

Energy Strategy Report

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

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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



Predicted CO2 Emissions - Residential

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%



Predicted CO2 Emissions - Non-Residential

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 kgCO₂/m². 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	0.20 W/m ² K	0.30 W/m²K	33%
corridors/stores)			
Heat loss floors (ground and exposed)	0.15 W/m²K	0.25 W/m²K	40%
Heat loss roofs/ceilings	0.20 W/m ² K	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.

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

The below tables detail the proposed building services specification.

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 CO₂ 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 CO₂ 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/ km² (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/km²/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 CO₂ 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	CO ₂ reduction	Cumulative CO ₂		
	(Tonnes CO ₂ /annum)	(%)	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 CO₂ 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.

Scenario -	Regulated CO ₂ emissions	CO ₂ reduction	Cumulative CO ₂		
	(Tonnes CO ₂ /annum)	(%)	reduction (%)		
Building Regulations	350	-	-		
Use Less Energy	339	3.14	3.14		
With Renewables	305	10	12.86		

Residential

Non-Residential

Scenario -	Regulated CO ₂ emissions	CO ₂ reduction	Cumulative CO ₂		
	(Tonnes CO ₂ /annum)	(%)	reduction (%)		
Building Regulations	3.60	-	-		
Use Less Energy	3.58	0.54	0.54		
With Renewables	3.10	13.39	13.86		



Predicted CO2 Emissions - Residential

Predicted CO2 Emissions - Non-Residential



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 – CO₂ 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.

User Details:											
Assessor Name:	Chris Armstrong			Stroma	a Num	STRO	002044				
Software Name:	Stroma FSAP 20	12		Softwa	are Ver	sion:		Versic	on: 1.0.4.16		
		P	roperty A	Address:	A G01						
Address :	GRD Medium										
1. Overall dwelling dimen	sions:		•	· (A 11.			Malana (m. 2)		
Ground floor				a(m²) 6.15	(1a) x	AV. Hel	ignt(m) 5	(2a) =	190.38	(3a)	
Total floor area TFA = (1a))+(1b)+(1c)+(1d)+(1	e)+(1n) 7	6.15	(4)						
Dwelling volume					(3a)+(3b)	+(3c)+(3d)+(3e)+	.(3n) =	190.38	(5)	
2. Ventilation rate:									<u> </u>		
Number of chimneys	main heating	secondar heating 0	у] + [⁻	0 Other] = [total	x 4	40 =	m ³ per hour	(6a)	
Number of open flues	0 +	0] + [0	i - Г	0	×	20 =	0	(6b)	
Number of intermittent fan	s					3	x '	10 =	30	(7a)	
Number of passive vents						0	x /	10 =	0	(7b)	
Number of flueless gas fire	es					0	x 4	40 =	0	_](7c)	
C C					L	-]``	
								Air ch	anges per ho	ur	
Infiltration due to chimneys If a pressurisation test has been	s, flues and fans = en carried out or is inten	(6a)+(6b)+(7 ded, proceed	a)+(7b)+(7 d to (17), c	7c) = otherwise c	continue fro	30 om (9) to ((16)	÷ (5) =	0.16	(8)	
Number of storeys in the	e dwelling (ns)						,		0	(9)	
Additional infiltration							[(9)	-1]x0.1 =	0	(10)	
Structural infiltration: 0.2	25 for steel or timbe	r frame or	0.35 for	masonr	y constr	uction			0	(11)	
deducting areas of opening	sent, use the value cond is); if equal user 0.35	esponding to	line great	er wall area	a (allel						
If suspended wooden flo	oor, enter 0.2 (unse	aled) or 0.	1 (seale	d), else	enter 0				0	(12)	
If no draught lobby, ente	er 0.05, else enter 0								0	(13)	
Percentage of windows	and doors draught	stripped							0	(14)	
Window infiltration				0.25 - [0.2	x (14) ÷ 1	= [00	() =)		0	(15)	
Infiltration rate				(8) + (10) -	+ (11) + (1	2) + (13) +	+ (15) =		0	(16)	
Air permeability value, q	50, expressed in cu	(17) : 201	s per ho	our per so $(18) = ($	quare mo	etre of e	nvelope	area	5	(17)	
Air permeability value applies	y value, then $(10) = 1$	(17) ÷ 20]+(C	e or a dec	se (10) = (rmeahility i	is haina us	ad		0.41	(18)	
Number of sides sheltered					mousinty	o boing ac			2	(19)	
Shelter factor				(20) = 1 - [0.075 x (1	9)] =			0.85	(20)	
Infiltration rate incorporatir	ng shelter factor			(21) = (18)	x (20) =				0.35	(21)	
Infiltration rate modified for	r monthly wind spee	ed								-	
Jan Feb M	/lar Apr May	/ Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Monthly average wind spe	ed 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			

