'	11	3.14
Savings from 'With Renewables'	34	10
Cumulative savings	45	12.86



Non-Residential

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)
Building Regulations	3.60
Use Less Energy	3.58
With Renewables	3.10

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Use Less Energy'	0.02	0.54%
Savings from 'With Renewables'	0.48	13.39%
Cumulative savings	0.50	13.86%



2. Introduction

This Energy Assessment has been prepared by Stroma Built Environment, to accompany an application for full planning permission for the proposed development known as Broadwater Gardens at Broadwater Road, Welwyn Garden City.

The proposed development concerns the demolition of existing buildings and construction of residential units (Use Class C3) and community hub (Use Class E/F.2), with public realm and open space, landscaping, access, associated car and cycle parking, refuse and recycling storage and supporting infrastructure.

This statement shall set out the applicable policies on carbon emission for the proposed scheme, as well as the methodology for, and results from, an Energy Assessment. It shall detail the energy efficiency measures and low carbon technologies proposed within the design.

3. Planning policy

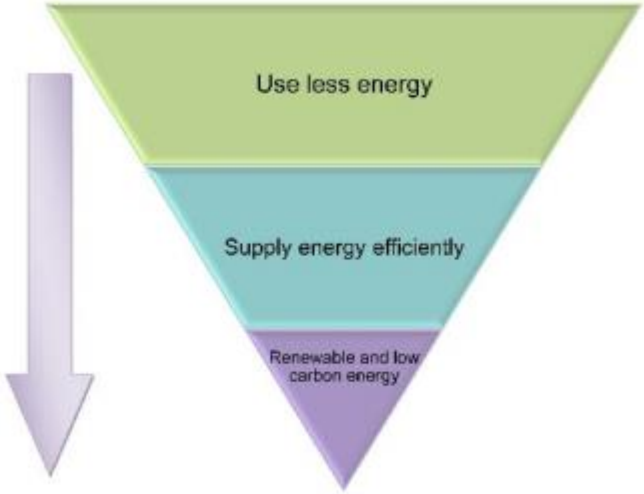
Broadwater Road West Supplementary Planning Document Section 7 Core National Indicator 2 requires all new developments in the Broadwater Road West development area, to achieve a site target of at least 10% of their energy requirements from decentralised and renewable or low-carbon sources.

Draft Policy SP 1 requires that adaption and mitigation principles relating to climate change are incorporated into the design and construction of new development which include energy efficient measures and the use of low carbon and renewable energy.

Draft Policy SP 10 requires developments to maximise opportunities to reduce carbon emissions, through the use of renewable and low carbon energy infrastructure, where it is appropriate.

Draft Policy SADM 13 requests that all major development proposals must demonstrate that they have sought to maximise opportunities for renewable and low carbon sources of energy supply where consistent with other Local Plan policies.

Draft Policy SADM 13 of The Draft Local Plan details an ‘energy hierarchy’ to be followed. This is to ensure that poorly designed buildings cannot be offset by renewable energy alone.



To demonstrate compliance with the policy it is necessary to assess the energy demand and emissions in detail, and to demonstrate how each stage of the energy hierarchy is being followed and how the emissions targets will be met using efficiency measures, decentralised energy systems and renewable energy technologies as appropriate.

4. Calculation methodology

The schemes regulated carbon emissions have been calculated using the Standard Assessment Procedure (SAP) 2012, and the Simplified Building Energy Model (SBEM) or Dynamic Simulation Model (DSM). These are the Government's approved tools for assessing regulated carbon emissions from dwellings and non-dwellings respectively, and are used to demonstrate compliance with *Building Regulations Part L: Conservation of Fuel and Power*.

The 'Building Regulations' case for emissions was determined by using the 'Target Emission Rate' (TER) from the compliance calculations. These figures provide an emission rate for the 'notional' target building, and hence a figure for acceptable total regulated emissions.

The emissions savings from energy efficiency proposals (Use Less Energy) was determined by comparing the total emissions from the TER figures, with the predicted dwelling emission rate (DER), based on the proposed specification without renewable technologies.

The feasibility of connecting to a District Heating Network (DHN) was considered by researching the availability of any existing networks.

The potential emission savings with renewable energy (Renewable and Low Carbon) proposals, were then appraised.

It should also be noted that the compliance methodology was produced with the sole intention of demonstrating compliance with the *Building Regulations Part L*. As such, standardised assumptions are made regarding building occupancy, use, conditioning setpoints etc. It is therefore important to note that they are intended to be used on a comparable scale, rather than give accurate predictions of real energy use. The results herein are provided solely for the purposes of demonstrating compliance and are not envisioned as an accurate prediction of operational energy use.

The energy calculations have been undertaken by an accredited Energy Assessor, licensed to use all applicable assessment software's.

5. Emissions at ‘Building Regulations’ Stage

The SAP and DSM calculations have been undertaken to assess regulated energy use, accounting for energy demands from space heating and hot water, and electricity for pumps, fans and lighting.

To determine the ‘baseline’ the energy assessment has first established the regulated CO_2 emissions assuming the development complied with Part L 2013 of the Building Regulations using the Building Regulations approved compliance software. When determining this ‘baseline’ case, it has been assumed that the heating would be provided by gas boilers and that any active cooling will be provided by electrically powered equipment. As a communal heating system is being proposed, this has been included when determining CO_2 emissions to ensure a consistent baseline.

The TER is the maximum permitted emissions for each dwellings/non-dwelling, and is expressed in $kgCO_2/m^2$. Thus, the total baseline emissions for the scheme are the sum of all the products of the TER and the total floor area (TFA).

Residential Baseline

Scenario	Annual CO_2 emissions (Tonnes CO_2/annum)
Building Regulations	350

Non-Residential Baseline

Scenario	Annual CO_2 emissions (Tonnes CO_2/annum)
Building Regulations	3.60

6. Emission at ‘Use less energy’ Stage

This section outlines the energy efficiency proposals to minimise energy demand. Performance and savings are assessed against the previously calculated ‘Building Regulations’ baseline scenario.

At an early stage, the design team have explored a range of energy efficiency measures including enhanced U-values and the use of efficient mechanical ventilation systems.

So that the improvements from energy efficiency alone can be properly understood, aspects of the proposals that relate to low carbon or renewable energy generation, have not been included at this stage.

6.1 Thermal envelope

Fundamental to achieving energy efficiency in any new building is a suitably designed and specified thermal envelope. Passive design features such as appropriate orientation, balancing solar gain and limiting heat loss are all proven techniques to reduce energy consumption. In addition, minimising thermal bridging and controlling air infiltration are important factors.

The following tables illustrate the proposed building fabric performance specification, with respect to the limiting values stipulated in Part L1A 2013. It is shown that the proposed specification represents a significant betterment of the minimum standards.

Element	Proposed	Part L1A 2013	Improvement
Heat loss walls (external and to unheated corridors/stores)	0.20 W/m²K	0.30 W/m²K	33%
Heat loss floors (ground and exposed)	0.15 W/m²K	0.25 W/m²K	40%
Heat loss roofs/ceilings	0.20 W/m²K	0.20 W/m²K	0%
Opaque doors (External)	1.4 W/m²K	2.20 W/m²K	36%
Air Permeability (Domestic)	3 m³/hm²	10 m³/hm²	70%

Glazing is proposed as a solar control glass where appropriate, in order to balance solar gain. The glazing specification used within the calculations can be seen below:

Element	U-Value	G-Value
Residential Glazing (Flats)	1.4 W/m²K	0.50
Residential Glazing (Townhouses)	1.4 W/m²K	0.60
Commercial Glazing	1.4 W/m²K	0.40

For the commercial unit the design team will need to ensure compliance with Criterion 3 (solar gains limits), which may need the inclusion of opaque panels and/or further reduction of G-Value. This should be investigated at design stage. Townhouses are generally less likely to have overheating issues due to cross/stack ventilation being more viable. Therefore, a lower G-Value is not considered to be a necessary, so a G-Value of 0.6 has been used within the calculations.

In addition to the primary envelope specification, non-repeating thermal bridging shall play a vital role in reducing energy demand, by ensuring that heat leakage at junctions is minimised. It is proposed that all junctions shall match or exceed Accredited Construction Details (ACD) standards where possible. Due to the design being at early stage, it is not appropriate to calculate the individual junctions, but it is considered that the PSI values associated with ACD's are a conservative estimate and have been applied to the calculations.

It should also be noted that all specification is subject to review, and as such U-Values, G-Values and thermal bridging details will be investigated further throughout the design stage, with the aim of limiting heat loss, and to reduce emissions as much as practically possible.

6.2 Building services

For the 'Use less Energy' case, the same heating specifications have been used as per the 'Building Regulations' case. This is so that the improvements from energy efficiency measures alone can be understood.

The heating system used within this stage of the assessment is a community heating system, supplied by gas fired boilers. A thermal efficiency of 95% has been specified by the design team, which will be the targeted efficiency of the supplementary boilers within the scheme.

Therefore, the applicable building services improvements relate to the controls, ventilation, lighting and auxiliary power equipment.

The below tables detail the proposed building services specification.

Residential Services	Specification
Heating System	Flats - Community heating scheme – With proposed gas boiler efficiency of 95% Townhouses – Individual gas boiler of 89.7% efficient
Heating System Controls	Flats - Charging system linked to use Townhouses – Time and temperature zone control
Hot Water System	Flats - From community system Townhouses – Cylinder from boiler, with low heat loss
Internal fixed lighting	100% 'Low Energy'
Ventilation	Mechanical Ventilation with Heat Recovery (MVHR) with low specific fan power (SFP) and high heat recovery efficiency

Commercial Services	Specification
Heating System	Gas boiler efficiency of 91%
Hot Water System	From above boiler – 5% losses form stores and pipes
Internal fixed lighting	100Lm/W efficacy luminaires,
Ventilation	Balanced supply and extract, with low specific fan power (SFP's) and highly efficient heat recovery.
Cooling	Via VRF system, EER of 5.0

With regard to the commercial services, the applicant plans only to progress the commercial space to a ‘shell’ state of completion. Therefore, the above services are assumed.

Due to the likely building use, the commercial aspects are expected to include cooling. This is beyond the control of the developer, whom is not undertaking the building services fit-out, and therefore represents a possible scenario analysis for the purposes of the planning consideration.

The above standards represent reasonable specifications, used in the preliminary calculations.

Regarding the communal access corridors and entrance lobbies, these spaces are not assessed within the compliance calculations, and shall not be conditioned. Lighting consumption to these areas will be minimised in any case, with the installation of PIR occupancy sensors and low energy LED lighting.

6.3 ‘Use Less Energy’ results

The below tables detail the CO_2 savings from the ‘Use Less Energy’ assessment

Residential

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
Building Regulations	350	-	-
Use Less Energy	339	3.14	3.14

As detailed in the table above, the passive design proposals demonstrate a 3.14% reduction in CO_2 emissions over the regulatory requirement of the building regulations.

Non-Residential

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
Building Regulations	3.60	-	-
Use Less Energy	3.58	0.54%	0.54%

As detailed in the table above, the passive design proposals demonstrate a 0.54% reduction in CO_2 emissions over the regulatory requirement of the building regulations.

It should a be noted that the nature of the units is such that the developer is only providing a shell, and as such the building services specification is entirely assumed. So, this report demonstrates that the stated improvement is possible, but not delivered by the developers’ proposals alone. This can only be known during the design stage of the first fit-out of each unit.