Adjust	ed infiltra	ation rat	e (allowi	ng for sł	nelter an	d wind s	peed) =	(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		
Calcul	late effec	ctive air	change i ion:	rate for t	he appli	cable ca	se							(220)
lf exh	haust air he	eat pump	using Appe	endix N. (2	(23a) = (23a	i) x Fmv (e	equation (N	N5)), other	wise (23b) = (23a)			0	(23a)
If bal	anced with	heat reco	overv: effic	iencv in %	allowing f	or in-use fa	actor (from	n Table 4h) =) (200)			0	(230)
یں میں ا	halanco	d mech	anicalve	ntilation	with he	at recove	arv (M1\/F	-IR) (24a	()m - (2)	2h)m ⊥ ('	23h) v ['	1 _ (23c)	1001	(230)
(24a)m=				0		0		0	0			$\frac{1}{0}$]	(24a)
(2 la)=	halance	d moch	nical ve	ntilation	without	boot roc		 /\/) (24h	$\int_{-\infty}^{\infty}$) 2b)m + ('	23h)	Ů	J	
(24b)m=				0					0		0	0	1	(24b)
c) If	whole h		tract ver	tilation (n positiv		l ventilatio	n from c	 utside	Ů	Ů	Ů	J	
0) 11	if (22b)m	טע <u>טפיפא</u> 1 < 0.5 א	(23b), t	hen (24	c) = (23b); other	vise (24	c) = (22b	b) m + 0.	.5 × (23b))			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0]	(24c)
d) If	natural	ventilatio	on or wh	ole hous	se positiv	/e input	ventilatio	on from I	oft				-	
(0.1.1)	if (22b)m	n = 1, th	en (24d)	m = (22)	$\frac{1}{2}$ of the $\frac{1}{2}$	erwise (2	(4d)m = 0	0.5 + [(2	2b)m² x	0.5]	0.50	0.50	ı	(244)
(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	J	(240)
Effe	ctive air		rate - er	ter (24a) or (24t) 0.57	o o o o o o o o o o o o o o o o o o o	c) or (24		(25)	0.57	0.59	0.59	1	(25)
(23)11=	0.0	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.50	0.57	0.56	0.56	J	(23)
3. He	eat losse	s and he	eat loss p	paramet	er:									
ELEN	MENT	Gros area	ss (m²)	Openin rr	gs 1 ²	Net Ar A ,r	ea n²	U-valı W/m2	le K	A X U (W/I	K)	k-value kJ/m²·l	e K	A X k kJ/K
Doors			· · ·			2.1	x	1		2.1				(26)
Windo	ws Type	e 1				2.46	x1,	/[1/(1.4)+	0.04] =	3.26	=			(27)
Windo	ws Type	2				8.07	x1,	/[1/(1.4)+	0.04] =	10.7				(27)
Floor						77.49) x	0.13		10.0737	7			(28)
Walls [·]	Type1	61.6	61	10.5	3	51.08	3 X	0.18		9.19	-		$\exists \vdash$	(29)
Walls	Type2	4.2	4	2.1		2.14	x	0.18		0.39	-		$\exists \vdash$	(29)
Walls [·]	Туре3	20.4	46	0		20.46	3 X	0.18		3.68	-		$\exists \vdash$	(29)
Walls [·]	Type4	6.1	5	0		6.15	×	0.18	=	1.11	= i		\dashv	(29)
Total a	area of e	lements	, m²			169.9	5		I					(31)
Party	wall					4.98	×	0	= [0				(32)
* for win	ndows and	roof wind	ows, use e	ffective wi	ndow U-va	alue calcul	ated using	formula 1,	 /[(1/U-valu	ie)+0.04] a	as given in	paragraph	n 3.2	
Fabric	heat los	s. W/K :	= S (A x)	U)	is and pan			(26)(30)	+ (32) =				40.5	(33)
Heat o	capacity	Cm = S('Axk)	0)				. , . ,	((28)	(30) + (32	2) + (32a).	(32e) =	40.3	(34)
Therm	al mass	parame	ter (TMF	P = Cm -	- TFA) ir	∩ kJ/m²K			Indica	tive Value	: Medium	(/	250	(35)
For des	ign assess	ments wh	ere the de	tails of the	, construct	ion are not	t known pr	ecisely the	indicative	e values of	TMP in Ta	able 1f	200	
can be u	used instea	ad of a de	tailed calc	ulation.			,							
Iherm	al bridge	es : S (L	x Y) cal	culated		pendix ł	ζ						10.7	(36)
Total f	abric he	at loss	are not Kn	own (36) =	= 0.05 X (3	1)			(33) +	(36) =			51.2	(37)
Ventila	ation hea	at loss ca	alculated	l monthl	v				(38)m	= 0.33 × (25)m x (5)	1	U1.2	(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
-	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 tr	ansfer o	coefficier	nt, W/K		1	1	1	1	(39)m	= (37) + (3	.			
(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 lo	ss para	meter (H	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		
Numbe	er of day	vs in moi	nth (Tab	le 1a)					,	<pre>Average =</pre>	Sum(40)1	12 / 1 Z=	1.14	(40)
	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. Wa	iter heat	ting ene	rgy requi	irement:								kWh/ye	ar:	
Accum	od occu	inonov I	N											(40)
if TF.	A > 13.9	9, N = 1	+ 1.76 x	[1 - exp	(-0.0003	849 x (TF	-A -13.9)2)] + 0.0	0013 x (⁻	FFA -13.	9) <u>2.</u>	39		(42)
if TF.	A £ 13.9	9, N = 1						(· · ·						
Annual Reduce	l averag the annua	e hot wa al average	ater usag hot water	ge in litre usage by	es per da 5% if the d	ay Vd,av Iwelling is	erage = designed i	(25 x N) to achieve	+ 36 a water us	se target o	90 f	.86		(43)
not more	e that 125	litres per	person per	r day (all w	ater use, l	hot and co	ld)			-				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage ii	n litres per	day for ea	ach month	Vd,m = fa	ctor from T	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		_
Enoral	ontont of	hot water	upped col	aulatad m	opthly_1	100 v Vd r	л v р <i>т v Г</i>	Tm / 2600	·	Total = Su	m(44) ₁₁₂ =	= [1090.34	(44)
					<i>Jilliny = 4</i> .				400.04	404.00				
(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	1420.61	(45)
lf instant	aneous w	ater heatii	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46) to (61)	10tal = 3u	III(43)112 =	- L	1429.01	_(+5)
(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:						1			·			
Storag	e volum	e (litres)	includin	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		150		(47)
If comr	nunity h	eating a	ind no ta	nk in dw	velling, e	nter 110	litres in	(47) mbi boil	oro) ont	or (0) in (47)			
Water	storage	loss:	not wate	er (unis ir		1151011101			ers) erne		47)			
a) If m	anufact	urer's de	eclared l	oss facto	or is kno	wn (kWł	n/day):				1.	39		(48)
Tempe	rature fa	actor fro	m Table	2b							0.	54		(49)
Energy	v lost fro	m water	storage	, kWh/ye	ear			(48) x (49)) =		0.	75		(50)
b) If m	anufact	urer's de	eclared of the second s	cylinder l	oss fact	or is not	known:							(54)
If comr	nunitv h	age loss leating s	ee secti	on 4.3	ez(kvv	n/iitie/ua	iy)					0		(51)
Volume	e factor	from Ta	ble 2a									0		(52)
Tempe	rature fa	actor fro	m Table	2b								0		(53)
Energy	lost fro	m water	· storage	, kWh/ye	ear			(47) x (51)	x (52) x (53) =		0		(54)
Enter	(50) or ((54) in (5	55)								0.	75		(55)
Water	storage	loss cal	culated f	for each	month			((56)m = (55) × (41)	n				
(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 cylinde	er contains	s dedicate	d solar sto	rage, (57)	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Appendi	хH	
(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)

Primar	y circuit	loss (ar	nual) fro	om Table	e 3							0		(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(mo	dified by	factor f	rom Tab	le H5 if t	here is s	solar wat	er heati	ng and a	cylinde	r thermo	stat)			
(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 ca	lculated	for each	month	(61)m =	(60) ÷ 36	65 × (41)m						
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat requ	uired for	water h	eating ca	alculated	l for eacl	n 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 Dł	IW input o	calculated	using App	endix G o	Appendix	H (negati	ve quantity	y) (enter '0	' if no sola	r contribut	ion to wate	er heating)		
(add a	dditiona	l lines if	FGHRS	and/or \	WWHRS	applies	, see Ap	pendix C	3)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from w	ater hea	ter					-		•	•	-		
(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		
								Outp	out from wa	ater heate	r (annual)₁	12	1978.23	(64)
Heat g	ains froi	m water	heating,	kWh/m	onth 0.2	5 ´ [0.85	× (45)m	n + (61)m	n] + 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)
inclu	ıde (57)ı	m in calo	ulation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	ater is fr	om com	munity h	eating	
5. Int	ternal ga	ains (see	Table 5	5 and 5a):									
Metab	olic gain	s (Table	5) Wat	ts										
motab	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)
Lightin	g gains	(calcula	ted in Ap	pendix	L, equat	ion L9 oi	r L9a), a	lso 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)
Applia	nces gai	ins (calc	ulated ir	Append	dix L, eq	uation L	13 or L1	3a), alsc	see Ta	ble 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)
Cookir	ng gains	(calcula	ted in A	ppendix	L, equat	ion L15	or L15a), also se	e 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 far	ns gains	(Table {	5a)									I	
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losses	se.a. ev	aporatio	n (nega	tive valu	es) (Tab	le 5)							I	
(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	u gains (T	able 5)	I				Į						
(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 i	nternal	gains =				(66)	m + (67)m	1 + (68)m +	L ⊦ (69)m + ((70)m + (7	1)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. <u>So</u>	lar gains	8:												
Solar g	jains are o	alculated	using sola	r flux from	Table 6a	and associ	ated equa	ations to co	onvert to th	e applicab	le orientat	ion.		
Orienta	ation: A	Access F	actor	Area		Flu	x		a		FF		Gains	

Onentation.	Table 6d		m ²	Table 6a			9_ Table 6b		Table 6c		(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)	

Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	8	35.75	1		0.63	x	0.7		=	211.49	(79)
Southwe	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	06.25	Ī		0.63	- x	0.7		=	262.05	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	19.01	Ī		0.63	- ×	0.7		=	293.52	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	18.15	Ī		0.63	×	0.7		=	291.39	(79)
Southwe	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	13.91	Ī		0.63		0.7		=	280.93	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	04.39	Ī		0.63		0.7		=	257.46	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	g	92.85	Ī		0.63	×	0.7		=	229	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	6	69.27	Ī		0.63	×	0.7		=	170.83	(79)
Southwe	est <mark>0.9x</mark>	0.77		x	8.0	7	x	4	14.07]		0.63	×	0.7		=	108.69	(79)
Southwe	est <mark>0.9x</mark>	0.77		x	8.0	7	x	3	31.49]		0.63	×	0.7		=	77.66	(79)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	1	1.28	x		0.63	×	0.7		=	8.48	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	22.97	x		0.63	×	0.7		=	17.27	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	x		0.63	×	0.7		=	31.11	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	2.46		6	67.96	x		0.63	×	0.7		=	51.09	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	2.46		g	91.35	x		0.63	×	0.7		=	68.67	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	97.38	x		0.63	×	0.7		=	73.21	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	91.1	x		0.63	×	0.7		=	68.49	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	72.63	x		0.63	×	0.7		=	54.6	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	2.46		5	50.42	x		0.63	×	0.7		=	37.91	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	x	2	28.07	x		0.63	×	0.7		=	21.1	(81)	
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	x		14.2	x		0.63	×	0.7		=	10.67	(81)	
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	9.21	x		0.63	×	0.7		=	6.93	(81)
Solar g	ains in	watts, ca	alcula	ated	for eacl	n mon	th		1	(83)m	ו = Su	im(74)m	.(82)m	-i	1		I	(00)
(83)m=	99.23	171.84	242	.6	313.14	362.19	$\frac{3}{3}$	64.61	349.42	312	.06	266.91	191.94	119.36	84	.59		(83)
rotar g	$\frac{1}{508.92}$		na se		(84)m =	= (73)	$\frac{1+(}{1+(}$	83)m		625	47	601.2	E 47 77	400.76	400		l	(94)
(84)m=	508.82	579.26	636.	78	686.08	713.64	+ 0	95.41	666.86	635	0.47	601.3	547.77	499.76	483	5.33		(04)
7. Me	an intei	nal temp	eratu	ure (heating	seaso	on)									-		
Temp	erature	during h	eatin	ig pe	eriods ir	the liv	ving	area	from Ta	ble 9	, Th1	l (°C)					21	(85)
Utilisa	tion fac	tor for ga	ains f	for li	ving are	ea, h1,	m (s	ee Ta	ible 9a)			0	0.1				l	
(00)	Jan	Feb	IVI	ar	Apr	May	/	Jun	Jui	A	ug	Sep	Oct	NOV				(86)
(86)m=	1	0.99	0.9	8	0.96	0.88		0.73	0.55	0.	6	0.83	0.97	0.99		1		(00)
Mean	interna	l tempera	ature	in li	ving are	ea T1	(follo	w ste	ps 3 to 7	7 in T	able	e 9c)			1		I	(07)
(87)m=	19.8	19.95	20.	2	20.51	20.78	2	20.94	20.99	20.	98	20.88	20.54	20.11	19	.78		(87)
Temp	erature	during h	eatin	ig pe	eriods ir	n rest o	of dv	/elling	from Ta	able 9	9, Th	2 (°C)					I	
(88)m=	19.95	19.95	19.9	95	19.96	19.97		9.98	19.98	19.	98	19.97	19.97	19.96	19	.96		(88)
Utilisa	tion fac	ctor for ga	ains f	for re	est of d	velling	, h2	,m (se	e Table	9a)								
(89)m=	1	0.99	0.9	8	0.94	0.84		0.63	0.43	0.4	48	0.76	0.95	0.99		1		(89)
Mean	interna	l tempera	ature	in tl	he rest	of dwe	lling	T2 (f	ollow ste	eps 3	8 to 7	in Table	e 9c)					
(90)m=	18.36	18.58	18.9	94	19.39	19.75	ŕ	19.94	19.97	19.	97	19.88	19.44	18.83	18	.33		(90)
-												fL	A = Liv	ing area ÷ (4) =		0.5	(91)

Mean	interna	l temper	ature (fo	or the wh	ole dwel	lling) = fl	A x T1	+ (1 – fl	A) x T2					
(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	/ adjustn	nent to t	he mear	n interna	l tempera	ature fro	m Table	4e, whe	ere appro	opriate				
(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. Sp	ace hea	ting requ	uirement											
Set T	i to the i	mean int	ernal te	mperatu	re obtain	ed at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	tilisation	factor fo	or gains	using Ta	able 9a			-						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hm		0.05	0.00	0.40	0.54	0.70	0.05				(04)
(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)
User(JI gains,	nmGm	, VV = (9)	4) m x (84	4)m	171 05	220.15	242.62	475.09	501 47	404.10	494 00		(95)
(95)m=		572.95	021.09	045.2	608.23	4/1.00	329.15	342.03	475.08	521.47	494.19	401.23		(33)
(96)m-							16.6	16.4	1.4.1	10.6	71	12		(96)
Hoat	4.3	4.9	o.5			$m W_{-}$	-[(30)m)	(03)m	(96)m	10.0	7.1	4.2		(00)
(97)m-	1312 17	1272 28	1153.8	963 52	745 13	502 77	334 14	350 35	- (90)111 542 87	J 816 76	1081 41	1304 87		(97)
Snac	o hoatin		amont fo		$\int \frac{1}{10000000000000000000000000000000000$	Mb/mont	b = 0.02	/ v [/07]	m = (95)	ml x (A)	1)m	1004.07		(0.)
(98)m=	599 79	469.95	395.89	229 19	101 85	0	0.02	0	0	219.7	422.8	612 78		
(00)	000.10	100.00	000.00	220.10	101.00	Ŭ	ů	Tota		(k)//b/vea	r = Sum(9)	8)	3051.05	(98)
•					.,			TOTA	i per year	(KVVII/yeai	i) – Sun(9	0)15,912 -	5051.95	
Space	e heatin	g require	ement in	kWh/m²	/year								40.08	(99)
9a. En	ergy rec	luiremer	nts – Ind	ividual h	eating sy	ystems i	ncluding	micro-C	HP)					
Spac	e heatir	ng:			, .									-
Fract	ion of sp	ace hea	at from s	econdar	y/supple	mentary	system					-	0	(201)
Fract	ion of sp	ace hea	at from m	nain syst	em(s)			(202) = 1 -	- (201) =				1	(202)
Fract	ion of to	tal heatii	ng from	main sys	stem 1			(204) = (2	02) × [1 – ((203)] =			1	(204)
Efficie	ency of I	main spa	ace heat	ing syste	em 1								93.5	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heating	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Space	e heatin	g require	ement (c	alculate	d above))		0						
	599.79	469.95	395.89	229.19	101.85	0	0	0	0	219.7	422.8	612.78		
(211)m	n = {[(98)m x (20	4)] } x 1	00 ÷ (20)6)						•			(211)
、	641.48	502.62	423.41	245.12	, 108.93	0	0	0	0	234.97	452.19	655.38		
								Tota	l (kWh/yea	ar) =Sum(2	1 211) _{15,1012}		3264.12	(211)
Space	e heatin	a fuel (s	econdar	v). kWh/	month							1		
= {[(98	s)m x (20)1)]}x1	00 ÷ (20))),										
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
								Tota	l (kWh/yea	ar) =Sum(2	215) _{15,1012}	=	0	(215)
Water	heating													
Output	t from w	, ater hea	ter (calc	ulated a	bove)						-			
	194.81	171.72	180.37	161.72	158.5	141.66	136.08	149.28	149	167.69	177.28	190.14		
Efficie	ncy of w	ater hea	iter										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 fo	or water	heating,	kWh/m	onth							_			
(219)m	1 = (64)	m x 100) ÷ (217)	m	100.40	477 - 4	170 50	107.00	100 70	106.05	202.04	010 77		
(219)m=	222.34	190.55	207.66	188.6	189.43	177.51	170.52	187.06 Toto	186.72	190.05	203.64	210.77		
								1019		$a_{112} =$			2342.87	(219)