7. District Heating Network Connection

7.1 District heating

Where location and development permits; the opportunity of connecting to existing district heating networks should be considered. District heating networks have the potential to offer significant energy, carbon and cost savings over localised alternatives. District heating networks often utilise low-carbon energy generation/harnessing technologies such as Anaerobic Digestion (AD), Combined Heat and Power (CHP) and Waste Heat Recovery (WHR). District networks also enable heat loads to be balanced between sites and therefore plant to operate more continuously and efficiently.

District energy networks are only generally feasible where there is a high density of heat demand. Capital costs and distribution losses must be relatively insignificant to support their viability. Where an opportunity exists, the network operator should be contacted to assess the viability and costs of current or, future connection.

From the review of the surrounding area, and taking into account the information contained with the Hertfordshire Renewable and Low Carbon Energy Technical Study, it is understood that if we assumed a viability threshold of 3,000 kW.km2, the immediate vicinity of the development is within an area with district heating potential. This is stated in the mentioned document in Section 4.3.2, as detailed below, and map on following page.

> Assuming a district heating viability threshold of 3,000 kW/ km^2 (see Figure 2.8), it can be surmised that urban areas such as Watford, Hemel Hempstead, Welwyn Garden City, Hatfield, Cheshunt, Hitchin, Letchworth, Hoddesdon, Hertford and Bishop Stortford all have large areas with district heating potential.

From desk top research it has been found that there is no existing DHN nearby to connect to.

Due to the energy density of the surrounding area and site itself, this makes a future district energy network potentially feasible. Therefore, the community heating system shall be designed in such a way as to facilitate a potential future connection, should one become available during the operational lifetime of the building.

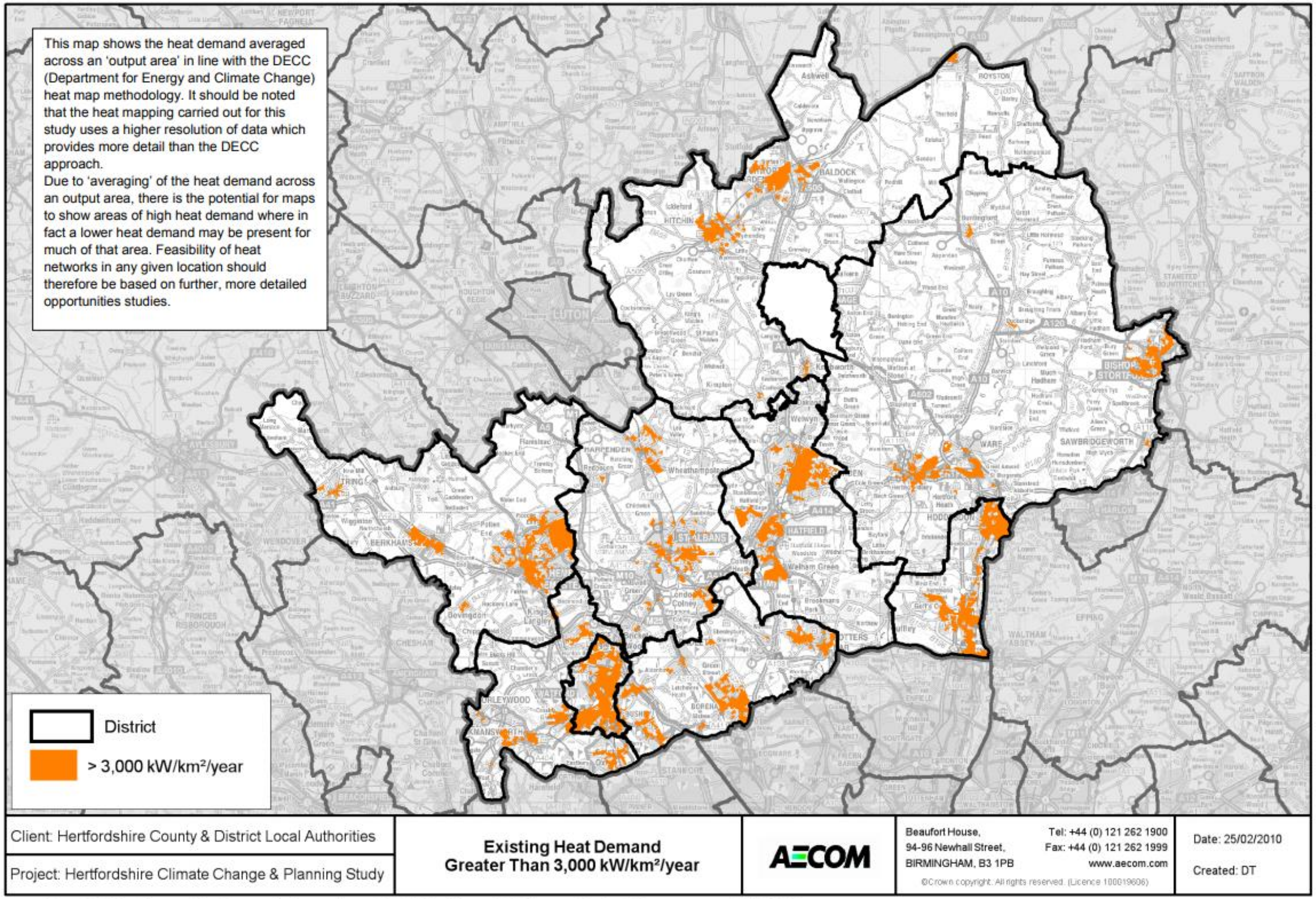


Figure 2.8: Heat demand density map for demand over 3,000 kW/km^2/year, 2009 (Source: Hertfordshire energy model, AECOM)

7.2 Site-wide heat network

As described above, the proposals are to provide a single site-wide heat network serving the flats, which will enable easy connection to a wider heat network in the future, should one become available. Combined Heat and Power (CHP) has been explored to establish its feasibility as the main heat source.

CHP produces heat at lower efficiencies compared to that of a gas boiler, but its advantage is that it also produces electricity with the 'waste heat'. This has until recently been a very effective way of reducing carbon emissions as the electricity generated would have otherwise been provided by grid electricity, which has historically been very carbon intensive. However, the ongoing decarbonisation of grid electricity has resulted in CHP being infeasible, as the benefits have diminished.

The site-wide heat network sourced from the Energy Centre will therefore only incorporate gas boilers to provide the connected flats with heat, for heating and hot water.

8. Feasibility of Renewable Energy

8.1 Overview

Renewable energy is defined as energy derived from energy flows that occur naturally and repeatedly in the environment. It may be contrasted with energy sources that can be depleted such as fossil fuels or nuclear power. It therefore follows that the commonly used phrase "equipment to generate renewable energy" is an oxymoron since renewable energy cannot be "generated" – the true function of the technology is to harness a natural energy flow.

Renewable energy technologies, with a couple of exceptions, all utilise energy from the sun – either directly or indirectly, the exceptions being true geothermal, which uses heat from the earth's core, and tidal / marine current electricity generation which uses the gravitational forces between the earth and the moon, (although some marine currents are also greatly affected by solar energy). Insofar as this report is only concerned with practical options for on-site renewable energy, these options are not considered further. The remaining range of "solar" technologies are however vast, and some would not even appear to be solar on superficial inspection. They can be summarised as follows:

- Solar thermal – direct heating of water for space heating or hot water;
- Photovoltaic – direct generation of electricity from sunlight;
- Hydroelectricity – use of solar (water cycle) driven water flows to generate electricity;
- Wind turbines – use of solar driven air movement to generate electricity;
- Heat pumps – extraction of solar heat from the earth, atmosphere or water bodies;
- Bio-fuels – combustion of solid or liquid bio-fuels to produce heat or electricity;

The technologies, and their potential application to this site are discussed in more detail in the following sections. However, one further pertinent point must be made. The reason for adopting renewable energy technologies is to reduce greenhouse gas emissions – mainly carbon dioxide, and none of the technologies are wholly "zero carbon". This is because when the whole life cycle is considered, some energy must be put into every system to manufacture and maintain the equipment (which has a finite life) or to operate the equipment, and generally at present this energy is derived from non-renewable sources. Examples include the energy needed to refine and process the silicon used to manufacture photovoltaic panels, the diesel fuel used to transport wood pellets to the development and to power the wood processing machinery, and where applicable to bio-fuels, the energy used to manufacture the fertilizers needed to maintain soil fertility.

Finally, due to the dynamic and innovative nature of the renewable energy technology industry even apparently similar products can differ in vital practical details which means that detailed design of installations must be undertaken by experts, often working closely with the product manufacturers, as virtually no two products are identical or interchangeable.

The following section contains an overview of the technologies selected for this development. For more detailed analyses of all listed technologies, and the reasons for their exclusion, please see Appendix A.

8.2 Heat Pumps

Heat pumps collect low temperature heat and “concentrate” it to a usable temperature. A typical heat pump serving a heat network will typically deliver 2-3 kWh of useful energy for every 1 kWh of input energy. A heat pump operating in this way can therefore be deemed to have delivered 1-2 kWh of low carbon energy.

There are two common types of heat pump – ground source and air source. Water source heat pumps are also available, but rarely applicable, as they require a local large body of water. In urban locations such as this, ground source heat pumps are also rarely viable, due to the complexity of drilling boreholes to collect heat. These are typically up to 100m deep and should be spaced at least 6m apart to avoid over-cooling the ground. A typical borehole can deliver a maximum output of 4kW of heat, therefore, a significantly large area is required in order to be considered feasible, which is generally not available in high-rise urban development.

Air source heat pumps collect heat from the ambient air using air-heat-exchanger units.

Whilst heat pumps can provide good levels of performance, they have practical limitations. Firstly, to be effective, the units must be located externally, which can impact acoustically as well as on visual amenity and space. In addition, as heat pumps collect heat from the air, their efficiency is intrinsically linked to air temperature. Therefore, when the demand for heat is at its peak, the efficiency of the system is at its lowest. Furthermore, as the system relies on grid-produced electricity to operate, its real carbon emissions will be heavily linked to the variable carbon intensity of the national grid.

Due to size and noise levels of required roof mounted plant, ASHPs are considered inappropriate for the dwellings.

As noted previously, the non-residential aspects shall be developed to shell-only stage, with the fit-out to be completed by the future tenants. The building services are therefore unknown, but the most likely technology that is incorporated into these types of units is heat pumps. This is generally due to the fact that these units usually require cooling, so a VRF system that provide both heating and cooling via ceiling cassettes, are generally preferred. So this technology has been assumed for the non-residential part of the development.

8.3 Solar photovoltaics

Photovoltaic panels are conceptually straightforward. The panels produce “zero carbon" electricity that is used in place of grid electricity, and the carbon dioxide emissions saved are the emissions that would have occurred had the electricity been produced by a power station feeding the grid.

This development proposal is well suited to photovoltaic panel technology becasue there is ample available roof space.

PV specification

It is proposed that a series of PV arrays be installed on the roofs of the development, totalling 76kWp.

Note that the specifics of the PV design, shall be evaluated fully during detailed design by a suitably qualified specialist.

To represent the emissions reduction the PV array has been entered into the Part L1A calculations for the dwellings.

The below table details the specifications applied to the various calculations.

Residential

	Specification
Installed Peak Power	76 kWp
Tilt	< 30°
Orientation	South
Over-shading	None

The system inverter will convert DC output to AC, bringing power into phase with the mains electricity supply. It is expected that the PV will feed directly into the landlord's electricity supply, and the power produced used to power the communal areas of the building (lifts, lighting etc). If there is any surplus electricity produced, this can be exported to the grid to be utilised by others.