Annual totals		kWh/yea	r	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 fac kg CO2/kWh	tor	Emissions kg CO2/yea	ır
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 =

(273)

18.85

User Details:												
Assessor Name:	Chris Arms	strong		Stroma	0002044							
Software Name:	Stroma FS	AP 2012		Softwa	are Ver	Versio	on: 1.0.4.16					
		P	roperty /	Address:	A 208							
Address :	Mid Medium	1										
1. Overall dwelling dimer	isions:											
Ground floor			Area	a(m²) 62	(1a) x	Av. Hei	ight(m) 48	(2a) =	Volume(m ³) 154.07	(3a)		
Total floor area TFA = (1a)+(1b)+(1c)+((1d)+(1e)+(1ı	ר) 🗌	62	(4)							
Dwelling volume					(3a)+(3b)	+(3c)+(3d)+(3e)+	.(3n) =	154.07	(5)		
2. Ventilation rate:									<u> </u>			
Number of chimneys	main heating	secondal heating	гу] + [0 Other] = [total	x 4	40 =	m ³ per hour	(6a)		
Number of open flues	0	+ 0		0	」 = [0	x 2	20 =	0	(6b)		
Number of intermittent fan	s	_			- F	2	x ′	10 =	20	(7a)		
Number of passive vents						0	x ′	10 =	0	(7b)		
Number of flueless gas fire	es					0	x 4	40 =	0	_](7c)		
-					L							
Air changes per hour												
Infiltration due to chimney	s, flues and fa	ans = (6a)+(6b)+(7	7a)+(7b)+(⁻	7c) =		20	•	÷ (5) =	0.13	(8)		
If a pressurisation test has be	en carried out or	is intended, procee	d to (17), c	otherwise c	continue fro	om (9) to (16)					
Additional infiltration	e awelling (ns	5)					[(0).	11v0 1 -	0	(9)		
Structural infiltration: 0.2	25 for steel or	timber frame o	0.35 for	masonr	v constr	uction	[(3)	1,0.1 -	0	$= \frac{(10)}{(11)}$		
if both types of wall are pre deducting areas of opening	sent, use the val s); if equal user	lue corresponding to 0.35	the great	er wall area	a (after				0			
If suspended wooden flo	oor, enter 0.2	(unsealed) or 0	.1 (seale	ed), else	enter 0				0	(12)		
If no draught lobby, ente	er 0.05, else e	enter 0							0	(13)		
Percentage of windows	and doors dra	aught stripped		0.05 10.0	~ (1 4) • 4	001			0	(14)		
vvindow inflitration				(8) ± (10) .	× (14) ÷ 1 + (11) + (1	00] = 2) ± (13) =	L (15) –		0	(15)		
	50 expresse	d in cubic metre	s ner ho		uare m	etre of e	nvelone	area	0	(10)		
If based on air permeabilit	v value. then	$(18) = [(17) \div 20] + ($	8), otherwi	se $(18) = ($	16)		nvelope	uluu	0.38			
Air permeability value applies	if a pressurisatio	on test has been doi	ne or a deg	gree air per	meability i	is being us	sed		0.00			
Number of sides sheltered	I								2	(19)		
Shelter factor				(20) = 1 - [0.075 x (1	9)] =			0.85	(20)		
Infiltration rate incorporation	ng shelter fac	tor		(21) = (18)	x (20) =				0.32	(21)		
Infiltration rate modified fo	r monthly win	d speed	1					i	I			
Jan Feb N	Mar Apr	May Jun	Jul	Aug	Sep	Oct	Nov	Dec				
Monthly average wind speed from Table 7												
(22)m= 5.1 5 4	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				

Adjust	ed infiltra	ation rat	e (allowi	ng for sl	nelter an	d wind s	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		
Calcul If m	late ettec echanica	ctive air	change i ition:	rate for t	he appli	cable ca	se						0	(220)
lf ext	haust air he	eat pump	using Appe	endix N. (2	3b) = (23a	i) x Fmv (e	equation (N	N5)), othe	wise (23b) = (23a)			0	(234)
lf bal	anced with	heat reco	overv: effic	iencv in %	allowing f	or in-use f	actor (from	n Table 4h) =	, (,			0	(230)
a) If	halance	d mech	anical ve	ntilation	with he	at recove	orv (M\/I	-IR) (24a))m – (2'	2h)m + (23h) 🗸 [ʻ	1 – (23c)	0 ∸ 1001	(230)
(24a)m=				0	0	0								(24a)
b) If	balance	d mech	I anical ve	Intilation	without	heat rec	L coverv (N	I //\/) (24b	m = (2)	I 2b)m + (;	L 23b)			
(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24b)
c) If	whole h	ouse ex	ract ver	tilation o	or positiv	re input v	ı ventilatio	n from c	outside					
-,	if (22b)m	n < 0.5 ×	(23b), t	hen (24	c) = (23b); other	wise (24	c) = (22b	o) m + 0.	5 × (23b)			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural	ventilatio	on or wh	ole hous	se positiv	/e input	ventilatio	on from I	oft	-	-	-		
	if (22b)m	n = 1, th	en (24d) I	m = (22l	o)m othe	erwise (2	24d)m =	0.5 + [(2	2b)m² x	0.5]		1	I	
(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)
Effe	ctive air	change	rate - er	nter (24a) or (24b	o) or (24	c) or (24	d) in box	(25)				I	
(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. He	at losse	s and he	eat loss p	paramet	er:									
ELEN	IENT	Gros	SS (m²)	Openin m	gs 2	Net Ar Ar	ea n²	U-valı W/m2	ĸ	A X U (W/	K)	k-value k.l/m²·l	e ≺	A X k k.I/K
Doors		aroa	()		•	21	 x	1		21			·	(26)
Windo	ws Type	e 1				2.1	x1	 /[1/(1.4)+	0.041 =	3.26	\exists			(27)
Windo	ws Type	2				2.46		/[1/(1.4)+	0.041 =	3.26	\exists			(27)
Windo	ws Type	3				7.85		. 、 / /[1/(1.4)+	0.041 –	10.41	\exists			(27)
Walls	Tvpe1	367	22	127	7	23.05		0.18		/ 31				(29)
Walls	Type2		•	2.7		20.00		0.10		0.52	╡┟		\dashv	(20)
Walle		4.9	٥	2.1		2.00		0.10		0.52	╡┟		\dashv	(20)
Walls	Type/	20.4				20.40	<u>^</u> ^	0.18		3.00	╡┟		\dashv	(29)
Total	rype 4		¹⁵	0		10.05		0.18	= [1.81				(24)
Dortu		lements	, 111-			72.2			—		—			(31)
* for wir	wall	roof wind		foctivo w	ndow I I vr	16.18	3 X		= [0		naragraph		(32)
** includ	de the area	as on both	sides of in	nternal wal	ls and part	titions	aleu using	i onnula 1	/[(1/ 0- vait	ie)+0.04j d	is given in	parayrapr	1 3.2	
Fabric	heat los	s, W/K	= S (A x	U)				(26)(30)	+ (32) =				29.3	5 (33)
Heat c	apacity	Cm = S((Axk)						((28)	.(30) + (32	2) + (32a).	(32e) =	0	(34)
Therm	al mass	parame	ter (TMF	P = Cm -	- TFA) in	n kJ/m²K			Indica	tive Value	: Medium		250	(35)
For des can be i	ign assess used inste	ments wh	ere the de tailed calci	tails of the	constructi	ion are noi	t known pr	ecisely the	indicative	e values of	TMP in Ta	able 1f		
Therm	al bridge	es : S (L	x Y) cal	culated	using Ap	pendix I	<						6.85	5 (36)
if details	s of therma	l bridging	are not kn	own (36) =	= 0.05 x (3	1)							0.00	()
Total f	abric he	at loss							(33) +	(36) =			36.2	2 (37)
Ventila	ation hea	at loss ca	alculated	monthl	y				(38)m	= 0.33 × (25)m x (5)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		