8.4 Emissions at 'With Renewables' Stage

The below tables detail the CO_2 savings from the 'With Renewables' assessment

Residential

Scenario -	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
Building Regulations	350	-	-
Use Less Energy	339	3.14	3.14
With Renewables	305	10	12.86

Non-Residential

Scenario -	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
Building Regulations	3.60	-	-
Use Less Energy	3.58	0.54	0.54
With Renewables	3.10	13.39	13.86

The above renewables proposals have been found to reduce emissions by a further 10% for the residential development, and 13.39% for the commercial development.

9. Conclusions

This Energy Statement has outlined the proposed preliminary specification for the development and the resulting savings implemented at each stage of the energy hierarchy, as detailed in Draft Policy SP 1, SP 10 and SADM 13 as detailed in Section 3.

A fabric-first approach has been taken, as detailed in Section 6, to realise savings against the calculated 'Building Regulation' baseline emissions, and has been shown to surpass the requirements of Part L alone.

As detailed in Section 7 there are no existing District Heat Networks to connect to. The opportunity for a site-wide heat network for flats has been evaluated and found to be technically viable. It is therefore proposed to provide an energy centre which will feed all flats for heating and hot water via gas boilers. This will be provided to allow for connection to a future district heating scheme if one becomes available.

It is not feasible to serve the proposed townhouses, therefore they will be provided with their own heating and hot water from independent boilers in each dwelling.

As detailed in Section 8 additional CO_2 savings will then be achieved through the use of a photovoltaic array in the case of dwellings, and ASHP in the case of the commercial unit as this has been assumed to be the most likely fit-out specification.

The above measures have shown to reduce carbon emission by 12.86% and 13.86% in the case of residential and non-residential respectively, when compared to the building regulations baseline case. It can also be seen that the improvement delivered by the renewable technologies is 10% in the case of residential, and 13.39% in the case of non-residential.

Residential

Scenario -	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
Building Regulations	350	-	-
Use Less Energy	339	3.14	3.14
With Renewables	305	10	12.86

Non-Residential

Scenario -	Regulated CO_2 emissions (Tonnes CO_2/annum)	CO_2 reduction (%)	Cumulative CO_2 reduction (%)
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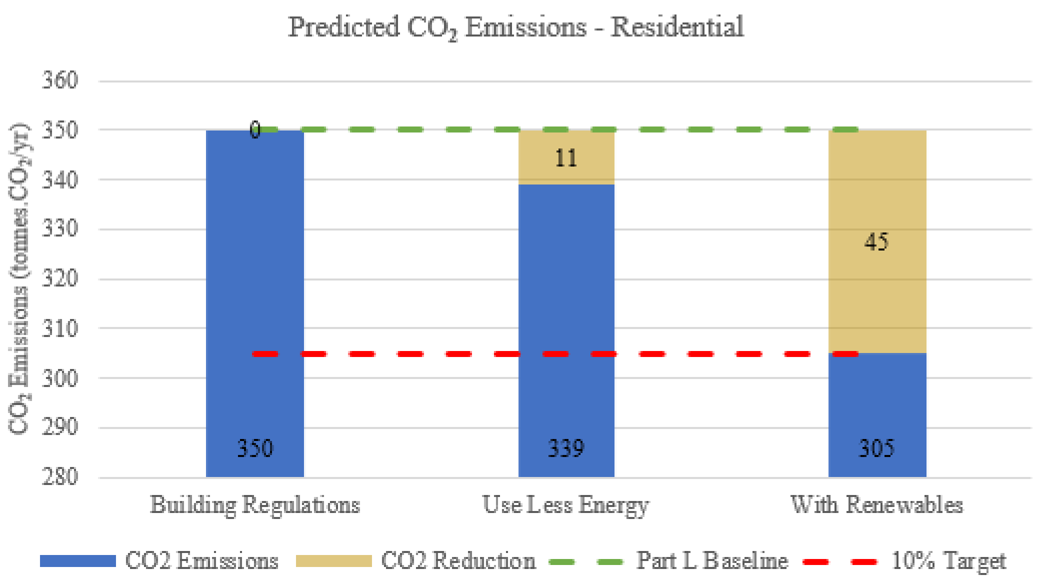
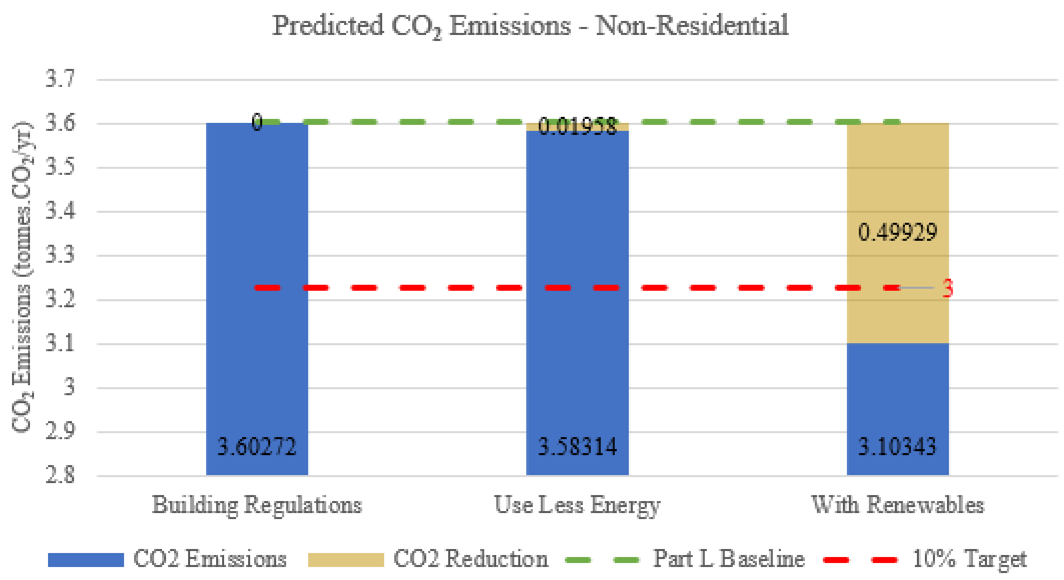

Predicted CO2 Emissions - Residential
CO2 Emissions (tonnes.CO2/yr)
360
350
340
330
320
310
300
290
280
0
11
45
350
339
305
Building Regulations
Use Less Energy
With Renewables
CO2 Emissions
CO2 Reduction
Part L Baseline
10% Target


Predicted CO2 Emissions - Non-Residential
CO2 Emissions (tonnes.CO2/yr)
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
0
0.01958
0.49929
3
3.60272
3.58314
3.10343
Building Regulations
Use Less Energy
With Renewables
CO2 Emissions
CO2 Reduction
Part L Baseline
10% Target

Appendix A – Renewable Technology Considerations

Solar Thermal Systems

Solar thermal panels use the sun's energy to contribute to the heat energy needed to provide space heating and/or domestic hot water. They are perhaps the oldest, and certainly the most obvious and easily understood type of renewable energy technology.

The panels consist of a roof-mounted solar heat collector which can be either a flat plat or tube system containing water, or a more complex evacuated tube system, which in some cases utilises "heat pipes". The systems also include provision to ensure that the water in the panel does not freeze in winter, and pumps to drive the "solar circuit". The principle disadvantage with solar thermal systems is that the heat cannot be stored for long periods, and unlike electricity cannot be exported when surplus is available.

In commercial schemes, such as this an array of panels would be connected to a storage vessel in the plant room. The amount of fossil fuel that can be saved is limited to the amount that would have been used if the solar heated water was not available. If surplus hot water is produced it will be wasted, so cannot be counted when determining the amount of renewable energy being delivered. Solar thermal systems also use electricity to power the pumps needed to circulate the heat exchange fluid through the solar panels, and the resulting carbon emissions from this electricity must be offset against the emissions saving from the heat collected.

In this case, a solar thermal array would require pumping the circulating fluid from roofs, to the ground floor plant room. The energy required to circulate the fluid this distance, and losses associated from the pipework, would negate any possible benefits from the system. It is therefore established that a Solar Photovoltaic array would be a more viable use of this roof space.

Micro-Hydroelectricity

The utilisation of "water power", together with "wind power" is generally recognised as having facilitated the early stages of the Industrial Revolution in Europe. Water wheels were simple to manufacture and produced high torque without gears and simple gears could be used to increase speed. Water power was, unlike wind power, controllable, and subject to a sufficient water level in the "mill pond", was available on demand.

Water power was of course used to grind wheat to produce flour, but also powered many types of machinery including fans for blast furnaces, and hammer mills used to produce wrought iron. Today, large hydroelectric schemes are still very important energy sources in many countries, although in the UK only 0.8% of the electricity demand is produced in this way, mainly because there are very few suitable sites. The Government estimates that if all the rivers and streams in the UK could be harnessed the output would still only be 3% of the total demand, so while local schemes can be important, strategically, this is one of the less important technologies.

Micro-hydro is the term used for very small schemes, although it is applied to any scheme producing less than 1 MW. On-site micro-hydro is clearly totally dependent on the availability of a suitable river or stream that could be utilised in an environmentally acceptable way, and produce a worthwhile output, and such availability is so limited in typical urban sites as to make this a technology that is generally of no relevance.

The extraction of energy from flowing water will by definition reduce its velocity and change water levels and introducing such changes even to a canalised urban river can have both upstream and downstream impacts. And where the site has a natural ecology the local impacts can be far greater and the necessary mitigation difficult to achieve. So, in conclusion, the most likely instance where a micro-hydro installation might be possible is one where an existing or historical site can be utilised, but these are very rare.

Micro-Hydro is clearly not suitable for this development.

Wind Turbines

The general principles of operation of small scale wind turbines are straightforward, and windmills are probably one of earliest ways that mankind harnessed natural energy flows and put them to practical use. However, while conceptually simple, wind turbines present complex challenges both on technical and planning terms and cannot be considered a simple option.

Considering in the first instance only the technical issues, it will first be necessary to establish whether a site has an adequate wind resource. Preliminary checks can be made using the DTI wind speed database and a site with a theoretical average wind speed of at least 5 m/s at 25m above ground level can be suitable. Other relevant issues are the amount of local wind shadowing and turbulence likely to be produced by nearby buildings and trees and whether the site is open in the direction of the prevailing wind. In practice, even on a promising site these issues mean that to have any confidence that a worthwhile amount of electricity could be generated and thereby validate an investment decision it is necessary to carry out extended wind speed measurements, typically over a full year.

In the normal absence of valid wind data at the beginning of a project some guidance is becoming available on the reduction in output typically seen on a sheltered urban site compared to manufacturer's wind-tunnel data. This can be illustrated by reference to the data for a 2.5kWe unit with a rotor diameter of 3.5m. In a rural environment with an average wind speed of 8 m/s, such a unit would produce 10,164 kWh/yr. and reduce carbon dioxide emissions by 5,773 kg. On an urban site where the wind speed is just 4.8 m/s it would produce only 392 kWh/yr. and reduce emissions by just 223 kg. A single turbine of this type would therefore reduce the emissions from the development by a negligible amount so would make no practical contribution to the emissions reduction target.

While this technical review indicates that wind turbines are very unlikely to be feasible, in addition, other issues must be considered. Clearly the overriding issue is the impact on the visual amenity of the site and surroundings and opinions are generally divided on the aesthetics of wind turbines.

So, while large wind turbines installed in "wind farms" in exposed locations and increasingly off shore, can and are providing a substantial amount of the UK's current renewable electricity, the use of micro wind turbines on small residential or commercial developments is of questionable value, and is frequently no more than a token gesture.

Bio Fuels

In the UK there are essentially two types of bio-fuels available at present. Biomass generally refers to either wood chips or wood pellets. Bio-diesel (or plant oil) is a liquid bio-fuel (chemically modified vegetable oil) that can be used in place of heating oil or to run diesel engines. In the built environment, bio-diesel is not a viable proposition at present due to fuel availability and cost, and it is questionable whether this should ever be the case since it is a valuable energy source which can be readily used for transport that cannot at present easily be powered by other bio-fuels. There are also real issues of the true carbon emissions associated with its production. There are a range of energy inputs associated with growing and processing the fuel, and while it is generally regarded as having a bio-fuel output to fossil fuel input ratio of around 4 : 1, some studies suggest it can be 2 : 1 or lower.

In contrast, biomass is readily available, requires minimal processing, and a proportion is sourced from the waste stream that would ultimately go to landfill where decomposition releases methane, a greenhouse gas 22 times more potent than CO2. However, the delivery, storage and utilisation of biomass is far less convenient than gas or even oil. In terms of types of system, there are essentially two – a simple biomass boiler burning either wood chips, which are cheaper but more difficult to handle, or wood pellets.

Biomass heating systems generally need a lot of room to store the fuel, and suitable arrangements to enable it to be delivered to the plant rooms. They are also an extremely high-maintenance system when compared to alternative solutions. In this instance, it is not considered a viable option.

Appendix B – CO_2 emission factors

These factors are taken from SAP2012 version 9.92, Table 12 and are used in Part L: 2013 of the Building Regulations.

It should be noted that these emission factors must be used to ensure a comparative approach between development, irrespective of the accuracy of the BRE data.

Fuel	CO2 emission factor kgCO2/kWh
Natural gas	0.216
LPG	0.241
Heating oil	0.298
House coal / Anthracite	0.394
Smokeless fuel (inc. coke)	0.347
Dual fuel appliances (mineral + wood)	0.226
Wood logs	0.019
Wood chips	0.016
Wood pellets	0.039
Grid supplied electricity	0.519
Grid displaced electricity	0.519
Waste heat from power stations	0.058

Appendix C – Part L (SAP and DSM) Calculations

Provided within separate file.

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A G01

Address : GRD Medium

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	76.15	(1a) x	2.5	(2a) =	190.38	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	76.15	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	190.38	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.16	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.41	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.35	(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 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

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

0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.35	0.37	0.39	0.41

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.6	0.59	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 box (25)

(25)m=	0.6	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 (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1	=	2.1			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			8.07	x1/[1/(1.4)+ 0.04]		=	10.7			(27)
Floor			77.49	x	0.13	=	10.0737			(28)
Walls Type1	61.61	10.53	51.08	x	0.18	=	9.19			(29)
Walls Type2	4.24	2.1	2.14	x	0.18	=	0.39			(29)
Walls Type3	20.46	0	20.46	x	0.18	=	3.68			(29)
Walls Type4	6.15	0	6.15	x	0.18	=	1.11			(29)
Total area of elements, m²			169.95							(31)
Party wall			4.98	x	0	=	0			(32)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 40.5 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 10.7 (36)

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

Total fabric heat loss (33) + (36) = 51.2 (37)

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

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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	37.54	37.3	37.07	35.97	35.77	34.81	34.81	34.64	35.18	35.77	36.18	36.62	(38)

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

(39)m=	88.74	88.51	88.27	87.18	86.97	86.02	86.02	85.84	86.39	86.97	87.39	87.82	

Average = Sum(39)$_{1...12}$ /12= 87.18 (39)

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

(40)m=	1.17	1.16	1.16	1.14	1.14	1.13	1.13	1.13	1.13	1.14	1.15	1.15	

Average = Sum(40)$_{1...12}$ /12= 1.14 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.39 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 90.86 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	99.95	96.31	92.68	89.04	85.41	81.78	81.78	85.41	89.04	92.68	96.31	99.95	

Total = Sum(44)$_{1...12}$ = 1090.34 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	148.22	129.63	133.77	116.62	111.9	96.56	89.48	102.68	103.91	121.09	132.18	143.54	

Total = Sum(45)$_{1...12}$ = 1429.61 (45)

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

(46)m=	22.23	19.45	20.07	17.49	16.79	14.48	13.42	15.4	15.59	18.16	19.83	21.53	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.39 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.75 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

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

Enter (50) or (54) in (55) 0.75 (55)

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

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	194.81	171.72	180.37	161.72	158.5	141.66	136.08	149.28	149	167.69	177.28	190.14	(62)

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

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

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

Output from water heater

(64)m=	194.81	171.72	180.37	161.72	158.5	141.66	136.08	149.28	149	167.69	177.28	190.14	

Output from water heater (annual)$_{1\ldots12}$	1978.23	(64)

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

(65)m=	86.56	76.77	81.75	74.85	74.48	68.18	67.03	71.42	70.62	77.54	80.02	85	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	(66)

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

(67)m=	20.25	17.99	14.63	11.08	8.28	6.99	7.55	9.82	13.18	16.73	19.53	20.82	(67)

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

(68)m=	211.21	213.4	207.88	196.12	181.28	167.33	158.01	155.82	161.34	173.1	187.94	201.89	(68)

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

(69)m=	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	(71)

Water heating gains (Table 5)

(72)m=	116.34	114.24	109.89	103.96	100.11	94.7	90.09	95.99	98.09	104.22	111.15	114.25	(72)

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

(73)m=	409.59	407.42	394.18	372.94	351.45	330.8	317.44	323.41	334.39	355.83	380.4	398.74	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a	g_ Table 6b		FF Table 6c		Gains (W)	
Southwest 0.9x	0.77	x	8.07	x	36.79	0.63	x	0.7	=	90.74	(79)
Southwest 0.9x	0.77	x	8.07	x	62.67	0.63	x	0.7	=	154.57	(79)

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Southwest 0.9x	0.77	x	8.07	x	85.75		0.63	x	0.7	=	211.49	(79)
Southwest 0.9x	0.77	x	8.07	x	106.25		0.63	x	0.7	=	262.05	(79)
Southwest 0.9x	0.77	x	8.07	x	119.01		0.63	x	0.7	=	293.52	(79)
Southwest 0.9x	0.77	x	8.07	x	118.15		0.63	x	0.7	=	291.39	(79)
Southwest 0.9x	0.77	x	8.07	x	113.91		0.63	x	0.7	=	280.93	(79)
Southwest 0.9x	0.77	x	8.07	x	104.39		0.63	x	0.7	=	257.46	(79)
Southwest 0.9x	0.77	x	8.07	x	92.85		0.63	x	0.7	=	229	(79)
Southwest 0.9x	0.77	x	8.07	x	69.27		0.63	x	0.7	=	170.83	(79)
Southwest 0.9x	0.77	x	8.07	x	44.07		0.63	x	0.7	=	108.69	(79)
Southwest 0.9x	0.77	x	8.07	x	31.49		0.63	x	0.7	=	77.66	(79)
Northwest 0.9x	0.77	x	2.46	x	11.28	x	0.63	x	0.7	=	8.48	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.63	x	0.7	=	17.27	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.63	x	0.7	=	51.09	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.63	x	0.7	=	73.21	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.63	x	0.7	=	68.49	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.63	x	0.7	=	54.6	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.63	x	0.7	=	37.91	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.63	x	0.7	=	6.93	(81)

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

(83)m=	99.23	171.84	242.6	313.14	362.19	364.61	349.42	312.06	266.91	191.94	119.36	84.59	(83)

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

(84)m=	508.82	579.26	636.78	686.08	713.64	695.41	666.86	635.47	601.3	547.77	499.76	483.33	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.96	0.88	0.73	0.55	0.6	0.83	0.97	0.99	1	(86)

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

(87)m=	19.8	19.95	20.2	20.51	20.78	20.94	20.99	20.98	20.88	20.54	20.11	19.78	(87)

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

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

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

(89)m=	1	0.99	0.98	0.94	0.84	0.63	0.43	0.48	0.76	0.95	0.99	1	(89)

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

(90)m=	18.36	18.58	18.94	19.39	19.75	19.94	19.97	19.97	19.88	19.44	18.83	18.33	(90)

fLA = Living area ÷ (4) = 0.5 (91)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(92)m=	19.09	19.28	19.57	19.95	20.27	20.44	20.48	20.48	20.38	19.99	19.47	19.06		(92)

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

(93)m=	19.09	19.28	19.57	19.95	20.27	20.44	20.48	20.48	20.38	19.99	19.47	19.06		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	0.99	0.99	0.98	0.94	0.85	0.68	0.49	0.54	0.79	0.95	0.99	1		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	506	572.95	621.69	645.2	608.23	471.85	329.15	342.63	475.08	521.47	494.19	481.23		(95)
Monthly average external temperature from Table 8														
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]														
(97)m=	1312.17	1272.28	1153.8	963.52	745.13	502.77	334.14	350.35	542.87	816.76	1081.41	1304.87		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	599.79	469.95	395.89	229.19	101.85	0	0	0	0	219.7	422.8	612.78		
										Total per year (kWh/year) = Sum(98)1...5,9...12 =			3051.95	(98)

Space heating requirement in kWh/m²/year | 40.08 | (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	599.79	469.95	395.89	229.19	101.85	0	0	0	0	219.7	422.8	612.78		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	641.48	502.62	423.41	245.12	108.93	0	0	0	0	234.97	452.19	655.38		
										Total (kWh/year) =Sum(211)1...5,10...12=			3264.12	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
										Total (kWh/year) =Sum(215)1...5,10...12=			0	(215)

Water heating

Output from water heater (calculated above)														
	194.81	171.72	180.37	161.72	158.5	141.66	136.08	149.28	149	167.69	177.28	190.14		
Efficiency of water heater													79.8	(216)
(217)m=	87.62	87.37	86.85	85.74	83.67	79.8	79.8	79.8	79.8	85.54	87.05	87.71		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	222.34	196.55	207.66	188.6	189.43	177.51	170.52	187.06	186.72	196.05	203.64	216.77		
										Total = Sum(219a)1...12 =			2342.87	(219)

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Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3264.12	
Water heating fuel used			2342.87	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			357.71	(232)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	705.05	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	506.06	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1211.11	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	185.65	(268)
Total CO2, kg/year			sum of (265)…(271) =		1435.68	(272)

TER =	18.85	(273)

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User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A 208

Address : Mid Medium

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	62	(1a) x	2.48	(2a) =	154.07	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	154.07	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							2	x 10 =	20	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.13	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.38	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed

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

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

0.41	0.4	0.4	0.36	0.35	0.31	0.31	0.3	0.32	0.35	0.36	0.38

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1	=	2.1			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 3			7.85	x1/[1/(1.4)+ 0.04]		=	10.41			(27)
Walls Type1	36.72	12.77	23.95	x	0.18	=	4.31			(29)
Walls Type2	4.98	2.1	2.88	x	0.18	=	0.52			(29)
Walls Type3	20.45	0	20.45	x	0.18	=	3.68			(29)
Walls Type4	10.05	0	10.05	x	0.18	=	1.81			(29)
Total area of elements, m²			72.2							(31)
Party wall			16.18	x	0	=	0			(32)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 29.35 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 6.85 (36)

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

Total fabric heat loss (33) + (36) = 36.2 (37)

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

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

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(38)m=	29.73	29.56	29.4	28.63	28.48	27.81	27.81	27.69	28.07	28.48	28.77	29.08	(38)