(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 tr	ansfer o	coefficier	nt, W/K						(39)m	= (37) + (3	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		
		motor (L	אי ים ור	/m2k					(40)~	Average =	Sum(39)1	12 /12=	64.82	(39)
(40)m=	1 06		1.06	1.05	1 04	1.03	1.03	1.03	(40)m	= (39)III - 1 04	1.05	1.05		
(40)11-	1.00	1.00	1.00	1.00	1.04	1.00	1.00	1.00	1.04	Average =	Sum(40)1	/12=	1.05	(40)
Numbe	er of day	s in moi	nth (Tab	le 1a)	-	-	-	-		.		L		
	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. Wa	iter heat	ting enei	rgy requi	irement:								kWh/ye	ear:	
Assum if TF if TF	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 bot water usage in litres per day Vd average = $(25 \times N) + 36$ (43)													
Annua Reduce not more	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 wate	er usage i	n litres per	r day for ea	ach month	Vd,m = fa	ctor from T	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		
$Total = Sum(44)_{112} = 991.11$ (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)													(44)	
(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		
lf instant	taneous w	vater heatii	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46) to (61)	Fotal = Su	m(45) ₁₁₂ =	=	1299.5	(45)
(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:						1						
Storag	e volum	e (litres)	includir	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		150		(47)
If comr Otherw	nunity h /ise if no	eating a stored	nd no ta hot wate	ink in dw er (this ir	velling, e ncludes i	nter 110 nstantar) litres in neous co	(47) ombi boil	ers) ente	er '0' in (47)			
a) If m	anufact	urer's de	eclared I	oss facto	or is kno	wn (kWł	n/dav):				1	39		(48)
Tempe	erature f	actor fro	m Table	2b		,	, , , , , , , , , , , , , , , , , , ,				0	.54		(49)
Energy	/ lost fro	m water	· storage	, kWh/ye	ear			(48) x (49)) =		0.	.75		(50)
b) If m Hot wa	anufact	urer's de age loss	eclared of factor fr	cylinder l com Tabl	oss fact e 2 (kW	or is not h/litre/da	known: av)					0		(51)
If comr	nunity h	eating s	ee secti	on 4.3	- (J					<u> </u>		(-)
Volum	e factor	from Ta	ble 2a									0		(52)
Tempe	erature f	actor fro	m Table	2b								0		(53)
Energy	lost fro	m water	storage	e, kWh/ye	ear			(47) x (51)	x (52) x (53) =		0		(54)
Enter	(50) or ((54) in (5	o5)					((56))			0.	.75		(55)
vvater	storage	ioss cal	culated f	ror each	month			((56)m = (55) × (41)ı	m	1	· · · · · ·		
(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	<u>~ Ц</u>	(56)
			u solar sto I	iaye, (57)l I	m = (סכ) m	x [(00) – (כו ו ח] ÷ (5 ד	u), eise (5	(00) = (11(1	m where (n i i) is fro T		X []	
(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)

													_				
Primar	y circuit	loss (ar	nnual) fro	om Table	e 3							0]	(58)			
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m								
(mo	dified by	r factor f	rom Tab	le H5 if t T	here is s	solar wat	er heati	ng and a	t cylinde	r thermo	stat)		1				
(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 ca	lculated	for each	month	(61)m =	(60) ÷ 36	65 × (41)m					_				
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)			
Total h	neat requ	uired for	water h	eating ca	alculated	for eac	h 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 Dł	-IW input of	calculated	using App	endix G o	Appendix	H (negati	ve quantity	y) (enter '0	' if no sola	r contribut	ion to wate	er heating)					
(add a	dditiona	l lines if	FGHRS	and/or \	WWHRS	applies	, see Ap	pendix (G)								
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)			
Output	t from w	ater hea	ter										-				
(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					
					-		-	Outp	out from wa	ater heate	r (annual)₁	12	1848.12	(64)			
Heat g	leat 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)			
inclu	include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating																
5. Int	5. Internal gains (see Table 5 and 5a):																
Metabolic gains (Table 5), Watts																	
motab	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)			
Lightin	g gains	(calcula	ted in A	pendix	L, equat	ion L9 o	r L9a), a	lso see ⁻	Table 5				1				
(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)			
Applia	nces dai	ins (calc	ulated ir	n Append	dix L. ea	uation L	13 or L1	3a), also	see Ta	ble 5			1				
(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)			
Cookir	na aains	(calcula	ted in A	ı ppendix	L. equat	tion L15	u or L15a), also se	e Table	5	I	I	1				
(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 far	L ns dains	(Table !	1 5a)									1				
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)			
			n (nega	tive valu	es) (Tab	1			-		-	_	I	, í			
(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	beating		[0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	I				
(72)m-	110 31	108.41	104 44	99.06	95 56	90.64	86.45	01.81	03 72	99.29	105 59	108.41	1	(72)			
Total :	nternel		104.44	00.00	00.00	(66)	$m \pm (67)m$	(68)m -	(60)m ± ($(70)m \pm (7)$	$1)m \pm (72)$	100.41	l	(/			
(72)m-		gains =	247.67	220 50	211 20	202 60	202.00		206 50	214 07	225.07	251.46	1	(73)			
(13)III=	lar gaine	330.93	347.07	529.00	311.30	293.09	202.09	207.39	290.09	514.07	333.07	331.40		(10)			
Solar o	ains are o	alculated	using sola	r flux from	Table 6a	and assoc	iated equa	ations to co	onvert to th	e applicat	ole orientat	ion.					
Orient	ation: A	Access F	actor	Area		Flu	X		a		FF		Gains				
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	1	1.28	x	0.63	x	0.7		=	27.07	(81)
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Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	22.97	x	0.63	x	0.7		=	17.27	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	22.97	x	0.63	x	0.7		=	17.27	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	2	2.97	x	0.63	x	0.7		=	55.1	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	x	0.63	×	0.7		=	31.11	 (81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	x	0.63	x	0.7		=	31.11	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	4	1.38	x	0.63	x	0.7		=	99.27	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	ŀ6	x	6	67.96	x	0.63	x	0.7		=	51.09	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	ŀ6	x	6	67.96	x	0.63	x	0.7		=	51.09	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	6	67.96	x	0.63	x	0.7		=	163.03	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	ŀ6	x	g	1.35	x	0.63	x	0.7		=	68.67	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	1.35	x	0.63	x	0.7		=	68.67	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	85	x	9	1.35	x	0.63	x	0.7		=	219.14	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	97.38	x	0.63	x	0.7		=	73.21	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	7.38	x	0.63	x	0.7		=	73.21	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	85	x	g	97.38	x	0.63	x	0.7		=	233.63	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		91.1	x	0.63	x	0.7		=	68.49	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		91.1	x	0.63	x	0.7		=	68.49	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x		91.1	x	0.63	x	0.7		=	218.56	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	2.63	x	0.63	x	0.7		=	54.6	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	2.63	x	0.63	x	0.7		=	54.6	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	7	2.63	x	0.63	x	0.7		=	174.24	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	5	50.42	x	0.63	x	0.7		=	37.91	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	5	50.42	x	0.63	x	0.7		=	37.91	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	5	50.42	x	0.63	x	0.7		=	120.96	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	28.07	x	0.63	x	0.7		=	21.1	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	28.07	x	0.63	x	0.7		=	21.1	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	35	x	2	28.07	x	0.63	x	0.7		=	67.33	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		14.2	x	0.63	x	0.7		=	10.67	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		14.2	x	0.63	x	0.7		=	10.67	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	85	x		14.2	x	0.63	x	0.7		=	34.06	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		9.21	x	0.63	x	0.7		=	6.93	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	9.21	x	0.63	x	0.7		=	6.93	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	85	x	9	9.21	x	0.63	x	0.7		=	22.11	(81)
Solar g	ains in	watts, ca	alculat	ted	for eac	h mont	h			(83)m	= Sum(74)m .	(82)m				I	
(83)m=	44.03	89.63	161.4	19	265.21	356.49) 3	380.06	355.54	283	.44 196.78	109.54	4 55.41	35.9	96		(83)
l otal g	ains –	Internal a	ina so	biar	(84)m =	= (73)m) + (. T .	(83)m	, watts		<u></u>			0.07	40	1	(0.4)
(84)m=	404.81	448.56	509.1	16	594.79	667.87		573.75	637.63	570	.83 493.37	424.4	391.28	387.	42		(84)
7. Me	an inte	rnal temp	eratu	re (heating	seaso	n)										
Temp	erature	e during h	eating	g pe	eriods ir	n the liv	/ing	area	trom Tal	ole 9,	[h1 (°C)					21	(85)
Utilisa	ation fac	ctor for g	ains fo	or li	ving are	ea, h1,i	m (s	see Ta	ible 9a)	. .				<u> </u>		1	
	Jan	Feb	Ma	ar	Apr	May	1	Jun	Jul	A A	ug Sep	Oct	Nov	De	ec		

(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	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 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)
Temp	erature	durina h	eating r	eriods ir	n rest of	u dwelling	from Ta	hle 9 Tl	հշ (°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)
Utilisa	ation fac	tor for a	ains for	rest of d	wellina	h2 m (se	e 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	interna	l temper	ature in	the rest	of dwelli	ina T2 (f	n Now ste	ens 3 to 7	r in Tahl	e 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)
									lf	L iLA = Livin	g area ÷ (4	4) =	0.41	(91)
Moon	intorno	ltompor	oturo (fo	r tho wh	olo dwo	llina) – fl	ΙΛ ν Τ1	ı (1 fl	۸) کر ۲۵			I		
(92)m=	19.14	19.31	19.63	20.05	20.33	20.43	20.44	+ (1 – 1L 20.44	20.37	19.99	19.5	19.12		(92)
Apply	adiustr	nent to t	he mear	internal	temper	ature fro	m Table	4e. whe	ere appro	opriate				
(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. Spa	ace hea	ting requ	uirement											
Set Ti	i to the i	mean int	ernal tei	mperatui	re obtair	ned at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	ilisation	factor fo	or gains	using Ta	ble 9a	i			·	·	·		1	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hm	1: 										(0.4)
(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	I	(94)
Usetu	I gains,	hmGm	, W = (94)	4)m x (84	4)m	266.44	244.06	256.40	260 50	404.00	207.00	205.04		(05)
(95)m=	402.09	444.25	490.33		507.69	ablo 9	244.90	250.19	309.30	404.23	307.22	303.01	i	(33)
(96)m=	43	4 9	65	89	11 7	14.6	16.6	16.4	14 1	10.6	71	42		(96)
Heat	loss rate	for me	an interr	al tempe	erature	[[W	-[(39)m	x [(93)m	_ (96)m	1				()
(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	e heatin	a require	ement fo	r each n	L nonth, k ^v	I Wh/mont	1 = 0.02	1 24 x [(97]	l)m – (95)m] x (4	1)m			
(98)m=	428.39	338.15	271.23	129.07	37.61	0	0	0	0	151.34	, 301.43	437.48		
l								Tota	l per year	(kWh/year	·) = Sum(9	8)15,912 =	2094.69	(98)
Space	e heatin	a reauire	ement in	kWh/m ²	/vear								33.79	(99)
		uiromor	te Ind	ividual b		vetome i	ncluding	umiero (חחי			l		
Sa. Lin	o hoatir	anemer a.		iviuuai n	eating s	ysterns i	nonuunig		, , , ,					
Fracti	on of sp	bace hea	at from s	econdar	y/supple	mentary	system					[0	(201)
Fracti	on of sc	ace hea	at from m	nain svst	em(s)			(202) = 1 -	- (201) =				1	(202)
Fracti	on of to	tal heatii	na from	, main sve	stem 1			(204) = (2	02) × [1 –	(203)] =			1	(204)
Efficie	ency of i	main spa	ace heat	ina syste	em 1								93.5	
Efficie				omontor	y hoatin	a ovetor	o 0/						90.0	
EIIICIE		Seconda	i y/suppi	l	y neaun		I, 70		_				0	(200)
0	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Space	e neatin	g require)	0		0	151.04	201 42	127 10		
(0.1.1)	420.39	330.15	2/1.23	129.07	0)		0	0	0	101.04	301.43	437.40		/
(211)m	$1 = \{[(98)]$)m x (20	4)] } x 1	$00 \div (20)$)6) 40.00				0	101.00	202.00	467.00		(211)
	408.17	301.00	290.08	138.04	40.23	U	U			08.101 ar) -Sum(322.39	407.89	0040.54	
								TUId		-0um(2	· · · / _{15,10} 12	-	2240.31	(211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (20	01)]}x1	00 ÷ (20)8)										
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
						-		Tota	l (kWh/yea	ar) =Sum(2	2 15) _{15,1012}	; =	0	(215)
Water	heating	9												_
Output	from w	ater hea	ter (calc	ulated a	bove)	400.07	407.00	400.00	400.54	450.07	405.05	477.07		
Efficien	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07	70.0	
				04.4	01 76	70.0	70.0	70.0	70.0	04 72	06.4	07 12	79.8	(217)
	07.03	booting	00.00	04.4	01.70	79.0	79.0	79.0	79.0	04.72	00.4	07.13		(217)
(219)m	n = (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		
								Tota	II = Sum(2	19a) ₁₁₂ =			2204.94	(219)
Annua	I totals	<i>.</i> .								k	Wh/year		kWh/year	-
Space	heating	fuel use	ed, main	system	1								2240.31	
Water	heating	fuel use	d										2204.94	
Electric	city for p	oumps, f	ans and	electric	keep-ho	t								
centra	al heatir	ng pump	:									30		(230c)
boiler	with a f	an-assis	ted flue									45		(230e)
Total e	lectricit	y for the	above, l	kWh/yea	ır			sum	of (230a)	(230g) =			75	(231)
Electric	city for I	ighting											281.38	(232)
12a. (CO2 em	issions -	– Individ	ual heat	ing syste	ems inclu	uding mi	cro-CHF						-
						En	erav			Emiss	ion fac	tor	Emissions	
						kW	/h/year			kg CO	2/kWh		kg CO2/yea	ır
Space	heating	(main s	ystem 1)		(21	1) x			0.2	16	=	483.91	(261)
Space	heating	(second	dary)			(21	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.2	16	=	476.27	(264)
Space	and wa	ter heati	ng			(26	1) + (262)	+ (263) + ((264) =				960.18	(265)
Electric	city for p	oumps, fa	ans and	electric	keep-ho	t (23 ⁻	1) x			0.5	19	=	38.93	(267)
Electric	city for I	ighting				(232	2) x			0.5	19	=	146.04	(268)
Total C	CO2, kg	/year							sum c	of (265)(2	271) =		1145.14	(272)

TER =

18.47 (273)