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

(39)m=	65.92	65.76	65.59	64.82	64.68	64.01	64.01	63.88	64.27	64.68	64.97	65.27

Average = Sum(39)$_{1...12}$ /12= 64.82 (39)

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

(40)m=	1.06	1.06	1.06	1.05	1.04	1.03	1.03	1.03	1.04	1.04	1.05	1.05

Average = Sum(40)$_{1...12}$ /12= 1.05 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 82.59 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85

Total = Sum(44)$_{1...12}$ = 991.11 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	134.73	117.84	121.6	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48

Total = Sum(45)$_{1...12}$ = 1299.5 (45)

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

(46)m=	20.21	17.68	18.24	15.9	15.26	13.17	12.2	14	14.17	16.51	18.02	19.57	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.39 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.75 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

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

Enter (50) or (54) in (55) 0.75 (55)

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

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07	(62)

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

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

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

Output from water heater

(64)m=	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07

Output from water heater (annual)$_{1...12}$ | 1848.12 | (64)

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

(65)m=	82.07	72.85	77.71	71.32	71.1	65.26	64.32	68.31	67.48	73.88	76.02	80.66	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	(66)

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

(67)m=	15.93	14.15	11.51	8.71	6.51	5.5	5.94	7.72	10.37	13.16	15.36	16.38	(67)

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

(68)m=	177.96	179.81	175.15	165.25	152.74	140.99	133.14	131.29	135.94	145.85	158.36	170.11	(68)

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

(69)m=	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	(71)

Water heating gains (Table 5)

(72)m=	110.31	108.41	104.44	99.06	95.56	90.64	86.45	91.81	93.72	99.29	105.59	108.41	(72)

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

(73)m=	360.77	358.93	347.67	329.58	311.38	293.69	282.09	287.39	296.59	314.87	335.87	351.46	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northwest	0.9x	0.77	x	2.46	x	11.28	x	0.63	x	0.7	=	8.48	(81)
Northwest	0.9x	0.77	x	2.46	x	11.28	x	0.63	x	0.7	=	8.48	(81)

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Northwest 0.9x	0.77	x	7.85	x	11.28	x	0.63	x	0.7	=	27.07	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.63	x	0.7	=	17.27	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.63	x	0.7	=	17.27	(81)
Northwest 0.9x	0.77	x	7.85	x	22.97	x	0.63	x	0.7	=	55.1	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	7.85	x	41.38	x	0.63	x	0.7	=	99.27	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.63	x	0.7	=	51.09	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.63	x	0.7	=	51.09	(81)
Northwest 0.9x	0.77	x	7.85	x	67.96	x	0.63	x	0.7	=	163.03	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	7.85	x	91.35	x	0.63	x	0.7	=	219.14	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.63	x	0.7	=	73.21	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.63	x	0.7	=	73.21	(81)
Northwest 0.9x	0.77	x	7.85	x	97.38	x	0.63	x	0.7	=	233.63	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.63	x	0.7	=	68.49	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.63	x	0.7	=	68.49	(81)
Northwest 0.9x	0.77	x	7.85	x	91.1	x	0.63	x	0.7	=	218.56	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.63	x	0.7	=	54.6	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.63	x	0.7	=	54.6	(81)
Northwest 0.9x	0.77	x	7.85	x	72.63	x	0.63	x	0.7	=	174.24	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.63	x	0.7	=	37.91	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.63	x	0.7	=	37.91	(81)
Northwest 0.9x	0.77	x	7.85	x	50.42	x	0.63	x	0.7	=	120.96	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	7.85	x	28.07	x	0.63	x	0.7	=	67.33	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	7.85	x	14.2	x	0.63	x	0.7	=	34.06	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.63	x	0.7	=	6.93	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.63	x	0.7	=	6.93	(81)
Northwest 0.9x	0.77	x	7.85	x	9.21	x	0.63	x	0.7	=	22.11	(81)

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

(83)m=	44.03	89.63	161.49	265.21	356.49	380.06	355.54	283.44	196.78	109.54	55.41	35.96	(83)

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

(84)m=	404.81	448.56	509.16	594.79	667.87	673.75	637.63	570.83	493.37	424.41	391.28	387.42	(84)

7. Mean internal temperature (heating season)

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

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

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

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(86)m=	1	0.99	0.98	0.94	0.8	0.59	0.44	0.51	0.8	0.97	0.99	1	(86)

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

(87)m=	19.93	20.06	20.31	20.65	20.89	20.98	21	20.99	20.92	20.6	20.21	19.9	(87)

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

(88)m=	20.03	20.03	20.04	20.05	20.05	20.06	20.06	20.06	20.05	20.05	20.04	20.04	(88)

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

(89)m=	1	0.99	0.98	0.91	0.74	0.51	0.35	0.41	0.72	0.95	0.99	1	(89)

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

(90)m=	18.6	18.79	19.16	19.64	19.95	20.05	20.06	20.06	19.99	19.58	19.02	18.58	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	19.14	19.31	19.63	20.05	20.33	20.43	20.44	20.44	20.37	19.99	19.5	19.12	(92)

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

(93)m=	19.14	19.31	19.63	20.05	20.33	20.43	20.44	20.44	20.37	19.99	19.5	19.12	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.91	0.76	0.54	0.38	0.45	0.75	0.95	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	402.69	444.25	496.35	543.62	507.89	366.41	244.96	256.19	369.58	404.23	387.22	385.81	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	978.48	947.45	860.91	722.88	558.45	373.06	245.77	258.01	403.09	607.64	805.88	973.81	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	428.39	338.15	271.23	129.07	37.61	0	0	0	0	151.34	301.43	437.48	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2094.69 (98)

Space heating requirement in kWh/m²/year 33.79 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	428.39	338.15	271.23	129.07	37.61	0	0	0	0	151.34	301.43	437.48	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	458.17	361.66	290.08	138.04	40.23	0	0	0	0	161.86	322.39	467.89	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 2240.31 (211)

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Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07

Efficiency of water heater 79.8 (216)

(217)m=	87.03	86.76	86.08	84.4	81.76	79.8	79.8	79.8	79.8	84.72	86.4	87.13	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	208.35	184.32	195.38	179.04	181.41	166.5	160.32	175.35	174.87	184.92	191.26	203.22

Total = Sum(219a)$_{1...12}$ = 2204.94 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		2240.31	
Water heating fuel used		2204.94	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		75	(231)
Electricity for lighting		281.38	(232)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	483.91	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	476.27	(264)
Space and water heating	(261) + (262) + (263) + (264) =				960.18	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	146.04	(268)
Total CO2, kg/year			sum of (265)…(271) =		1145.14	(272)

TER = 18.47 (273)

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User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A 406

Address : Top Medium

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	62	(1a) x	2.6	(2a) =	161.2	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	161.2	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							2	x 10 =	20	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.12	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
Number of storeys in the dwelling (ns)			0	(9)
Additional infiltration		[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35				
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0	(12)
If no draught lobby, enter 0.05, else enter 0			0	(13)
Percentage of windows and doors draught stripped			0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			5	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.37	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides sheltered			2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.32	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.41	0.4	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.36	0.37

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

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

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1	=	2.1			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			7.85	x1/[1/(1.4)+ 0.04]		=	10.41			(27)
Windows Type 3			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Walls Type1	44.94	12.77	32.17	x	0.18	=	5.79			(29)
Walls Type2	5.22	2.1	3.12	x	0.18	=	0.56			(29)
Walls Type3	21.39	0	21.39	x	0.18	=	3.85			(29)
Walls Type4	10.51	0	10.51	x	0.18	=	1.89			(29)
Roof	62.34	0	62.34	x	0.13	=	8.1			(30)
Total area of elements, m²			144.4							(31)
Party wall			10.41	x	0	=	0			(32)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 39.23 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 15.6 (36)

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

Total fabric heat loss (33) + (36) = 54.83 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	30.97	30.8	30.63	29.85	29.71	29.02	29.02	28.9	29.29	29.71	30	30.31	(38)

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

(39)m=	85.8	85.63	85.47	84.68	84.54	83.86	83.86	83.73	84.12	84.54	84.83	85.14	

Average = Sum(39)$_{1…12}$ /12= 84.68 (39)

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

(40)m=	1.38	1.38	1.38	1.37	1.36	1.35	1.35	1.35	1.36	1.36	1.37	1.37

Average = Sum(40)$_{1…12}$ /12= 1.37 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 82.59 (43)

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

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

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

(44)m=	90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85

Total = Sum(44)$_{1…12}$ = 991.11 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	134.73	117.84	121.6	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48

Total = Sum(45)$_{1…12}$ = 1299.5 (45)

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

(46)m=	20.21	17.68	18.24	15.9	15.26	13.17	12.2	14	14.17	16.51	18.02	19.57	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.39 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.75 (50)

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

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

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

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

Enter (50) or (54) in (55) 0.75 (55)

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

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07	(62)

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

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

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

Output from water heater

(64)m=	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07

Output from water heater (annual)$_{1...12}$ | 1848.12 | (64)

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

(65)m=	82.07	72.85	77.71	71.32	71.1	65.26	64.32	68.31	67.48	73.88	76.02	80.66	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	(66)

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

(67)m=	15.93	14.15	11.51	8.71	6.51	5.5	5.94	7.72	10.37	13.16	15.36	16.38	(67)

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

(68)m=	177.96	179.81	175.15	165.25	152.74	140.99	133.14	131.29	135.94	145.85	158.36	170.11	(68)

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

(69)m=	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	(71)

Water heating gains (Table 5)

(72)m=	110.31	108.41	104.44	99.06	95.56	90.64	86.45	91.81	93.72	99.29	105.59	108.41	(72)

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

(73)m=	360.77	358.93	347.67	329.58	311.38	293.69	282.09	287.39	296.59	314.87	335.87	351.46	(73)

6. Solar gains:

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

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

Northwest 0.9x	0.77	x	2.46	x	11.28	x	0.63	x	0.7	=	8.48	(81)
Northwest 0.9x	0.77	x	7.85	x	11.28	x	0.63	x	0.7	=	27.07	(81)
Northwest 0.9x	0.77	x	2.46	x	11.28	x	0.63	x	0.7	=	8.48	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.63	x	0.7	=	17.27	(81)
Northwest 0.9x	0.77	x	7.85	x	22.97	x	0.63	x	0.7	=	55.1	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.63	x	0.7	=	17.27	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	7.85	x	41.38	x	0.63	x	0.7	=	99.27	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.63	x	0.7	=	51.09	(81)
Northwest 0.9x	0.77	x	7.85	x	67.96	x	0.63	x	0.7	=	163.03	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.63	x	0.7	=	51.09	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	7.85	x	91.35	x	0.63	x	0.7	=	219.14	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.63	x	0.7	=	73.21	(81)
Northwest 0.9x	0.77	x	7.85	x	97.38	x	0.63	x	0.7	=	233.63	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.63	x	0.7	=	73.21	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.63	x	0.7	=	68.49	(81)
Northwest 0.9x	0.77	x	7.85	x	91.1	x	0.63	x	0.7	=	218.56	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.63	x	0.7	=	68.49	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.63	x	0.7	=	54.6	(81)
Northwest 0.9x	0.77	x	7.85	x	72.63	x	0.63	x	0.7	=	174.24	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.63	x	0.7	=	54.6	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.63	x	0.7	=	37.91	(81)
Northwest 0.9x	0.77	x	7.85	x	50.42	x	0.63	x	0.7	=	120.96	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.63	x	0.7	=	37.91	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	7.85	x	28.07	x	0.63	x	0.7	=	67.33	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	7.85	x	14.2	x	0.63	x	0.7	=	34.06	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.63	x	0.7	=	6.93	(81)
Northwest 0.9x	0.77	x	7.85	x	9.21	x	0.63	x	0.7	=	22.11	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.63	x	0.7	=	6.93	(81)

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

(83)m=	44.03	89.63	161.49	265.21	356.49	380.06	355.54	283.44	196.78	109.54	55.41	35.96	(83)

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

(84)m=	404.81	448.56	509.16	594.79	667.87	673.75	637.63	570.83	493.37	424.41	391.28	387.42	(84)

7. Mean internal temperature (heating season)

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

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

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

TER WorkSheet: New dwelling design stage

(86)m=	1	0.99	0.99	0.96	0.87	0.71	0.56	0.63	0.87	0.98	0.99	1	(86)

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

(87)m=	19.5	19.64	19.93	20.34	20.71	20.92	20.98	20.96	20.78	20.32	19.85	19.48	(87)

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

(88)m=	19.78	19.78	19.78	19.79	19.79	19.8	19.8	19.8	19.8	19.79	19.79	19.78	(88)

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

(89)m=	1	0.99	0.98	0.94	0.82	0.61	0.42	0.49	0.8	0.97	0.99	1	(89)

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

(90)m=	17.81	18.01	18.43	19.02	19.51	19.75	19.79	19.79	19.62	19.01	18.32	17.78	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.5	18.68	19.04	19.56	20	20.22	20.28	20.27	20.09	19.55	18.94	18.47	(92)

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

(93)m=	18.5	18.68	19.04	19.56	20	20.22	20.28	20.27	20.09	19.55	18.94	18.47	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.94	0.83	0.65	0.47	0.55	0.82	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	402.55	444.41	498.54	558.42	556.99	437.51	301.78	311.88	406.53	409.02	387.43	385.64	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1218.42	1179.96	1071.82	902.47	701.29	471.67	308.31	323.81	504.22	756.2	1004.76	1215.25	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	607.01	494.29	426.52	247.71	107.36	0	0	0	0	258.3	444.48	617.23	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3202.91 (98)

Space heating requirement in kWh/m²/year 51.66 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	607.01	494.29	426.52	247.71	107.36	0	0	0	0	258.3	444.48	617.23	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	649.21	528.65	456.17	264.93	114.82	0	0	0	0	276.26	475.38	660.14	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 3425.57 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
								Total (kWh/year) =Sum(215)$_{1...5,10...12}$=					0	(215)

Water heating

Output from water heater (calculated above)

	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07		
Efficiency of water heater													79.8	(216)
(217)m=	87.79	87.63	87.19	86.12	83.97	79.8	79.8	79.8	79.8	86.14	87.33	87.87		(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	206.54	182.5	192.89	175.45	176.63	166.5	160.32	175.35	174.87	181.88	189.23	201.51		
								Total = Sum(219a)$_{1...12}$ =					2183.66	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3425.57	
Water heating fuel used			2183.66	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			281.38	(232)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	739.92	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	471.67	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1211.6	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	146.04	(268)
Total CO2, kg/year			sum of (265)…(271) =		1396.56	(272)

TER =	22.53	(273)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A G01

Address : GRD Medium

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	76.15	(1a)	x	2.5	(2a)	=	190.38	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	76.15	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	190.38	(5)

2. Ventilation rate:

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

Air changes per hour

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

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	76.5	(23c)

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

(24a)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1.4	=	2.94			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			8.07	x1/[1/(1.4)+ 0.04]		=	10.7			(27)
Floor			77.49	x	0.15	=	11.6235			(28)
Walls Type1	61.61	10.53	51.08	x	0.2	=	10.22			(29)
Walls Type2	4.24	2.1	2.14	x	0.2	=	0.43			(29)
Walls Type3	20.46	0	20.46	x	0.2	=	4.09			(29)
Walls Type4	6.15	0	6.15	x	0.2	=	1.23			(29)
Total area of elements, m²			169.95							(31)
Party wall			4.98	x	0	=	0			(32)

* *for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
** *include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	44.49	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	0	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Medium	250	(35)

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

Thermal bridges : S (L x Y) calculated using Appendix K		12.89	(36)

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

Total fabric heat loss	(33) + (36) =	57.38	(37)

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

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

DER WorkSheet: New dwelling design stage

(38)m=	17.59	17.39	17.19	16.19	15.99	14.99	14.99	14.79	15.39	15.99	16.39	16.79	(38)

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

(39)m=	74.98	74.78	74.58	73.57	73.37	72.37	72.37	72.17	72.77	73.37	73.77	74.17	

Average = Sum(39)$_{1...12}$ /12= 73.52 (39)

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

(40)m=	0.98	0.98	0.98	0.97	0.96	0.95	0.95	0.95	0.96	0.96	0.97	0.97	

Average = Sum(40)$_{1...12}$ /12= 0.97 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.39 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 90.86 (43)
Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

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

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

(44)m=	99.95	96.31	92.68	89.04	85.41	81.78	81.78	85.41	89.04	92.68	96.31	99.95

Total = Sum(44)$_{1...12}$ = 1090.34 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	148.22	129.63	133.77	116.62	111.9	96.56	89.48	102.68	103.91	121.09	132.18	143.54

Total = Sum(45)$_{1...12}$ = 1429.61 (45)

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

(46)m=	22.23	19.45	20.07	17.49	16.79	14.48	13.42	15.4	15.59	18.16	19.83	21.53	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	203.5	179.56	189.05	170.12	167.18	150.06	144.76	157.96	157.4	176.37	185.68	198.82	(62)

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

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

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

Output from water heater

(64)m=	203.5	179.56	189.05	170.12	167.18	150.06	144.76	157.96	157.4	176.37	185.68	198.82

Output from water heater (annual)$_{1...12}$ | 2080.45 | (64)

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

(65)m=	93.5	83.05	88.7	81.57	81.43	74.9	73.97	78.36	77.34	84.49	86.75	91.95	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	119.29	(66)

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

(67)m=	19.69	17.49	14.22	10.77	8.05	6.8	7.34	9.55	12.81	16.27	18.99	20.24	(67)

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

(68)m=	211.21	213.4	207.88	196.12	181.28	167.33	158.01	155.82	161.34	173.1	187.94	201.89	(68)

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

(69)m=	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	34.93	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	-95.43	(71)

Water heating gains (Table 5)

(72)m=	125.68	123.58	119.22	113.3	109.45	104.03	99.43	105.33	107.42	113.56	120.48	123.59	(72)

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

(73)m=	415.36	413.25	400.11	378.97	357.56	336.94	323.56	329.47	340.36	361.71	386.19	404.5	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a	g_ Table 6b		FF Table 6c		Gains (W)	
Southwest 0.9x	0.77	x	8.07	x	36.79	0.5	x	0.8	=	82.31	(79)
Southwest 0.9x	0.77	x	8.07	x	62.67	0.5	x	0.8	=	140.2	(79)

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Southwest	0.9x	0.77	x	8.07	x	85.75		0.5	x	0.8	=	191.83	(79)
Southwest	0.9x	0.77	x	8.07	x	106.25		0.5	x	0.8	=	237.69	(79)
Southwest	0.9x	0.77	x	8.07	x	119.01		0.5	x	0.8	=	266.23	(79)
Southwest	0.9x	0.77	x	8.07	x	118.15		0.5	x	0.8	=	264.3	(79)
Southwest	0.9x	0.77	x	8.07	x	113.91		0.5	x	0.8	=	254.82	(79)
Southwest	0.9x	0.77	x	8.07	x	104.39		0.5	x	0.8	=	233.52	(79)
Southwest	0.9x	0.77	x	8.07	x	92.85		0.5	x	0.8	=	207.71	(79)
Southwest	0.9x	0.77	x	8.07	x	69.27		0.5	x	0.8	=	154.95	(79)
Southwest	0.9x	0.77	x	8.07	x	44.07		0.5	x	0.8	=	98.59	(79)
Southwest	0.9x	0.77	x	8.07	x	31.49		0.5	x	0.8	=	70.44	(79)
Northwest	0.9x	0.77	x	2.46	x	11.28	x	0.5	x	0.8	=	7.69	(81)
Northwest	0.9x	0.77	x	2.46	x	22.97	x	0.5	x	0.8	=	15.66	(81)
Northwest	0.9x	0.77	x	2.46	x	41.38	x	0.5	x	0.8	=	28.22	(81)
Northwest	0.9x	0.77	x	2.46	x	67.96	x	0.5	x	0.8	=	46.34	(81)
Northwest	0.9x	0.77	x	2.46	x	91.35	x	0.5	x	0.8	=	62.29	(81)
Northwest	0.9x	0.77	x	2.46	x	97.38	x	0.5	x	0.8	=	66.41	(81)
Northwest	0.9x	0.77	x	2.46	x	91.1	x	0.5	x	0.8	=	62.12	(81)
Northwest	0.9x	0.77	x	2.46	x	72.63	x	0.5	x	0.8	=	49.53	(81)
Northwest	0.9x	0.77	x	2.46	x	50.42	x	0.5	x	0.8	=	34.38	(81)
Northwest	0.9x	0.77	x	2.46	x	28.07	x	0.5	x	0.8	=	19.14	(81)
Northwest	0.9x	0.77	x	2.46	x	14.2	x	0.5	x	0.8	=	9.68	(81)
Northwest	0.9x	0.77	x	2.46	x	9.21	x	0.5	x	0.8	=	6.28	(81)

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

(83)m=	90	155.86	220.05	284.03	328.52	330.71	316.94	283.05	242.09	174.09	108.27	76.72	(83)

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

(84)m=	505.37	569.12	620.15	662.99	686.08	667.65	640.5	612.52	582.45	535.8	494.46	481.22	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.95	0.85	0.67	0.49	0.54	0.78	0.96	0.99	1	(86)

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

(87)m=	20.05	20.19	20.4	20.66	20.87	20.98	21	20.99	20.94	20.68	20.32	20.02	(87)

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

(88)m=	20.1	20.1	20.1	20.11	20.11	20.12	20.12	20.13	20.12	20.11	20.11	20.11	(88)

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

(89)m=	1	0.99	0.98	0.93	0.8	0.59	0.4	0.44	0.71	0.94	0.99	1	(89)

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

(90)m=	18.83	19.03	19.34	19.72	19.99	20.11	20.12	20.12	20.08	19.75	19.23	18.8	(90)

fLA = Living area ÷ (4) = 0.5 (91)

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

(92)m=	19.44	19.61	19.87	20.2	20.44	20.55	20.56	20.56	20.51	20.22	19.78	19.42	(92)

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

(93)m=	19.44	19.61	19.87	20.2	20.44	20.55	20.56	20.56	20.51	20.22	19.78	19.42	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.93	0.82	0.63	0.45	0.49	0.75	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	502.58	562.69	604.06	616.82	564.35	418.18	285.44	298.14	434.11	505.02	488.52	479.17	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1135.35	1100.23	997.27	831.12	641.02	430.39	286.86	300.48	466.63	705.82	935.36	1128.65	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	470.78	361.23	292.55	154.3	57.05	0	0	0	0	149.4	321.72	483.22	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2290.24 (98)

Space heating requirement in kWh/m²/year 30.08 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		2290.24	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	2404.75	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		2080.45	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2184.47	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	45.89	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)

Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside			150.97	(330a)
warm air heating system fans			0	(330b)
pump for solar water heating			0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =		150.97	(331)
Energy for lighting (calculated in Appendix L)			347.78	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				95	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	1043.44	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	23.82	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	1067.26	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				1067.26	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	78.35	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	180.5	(379)
Total CO2, kg/year	sum of (376)…(382) =				1326.11	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				17.41	(384)
EI rating (section 14)					85.33	(385)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A 208