		User De	etails:						
Assessor Name: Chris A Software Name: Stroma	rmstrong FSAP 2012	:	Stroma Softwa	a Numi are Ver	ber: sion:		STRO Versio	002044 n: 1.0.4.16	
	Р	roperty A	Address:	A 406					
Address : Top Med	lium								
1. Overall dwelling dimensions:									
Ground floor		Area	62	(1a) x	Av. Hei	i ght(m) 6	(2a) =	Volume(m ³) 161.2	(3a)
Total floor area $TFA = (1a)+(1b)+(1b)$	c)+(1d)+(1e)+(1r	n) 👘	62	(4)					
Dwelling volume				(3a)+(3b)	+(3c)+(3d)+(3e)+	.(3n) =	161.2	(5)
2. Ventilation rate:			4					<u>, , , , , , , , , , , , , , , , , , , </u>	
Number of chimneys	ng heating + 0	y (0] = [total	x 4	40 =	m ³ per hour	(6a)
Number of open flues 0	+ 0	+	0	=	0	x 2	20 =	0	(6b)
Number of intermittent fans				Γ	2	x 1	10 =	20	(7a)
Number of passive vents					0	x 1	10 =	0	(7b)
Number of flueless gas fires					0	x 4	40 =	0] (7c)
							Air ch	anges per be	
				_					
Infiltration due to chimneys, flues an	d fans = (6a) + (6b) + (7a)	a)+(7b)+(7	'C) = therwise c	ontinue fri	20	(16)	÷ (5) =	0.12	(8)
Number of storevs in the dwelling	(ns)	u to (17), o		onunuo ne	5111 (5) 10 (10)	ĺ	0	(9)
Additional infiltration						[(9)-	-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for stee	el or timber frame or	0.35 for	masonr	y constr	uction			0	(11)
if both types of wall are present, use th deducting areas of openings); if equal	e value corresponding to user 0.35	the greate	er wall area	a (after					_
If suspended wooden floor, enter	0.2 (unsealed) or 0	1 (seale	d), else	enter 0				0	(12)
If no draught lobby, enter 0.05, el	se enter 0							0	(13)
Percentage of windows and doors	s draught stripped			$\chi(14) \cdot 1$	001 -			0	(14)
			(8) ± (10) -	x (14) ÷ 1 ⊾ (11) ⊥ (1	00] = 2) ± (13) J	(15) -		0	(15)
Air permechility value, a50, expre	ecod in cubic motro		(0) + (10)		2) + (10) +	nvolono	araa	0	(16)
If based on air permeability value, the	$(18) = [(17) \div 20] + (18)$	3), otherwis	(18) = (18)	16)		ivelope	alea	5	$1^{(17)}_{(19)}$
Air permeability value applies if a pressure	isation test has been dor	ne or a deg	ree air per	meability	is being us	sed		0.37	
Number of sides sheltered		Ū			0			2	(19)
Shelter factor		((20) = 1 - [0.075 x (1	9)] =			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 Ar	or May Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind speed from T	able 7								
(22)m= 5.1 5 4.9 4.4	4 4.3 3.8	3.8	3.7	4	4.3	4.5	4.7		
Wind Factor (22a)m = (22)m \div 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		

Adjust	ed infiltr	ation rat	te (allowi	ing for sł	nelter an	d wind s	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		
Calcul	ate etter	ctive air	change	rate for t	he appli	cable ca	ise					I		(220)
lf exh	aust air h	eat numn	using App	endix N (2	3b) = (23a	a) x Fmv (e	equation (I	N5)) othe	rwise (23h	(23a)		l	0	(234)
lf bala	anced with	n heat rec	overv: effic	iency in %	allowing f	or in-use f	actor (fron	n Table 4h) =	<i>)</i> = (200)		l	0	(220)
a) If	balance	nd moch			with ho	ot rocov			$y^{-} = (2)$	2b)m i (22h) v [/	 ۱ (22م)	· 1001	(230)
a) 11 (24a)m-								IK) (242	() (2)			$\frac{1-(230)}{1-(230)}$	÷ 100]	(24a)
b) If					without	boot roo		1)/) (24h	$\int_{-\infty}^{\infty}$	$\frac{1}{2}$	23b)	Ů		(_ · · ·)
(24b)m=											230)	0		(24b)
c) If	whole h		tract ver	L	or positiv		l ventilatio	n from c		, ,	<u> </u>	, , , , , , , , , , , , , , , , , , ,		· · · ·
i c)	if (22b)n	n < 0.5 x	x (23b), 1	then (24	c) = (23b); other	wise (24	c) = (22k	m + 0	.5 × (23t))			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural	ventilati	on or wh	lole hous	e positiv	ve input	ventilatio	on from l	oft					
í	if (22b)n	n = 1, th	en (24d)	m = (22	o)m othe	erwise (2	24d)m =	0.5 + [(2	2b)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)
Effe	ctive air	change	rate - er	nter (24a) or (24t	o) or (24	c) or (24	d) in boy	(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. He	at losse	s and he	eat loss	paramet	er:									
ELEN	IENT	Gro	SS	Openin	gs	Net Ar	ea	U-valı	he	ΑXU		k-value	;	A X k
		area	(m²)	r	2	A ,r	m²	W/m2	K	(W/	K)	kJ/m²∙ł	<	kJ/K
Doors						2.1	X	1	=	2.1				(26)
Windo	ws Type	91				2.46	x1	/[1/(1.4)+	0.04] =	3.26				(27)
Windo	ws Type	e 2				7.85	x1	/[1/(1.4)+	0.04] =	10.41				(27)
Windo	ws Type	e 3				2.46	x1	/[1/(1.4)+	0.04] =	3.26				(27)
Walls 7	Type1	44.9	94	12.7	7	32.17	7 X	0.18	=	5.79				(29)
Walls 7	Type2	5.2	2	2.1		3.12	x	0.18	=	0.56				(29)
Walls ⁻	ТуреЗ	21.3	39	0		21.39	x	0.18	=	3.85				(29)
Walls 7	Type4	10.5	51	0		10.51	1 X	0.18	=	1.89				(29)
Roof		62.3	34	0		62.34	4 X	0.13	=	8.1	ו ר		$\neg \square$	(30)
Total a	area of e	elements	s, m²			144.4	4							(31)
Party v	wall					10.41	1 X	0	=	0				(32)
* for win ** inclua	dows and le the area	l roof wind as on both	lows, use e n sides of ir	effective wi nternal wal	ndow U-va Is and part	alue calcul titions	lated using	formula 1	/[(1/U-valu	ue)+0.04] a	as given in	paragraph	3.2	
Fabric	heat los	ss, W/K	= S (A x	U)				(26)(30)	+ (32) =			[39.23	(33)
Heat c	apacity	Cm = S	(Axk)						((28).	(30) + (3	2) + (32a).	(32e) =	0	(34)
Therm	al mass	parame	eter (TMI	- = Cm +	- TFA) ir	n kJ/m²K			Indica	ative Value	: Medium		250	(35)
For desi can be ι	ign assess used inste	sments wh ad of a de	nere the de stailed calc	etails of the ulation.	construct	ion are no	t known pr	ecisely the	e indicative	e values of	TMP in Ta	able 1f		
Therm	al bridg	es : S (L	. x Y) cal	culated	using Ap	pendix l	K						15.6	(36)
if details	s of therma	al bridging	are not kr	nown (36) =	= 0.05 x (3	1)								
Total fa	abric he	at loss							(33) +	- (36) =			54.83	(37)