Address : Mid Medium

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	62	(1a) x	2.48	(2a) =	154.07	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	154.07	(5)

2. Ventilation rate:

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

Air changes per hour

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

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5 (23c)

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

(24a)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1.4	=	2.94			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 3			7.85	x1/[1/(1.4)+ 0.04]		=	10.41			(27)
Walls Type1	36.72	12.77	23.95	x	0.2	=	4.79			(29)
Walls Type2	4.98	2.1	2.88	x	0.2	=	0.58			(29)
Walls Type3	20.45	0	20.45	x	0.2	=	4.09			(29)
Walls Type4	10.05	0	10.05	x	0.2	=	2.01			(29)
Total area of elements, m²			72.2							(31)
Party wall			16.18	x	0	=	0			(32)

* *for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

** *include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 31.34 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 10.79 (36)

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

Total fabric heat loss (33) + (36) = 42.12 (37)

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

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

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(38)m=	14.24	14.08	13.92	13.1	12.94	12.13	12.13	11.97	12.46	12.94	13.27	13.59	(38)

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

(39)m=	56.36	56.2	56.04	55.23	55.07	54.25	54.25	54.09	54.58	55.07	55.39	55.71	

Average = Sum(39)$_{1...12}$ /12= 55.19 (39)

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

(40)m=	0.91	0.91	0.9	0.89	0.89	0.88	0.88	0.87	0.88	0.89	0.89	0.9

Average = Sum(40)$_{1...12}$ /12= 0.89 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 82.59 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85

Total = Sum(44)$_{1...12}$ = 991.11 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	134.73	117.84	121.6	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48

Total = Sum(45)$_{1...12}$ = 1299.5 (45)

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

(46)m=	20.21	17.68	18.24	15.9	15.26	13.17	12.2	14	14.17	16.51	18.02	19.57	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	190.01	167.76	176.87	159.5	157	141.27	136.61	148.61	147.94	165.35	173.65	185.76	(62)

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

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

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

Output from water heater

(64)m=	190.01	167.76	176.87	159.5	157	141.27	136.61	148.61	147.94	165.35	173.65	185.76

Output from water heater (annual)$_{1...12}$ | 1950.34 | (64)

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

(65)m=	89.02	79.12	84.65	78.04	78.04	71.98	71.27	75.26	74.2	80.82	82.75	87.61	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	(66)

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

(67)m=	15.87	14.09	11.46	8.68	6.49	5.48	5.92	7.69	10.32	13.11	15.3	16.31	(67)

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

(68)m=	177.96	179.81	175.15	165.25	152.74	140.99	133.14	131.29	135.94	145.85	158.36	170.11	(68)

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

(69)m=	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	(71)

Water heating gains (Table 5)

(72)m=	119.65	117.74	113.78	108.39	104.9	99.97	95.79	101.15	103.06	108.63	114.93	117.75	(72)

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

(73)m=	367.04	365.21	353.96	335.88	317.69	300	288.4	293.69	302.88	321.15	342.14	357.73	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northwest	0.9x	0.77	x	2.46	x	11.28	x	0.5	x	0.8	=	7.69	(81)
Northwest	0.9x	0.77	x	2.46	x	11.28	x	0.5	x	0.8	=	7.69	(81)

Northwest	0.9x	0.77	x	7.85	x	11.28	x	0.5	x	0.8	=	24.55	(81)
Northwest	0.9x	0.77	x	2.46	x	22.97	x	0.5	x	0.8	=	15.66	(81)
Northwest	0.9x	0.77	x	2.46	x	22.97	x	0.5	x	0.8	=	15.66	(81)
Northwest	0.9x	0.77	x	7.85	x	22.97	x	0.5	x	0.8	=	49.98	(81)
Northwest	0.9x	0.77	x	2.46	x	41.38	x	0.5	x	0.8	=	28.22	(81)
Northwest	0.9x	0.77	x	2.46	x	41.38	x	0.5	x	0.8	=	28.22	(81)
Northwest	0.9x	0.77	x	7.85	x	41.38	x	0.5	x	0.8	=	90.04	(81)
Northwest	0.9x	0.77	x	2.46	x	67.96	x	0.5	x	0.8	=	46.34	(81)
Northwest	0.9x	0.77	x	2.46	x	67.96	x	0.5	x	0.8	=	46.34	(81)
Northwest	0.9x	0.77	x	7.85	x	67.96	x	0.5	x	0.8	=	147.87	(81)
Northwest	0.9x	0.77	x	2.46	x	91.35	x	0.5	x	0.8	=	62.29	(81)
Northwest	0.9x	0.77	x	2.46	x	91.35	x	0.5	x	0.8	=	62.29	(81)
Northwest	0.9x	0.77	x	7.85	x	91.35	x	0.5	x	0.8	=	198.77	(81)
Northwest	0.9x	0.77	x	2.46	x	97.38	x	0.5	x	0.8	=	66.41	(81)
Northwest	0.9x	0.77	x	2.46	x	97.38	x	0.5	x	0.8	=	66.41	(81)
Northwest	0.9x	0.77	x	7.85	x	97.38	x	0.5	x	0.8	=	211.91	(81)
Northwest	0.9x	0.77	x	2.46	x	91.1	x	0.5	x	0.8	=	62.12	(81)
Northwest	0.9x	0.77	x	2.46	x	91.1	x	0.5	x	0.8	=	62.12	(81)
Northwest	0.9x	0.77	x	7.85	x	91.1	x	0.5	x	0.8	=	198.24	(81)
Northwest	0.9x	0.77	x	2.46	x	72.63	x	0.5	x	0.8	=	49.53	(81)
Northwest	0.9x	0.77	x	2.46	x	72.63	x	0.5	x	0.8	=	49.53	(81)
Northwest	0.9x	0.77	x	7.85	x	72.63	x	0.5	x	0.8	=	158.04	(81)
Northwest	0.9x	0.77	x	2.46	x	50.42	x	0.5	x	0.8	=	34.38	(81)
Northwest	0.9x	0.77	x	2.46	x	50.42	x	0.5	x	0.8	=	34.38	(81)
Northwest	0.9x	0.77	x	7.85	x	50.42	x	0.5	x	0.8	=	109.72	(81)
Northwest	0.9x	0.77	x	2.46	x	28.07	x	0.5	x	0.8	=	19.14	(81)
Northwest	0.9x	0.77	x	2.46	x	28.07	x	0.5	x	0.8	=	19.14	(81)
Northwest	0.9x	0.77	x	7.85	x	28.07	x	0.5	x	0.8	=	61.07	(81)
Northwest	0.9x	0.77	x	2.46	x	14.2	x	0.5	x	0.8	=	9.68	(81)
Northwest	0.9x	0.77	x	2.46	x	14.2	x	0.5	x	0.8	=	9.68	(81)
Northwest	0.9x	0.77	x	7.85	x	14.2	x	0.5	x	0.8	=	30.89	(81)
Northwest	0.9x	0.77	x	2.46	x	9.21	x	0.5	x	0.8	=	6.28	(81)
Northwest	0.9x	0.77	x	2.46	x	9.21	x	0.5	x	0.8	=	6.28	(81)
Northwest	0.9x	0.77	x	7.85	x	9.21	x	0.5	x	0.8	=	20.05	(81)

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

(83)m=	39.94	81.3	146.47	240.55	323.35	344.73	322.48	257.09	178.48	99.35	50.25	32.62	(83)

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

(84)m=	406.98	446.5	500.43	576.43	641.04	644.73	610.89	550.78	481.37	420.5	392.4	390.35	(84)

7. Mean internal temperature (heating season)

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

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

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

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(86)m=	1	0.99	0.98	0.92	0.75	0.53	0.39	0.45	0.74	0.96	0.99	1		(86)

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

(87)m=	20.15	20.27	20.49	20.78	20.95	20.99	21	21	20.97	20.73	20.4	20.13		(87)

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

(88)m=	20.16	20.16	20.16	20.18	20.18	20.19	20.19	20.19	20.18	20.18	20.17	20.17		(88)

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

(89)m=	1	0.99	0.97	0.89	0.7	0.47	0.32	0.37	0.67	0.94	0.99	1		(89)

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

(90)m=	19.03	19.2	19.52	19.92	20.13	20.19	20.19	20.19	20.16	19.87	19.39	19		(90)
										fLA = Living area ÷ (4) =			0.41	(91)

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

(92)m=	19.49	19.63	19.91	20.27	20.47	20.52	20.52	20.52	20.49	20.22	19.8	19.46		(92)

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

(93)m=	19.49	19.63	19.91	20.27	20.47	20.52	20.52	20.52	20.49	20.22	19.8	19.46		(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, hm:														
(94)m=	0.99	0.99	0.97	0.9	0.72	0.49	0.35	0.4	0.69	0.94	0.99	1		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	404.66	441.71	485.76	515.97	459.18	318.94	212.46	222.43	334.54	395.02	387.63	388.59		(95)
Monthly average external temperature from Table 8														
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]														
(97)m=	855.85	828.1	751.66	628.01	482.67	320.96	212.65	222.87	348.67	529.69	703.51	850.45		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	335.68	259.65	197.82	80.67	17.48	0	0	0	0	100.19	227.43	343.62		
									Total per year (kWh/year) = Sum(98)1...5,9...12 =				1562.55	(98)

Space heating requirement in kWh/m²/year	25.2	(99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		1562.55	

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Space heat from Community boilers	(98) x (304a) x (305) x (306) =	1640.68	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)

Water heating

Annual water heating requirement		1950.34	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2047.86	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	36.89	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		122.18	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	122.18	(331)
Energy for lighting (calculated in Appendix L)		280.19	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				95	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	838.66	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	19.14	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	857.8	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.52	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				857.8	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	63.41	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	145.42	(379)
Total CO2, kg/year	sum of (376)…(382) =				1066.63	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				17.2	(384)
EI rating (section 14)					86.64	(385)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Armstrong	**Stroma Number:**	STRO002044
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: A 406

Address : Top Medium

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	62	(1a) x	2.6	(2a) =	161.2	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	62	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		161.2	(5)

2. Ventilation rate:

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

Air changes per hour

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

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

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

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

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 76.5 (23c)

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

(24a)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2.1	x	1.4	=	2.94			(26)
Windows Type 1			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Windows Type 2			7.85	x1/[1/(1.4)+ 0.04]		=	10.41			(27)
Windows Type 3			2.46	x1/[1/(1.4)+ 0.04]		=	3.26			(27)
Walls Type1	44.94	12.77	32.17	x	0.2	=	6.43			(29)
Walls Type2	5.22	2.1	3.12	x	0.2	=	0.62			(29)
Walls Type3	21.39	0	21.39	x	0.2	=	4.28			(29)
Walls Type4	10.51	0	10.51	x	0.2	=	2.1			(29)
Roof	62.34	0	62.34	x	0.2	=	12.47			(30)
Total area of elements, m²			144.4							(31)
Party wall			10.41	x	0	=	0			(32)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 45.78 (33)

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

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 14.51 (36)

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

Total fabric heat loss (33) + (36) = 60.28 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	14.9	14.73	14.56	13.71	13.54	12.69	12.69	12.52	13.03	13.54	13.88	14.22	(38)

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

(39)m=	75.18	75.01	74.84	74	73.83	72.98	72.98	72.81	73.32	73.83	74.17	74.5	

Average = Sum(39)$_{1...12}$ /12= 73.95 (39)

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

(40)m=	1.21	1.21	1.21	1.19	1.19	1.18	1.18	1.17	1.18	1.19	1.2	1.2	

Average = Sum(40)$_{1...12}$ /12= 1.19 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 82.59 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85	

Total = Sum(44)$_{1...12}$ = 991.11 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	134.73	117.84	121.6	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48	

Total = Sum(45)$_{1...12}$ = 1299.5 (45)

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

(46)m=	20.21	17.68	18.24	15.9	15.26	13.17	12.2	14	14.17	16.51	18.02	19.57	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(57)

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

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

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

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	190.01	167.76	176.87	159.5	157	141.27	136.61	148.61	147.94	165.35	173.65	185.76	(62)

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

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

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

Output from water heater

(64)m=	190.01	167.76	176.87	159.5	157	141.27	136.61	148.61	147.94	165.35	173.65	185.76

Output from water heater (annual)$_{1...12}$ — 1950.34 (64)

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

(65)m=	89.02	79.12	84.65	78.04	78.04	71.98	71.27	75.26	74.2	80.82	82.75	87.61	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	101.88	(66)

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

(67)m=	15.87	14.09	11.46	8.68	6.49	5.48	5.92	7.69	10.32	13.11	15.3	16.31	(67)

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

(68)m=	177.96	179.81	175.15	165.25	152.74	140.99	133.14	131.29	135.94	145.85	158.36	170.11	(68)

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

(69)m=	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	33.19	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	-81.5	(71)

Water heating gains (Table 5)

(72)m=	119.65	117.74	113.78	108.39	104.9	99.97	95.79	101.15	103.06	108.63	114.93	117.75	(72)

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

(73)m=	367.04	365.21	353.96	335.88	317.69	300	288.4	293.69	302.88	321.15	342.14	357.73	(73)

6. Solar gains:

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

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

Northwest 0.9x	0.77	x	2.46	x	11.28	x	0.5	x	0.8	=	7.69	(81)
Northwest 0.9x	0.77	x	7.85	x	11.28	x	0.5	x	0.8	=	24.55	(81)
Northwest 0.9x	0.77	x	2.46	x	11.28	x	0.5	x	0.8	=	7.69	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.5	x	0.8	=	15.66	(81)
Northwest 0.9x	0.77	x	7.85	x	22.97	x	0.5	x	0.8	=	49.98	(81)
Northwest 0.9x	0.77	x	2.46	x	22.97	x	0.5	x	0.8	=	15.66	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.5	x	0.8	=	28.22	(81)
Northwest 0.9x	0.77	x	7.85	x	41.38	x	0.5	x	0.8	=	90.04	(81)
Northwest 0.9x	0.77	x	2.46	x	41.38	x	0.5	x	0.8	=	28.22	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.5	x	0.8	=	46.34	(81)
Northwest 0.9x	0.77	x	7.85	x	67.96	x	0.5	x	0.8	=	147.87	(81)
Northwest 0.9x	0.77	x	2.46	x	67.96	x	0.5	x	0.8	=	46.34	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.5	x	0.8	=	62.29	(81)
Northwest 0.9x	0.77	x	7.85	x	91.35	x	0.5	x	0.8	=	198.77	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	x	0.5	x	0.8	=	62.29	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.5	x	0.8	=	66.41	(81)
Northwest 0.9x	0.77	x	7.85	x	97.38	x	0.5	x	0.8	=	211.91	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	x	0.5	x	0.8	=	66.41	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.5	x	0.8	=	62.12	(81)
Northwest 0.9x	0.77	x	7.85	x	91.1	x	0.5	x	0.8	=	198.24	(81)
Northwest 0.9x	0.77	x	2.46	x	91.1	x	0.5	x	0.8	=	62.12	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.5	x	0.8	=	49.53	(81)
Northwest 0.9x	0.77	x	7.85	x	72.63	x	0.5	x	0.8	=	158.04	(81)
Northwest 0.9x	0.77	x	2.46	x	72.63	x	0.5	x	0.8	=	49.53	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.5	x	0.8	=	34.38	(81)
Northwest 0.9x	0.77	x	7.85	x	50.42	x	0.5	x	0.8	=	109.72	(81)
Northwest 0.9x	0.77	x	2.46	x	50.42	x	0.5	x	0.8	=	34.38	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.5	x	0.8	=	19.14	(81)
Northwest 0.9x	0.77	x	7.85	x	28.07	x	0.5	x	0.8	=	61.07	(81)
Northwest 0.9x	0.77	x	2.46	x	28.07	x	0.5	x	0.8	=	19.14	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.5	x	0.8	=	9.68	(81)
Northwest 0.9x	0.77	x	7.85	x	14.2	x	0.5	x	0.8	=	30.89	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	x	0.5	x	0.8	=	9.68	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.5	x	0.8	=	6.28	(81)
Northwest 0.9x	0.77	x	7.85	x	9.21	x	0.5	x	0.8	=	20.05	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	x	0.5	x	0.8	=	6.28	(81)

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

(83)m=	39.94	81.3	146.47	240.55	323.35	344.73	322.48	257.09	178.48	99.35	50.25	32.62	(83)

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

(84)m=	406.98	446.5	500.43	576.43	641.04	644.73	610.89	550.78	481.37	420.5	392.4	390.35	(84)

7. Mean internal temperature (heating season)

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

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

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

DER WorkSheet: New dwelling design stage

(86)m=	1	0.99	0.99	0.96	0.86	0.68	0.51	0.59	0.85	0.98	0.99	1	(86)

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

(87)m=	19.73	19.86	20.11	20.48	20.79	20.95	20.99	20.98	20.85	20.46	20.04	19.71	(87)

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

(88)m=	19.91	19.91	19.91	19.93	19.93	19.94	19.94	19.94	19.93	19.93	19.92	19.92	(88)

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

(89)m=	1	0.99	0.98	0.94	0.81	0.58	0.4	0.46	0.78	0.96	0.99	1	(89)

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

(90)m=	18.22	18.41	18.79	19.32	19.73	19.91	19.93	19.93	19.82	19.3	18.69	18.2	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.84	19	19.33	19.79	20.16	20.33	20.37	20.36	20.24	19.78	19.24	18.81	(92)

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

(93)m=	18.84	19	19.33	19.79	20.16	20.33	20.37	20.36	20.24	19.78	19.24	18.81	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.94	0.82	0.62	0.44	0.51	0.8	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	404.78	442.46	489.94	539.28	525.25	399.65	271.84	282.68	386.05	404	388.49	388.62	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1093	1057.86	960.22	806.11	624.84	418.53	274.8	288.42	450.21	677.43	900.24	1088.85	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	512.03	413.55	349.89	192.11	74.1	0	0	0	0	203.43	368.46	520.97	

Total per year (kWh/year) = $\mathrm{Sum}(98)_{1\ldots5,9\ldots12}$ = 2634.54 (98)

Space heating requirement in kWh/m²/year 42.49 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		1	(303a)
Fraction of total space heat from Community boilers	(302) x (303a) =	1	(304a)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

	kWh/year
Space heating	
Annual space heating requirement	2634.54

DER WorkSheet: New dwelling design stage

Space heat from Community boilers	(98) x (304a) x (305) x (306) =	2766.27	(307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		1950.34	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2047.86	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	48.14	(313)
Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		127.83	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	127.83	(331)
Energy for lighting (calculated in Appendix L)		280.19	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				95	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	1094.58	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	24.99	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	1119.57	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.52	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				1119.57	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	66.34	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	145.42	(379)
Total CO2, kg/year	sum of (376)…(382) =				1331.33	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				21.47	(384)
EI rating (section 14)					83.33	(385)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name | **Shell and Core**

Commercial Unit - Use Less Energy

As designed

Date: Tue Dec 01 09:54:46 2020

Administrative information

Building Details

Address: Broadwater Road, Welwyn Garden City,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Chris Armstrong LCEA171023

Telephone number: 01892 893727

Address: Stroma, 2 Kings Hill Avenue, Kings Hill, West Malling, ME19 4AQ

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	36.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	36.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	36.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	**Surface where the maximum value occurs***
Wall**	0.35	0.2	0.2	CM000000:Surf[1]
Floor	0.25	0.15	0.15	CM000000:Surf[7]
Roof	0.25	-	-	UNKNOWN
Windows***, roof windows, and rooflights	2.2	1.4	1.4	CM000000:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]

$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	**Worst acceptable standard**	**This building**
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- Main system BASE

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	5	0	0	0.8
Standard value	0.91*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Commercial	-	-	-	0.8	-	-	-	-	-	-	N/A

Shell and core configuration

Zone	Assumed shell?
Commercial	NO

General lighting and display lighting

	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Commercial	-	120	120	891

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Commercial	NO (-2.5%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	97.9	97.9
External area [m^2]	365.9	282.8
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	5
Average conductance [W/K]	204.34	122.46
Average U-value [W/m^2K]	0.56	0.43
Alpha value* [%]	13.2	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	55.46	28.49
Cooling	10.31	8.24
Auxiliary	3.75	3.06
Lighting	32.52	48.54
Hot water	1.96	1.87
Equipment*	20.26	20.26
TOTAL**	**104.01**	**90.19**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	301.06	200.85
Primary energy* [kWh/m^2]	213.08	216.15
Total emissions [kg/m^2]	36.6	36.8

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	169.3	131.8	55.5	10.3	3.8	0.85	3.55	0.91	5
	Notional	88.4	112.4	28.5	8.2	3.1	0.86	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.2	CM000000:Surf[9]
Floor	0.2	0.15	CM000000:Surf[7]
Roof	0.15	-	UNKNOWN
Windows, roof windows, and rooflights	1.5	1.4	CM000000:Surf[0]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m^{2}K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m^{2}K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m^3/(h.m^2) at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Shell and Core**

Commercial Unit - With ASHP

As designed

Date: Tue Dec 01 10:21:30 2020

Administrative information

Building Details

Address: Broadwater Road, Welwyn Garden City,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Chris Armstrong LCEA171023

Telephone number: 01892 893727

Address: Stroma, 2 Kings Hill Avenue, Kings Hill, West Malling, ME19 4AQ

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	35.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	35.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	31.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	CM000000:Surf[1]
Floor	0.25	0.15	0.15	CM000000:Surf[7]
Roof	0.25	-	-	UNKNOWN
Windows***, roof windows, and rooflights	2.2	1.4	1.4	CM000000:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- Main system Actual

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	5	0	0	0.8
Standard value	2.5*	2.6	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Commercial	-	-	-	0.8	-	-	-	-	-	-	N/A

Shell and core configuration

Zone	Assumed shell?
Commercial	NO

General lighting and display lighting

	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Commercial	-	120	120	891

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Commercial	NO (-2.5%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	97.9	97.9
External area [m^2]	365.9	282.8
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	5
Average conductance [W/K]	204.34	122.46
Average U-value [W/m^2K]	0.56	0.43
Alpha value* [%]	13.2	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
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	Others: Passenger terminals
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	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	12.62	9.6
Cooling	10.31	8.24
Auxiliary	3.75	3.06
Lighting	32.52	48.54
Hot water	1.79	1.87
Equipment*	20.26	20.26
TOTAL**	**60.99**	**71.31**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	301.06	200.85
Primary energy* [kWh/m^2]	187.25	209.91
Total emissions [kg/m^2]	31.7	35.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	169.3	131.8	12.6	10.3	3.8	3.73	3.55	4	5
	Notional	88.4	112.4	9.6	8.2	3.1	2.56	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3