Ventila	ition hea	t loss ca	alculated	d monthly	y				(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 tr	ansfer c	oefficier	nt, W/K						(39)m	= (37) + (3	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 lo	oss para	meter (H	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	4.07	(40)
Numbe	er of day	s in moi	nth (Tab	le 1a)					,	Average =	Sum(40)₁.	12 /12=	1.37	(40)
	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. Wa	ter heat	ing enei	rgy requ	irement:								kWh/ye	ear:	
Assum	ed occu	nancy I	N									04		(42)
if TF	A > 13.9	0, N = 1	+ 1.76 x	([1 - exp	(-0.0003	849 x (TF	- A -13.9)2)] + 0.0	0013 x (⁻	TFA -13.	.9)	04		(42)
if TF	A £ 13.9), N = 1												
Annua <i>Reduce</i>	I averag	e not Wa I average	ater usag hot water	ge in litre usage by	es per da 5% if the d	ay va,av Iwelling is	erage = designed	(25 X N) to achieve	+ 36 a water us	se target o	82 f	.59		(43)
not more	e that 125	litres per j	person pe	r day (all w	vater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage ir	n litres per	day for e	ach month	Vd,m = fa	ctor from T	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		
Enorm	contant of	hot water	upped op	loulotod m	opthly_1	100 v Vd r		Tm / 2600	·	Total = Su	m(44) ₁₁₂ =	- 1d)	991.11	(44)
Energy ($\int du = 4.$									
(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	1000 5	(45)
lf instan	taneous w	ater heatii	ng at poin	t of use (no	o hot water	r storage),	enter 0 in	boxes (46,) to (61)	10tal = 5u	m(40) ₁₁₂ =	-	1299.5	(43)
(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:												
Storag	e volum	e (litres)	includir	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		150		(47)
If com	munity h	eating a	ind no ta	ank in dw	velling, e	nter 110	litres in	(47) mbi boil	oro) ont	or (0) in (47)			
Water	storage	loss:	not wate		iciuues i	nstantai	ieous cu		ers) erne		47)			
a) If m	anufact	urer's de	eclared l	loss facto	or is kno	wn (kWł	n/day):				1.	39		(48)
Tempe	erature fa	actor fro	m Table	e 2b							0.	54		(49)
Energy	/ lost fro	m water	storage	e, kWh/ye	ear			(48) x (49)) =		0.	75		(50)
b) If m	anufact	urer's de	eclared	cylinder	oss fact	or is not	known:							
Hot wa	ater stora	age loss	factor fi	rom lab	e 2 (kW	h/litre/da	iy)					0		(51)
Volum	e factor	from Ta	ble 2a	011 4.5								0		(52)
Tempe	erature fa	actor fro	m Table	e 2b								0		(53)
Energy	/ lost fro	m water	storage	e, kWh/ye	ear			(47) x (51)	x (52) x (53) =		0		(54)
Enter	(50) or (54) in (5	55)	ŷ							0.	75		(55)
Water	storage	loss cal	culated	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 cylinde	er contaii	ns dedicated	d solar sto	rage, (57)r	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (57	7)m = (56))m where (H11) is fro	m Append	ix 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)
Primar	y circu	t loss (an	inual) fro	om Table	93							0		(58)
Primar	y circu	t loss cal	culated	for each	month (59)m = (58) ÷ 36	65 × (41)	m					
(moo	dified b	y factor fr	om Tab	le H5 if t	here is s	solar wat	er heatir	ng and a	cylinde	r thermo	stat)			
(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 ca	alculated	for each	month ((61)m =	(60) ÷ 36	65 × (41))m						
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat rec	uired for	water he	eating ca	alculated	for eacl	n 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 DH	W input	calculated	using App	endix G or	Appendix	H (negativ	ve quantity	/) (enter '0'	' if no sola	r contributi	on to wate	r heating)		
(add a	dditiona	al lines if	FGHRS	and/or V	WWHRS	applies,	, see Ap	pendix G	G)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from v	vater hea	ter							-				
(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		
								Outp	but from w	ater heate	r (annual)₁	12	1848.12	(64)
Heat g	ains fro	om water	heating,	kWh/mo	onth 0.2	5 ´ [0.85	× (45)m	+ (61)m	n] + 0.8 x	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)
inclu	de (57)m in calc	ulation (of (65)m	only if c	ylinder is	s in the c	dwelling	or hot w	/ater is fr	om com	munity h	eating	
5. Int	ernal o	ains (see	Table 5	and 5a):	•		-				-	-	
Motab	olic agi	ns (Table	5) Wat	te										
metab	Jan	Feb	Mar	Apr	Mav	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)
l iahtin	n dains	(calculat	ted in Ar	nendix l	equat	ion I 9 oi	· 9a) a	lso see ⁻	I Table 5	I				
(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)
Annlia		ains (calc	ulated in		hivl ea		13 or 1	(Sa) also		ble 5				. ,
7001101	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)
Cookir			tod in A	nondiv		ion 15	or 1 150			5	100.00	170.11		()
	19 yani		22 10		L, equal		01 L 15a)	22 10		22 10	22.10	22.10		(69)
(03)III=	55.15	33.13	(Table (-)	55.19	55.19	55.19	55.19	55.15	33.19	55.19	55.15		(00)
Pumps	and ta	ins gains		ba)			2				2	2		(70)
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losses	s e.g. e	vaporatio	n (nega	tive valu	es) (Tab	le 5)								(74)
(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	g gains (T	able 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 i	nterna	l gains =				(66)	m + (67)m	n + (68)m +	+ (69)m +	(70)m + (7	1)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. So	ar gair	IS:												
Solar g	ains are	calculated	using sola	r flux from	Table 6a	and associ	ated equa	tions to co	onvert to th	ne applicat	le orientat	ion.		
Orienta	ation:	Access F Table 6d	actor	Area m²		Flu Tat	x ble 6a	Т	g_ able 6b	Та	FF able 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	×	0.63	x	0.7	=	31.11	(81)
Northwest 0.9x	0.77	x	7.85	x	41.38	×	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	×	67.96	×	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	×	0.63	x	0.7	=	68.67	(81)
Northwest 0.9x	0.77	x	7.85	x	91.35	×	0.63	x	0.7	=	219.14	(81)
Northwest 0.9x	0.77	x	2.46	x	91.35	×	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	×	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	×	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	×	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	×	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	×	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	×	0.63	x	0.7	=	21.1	(81)
Northwest 0.9x	0.77	x	2.46	x	14.2	×	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	×	14.2	×	0.63	x	0.7	=	10.67	(81)
Northwest 0.9x	0.77	x	2.46	x	9.21	×	0.63	x	0.7	=	6.93	(81)
Northwest 0.9x	0.77	x	7.85	×	9.21	×	0.63	x	0.7	=	22.11	(81)
Northwest 0.9x	0.77	×	2.46	×	9.21	×	0.63	x	0.7	=	6.93	(81)

Solar g	ains in	watts, ca	alculated	for eacl	n month			(83)m = S	um(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 g	ains – ir	nternal a	nd 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. Me	an inter	nal temp	erature	(heating	season)								
Temp	erature	during h	eating p	eriods ir	n the livir	ng area f	rom Tab	ole 9, Th	1 (°C)				21	(85)
Utilisa	ation fac	tor for g	ains for l	iving are	ea, h1,m	(see Ta	ble 9a)							
Stroma I	SAP 201	2 vErsion:	1.0.4.96	SAP 9.52	- http://ww	vw.stroma	. _{com} Jul	Aug	Sep	Oct	Nov	Dec	Pag	ge 5 of 7

(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	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 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)
Temp	erature	during h	eating p	eriods ir	n rest of	dwelling	from Ta	able 9, Tl	h2 (°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)
Utilisa	ation fac	tor for g	ains for	rest of d	welling,	h2,m (se	e 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	interna	l temper	ature in	the rest	of dwelli	ng T2 (f	ollow ste	eps 3 to 7	7 in Tabl	e 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)
		_	-		-	-			f	iLA = Livin	g area ÷ (4	4) =	0.41	(91)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	lling) = f	LA x T1	+ (1 – fL	.A) × 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	adjustn	nent to t	he mear	internal	temper	ature fro	m Table	e 4e, whe	ere appro	opriate			l	
(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. Spa	ace hea	ting requ	uirement	i i									-	
Set Ti	i to the r ilisation	nean int factor fo	ernal ter	mperatui using Ta	re obtain able 9a	ied at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Αυα	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hm):	inay	oun	- O'GI	7.03	000	000		200		
(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)
Usefu	I gains,	hmGm	, W = (94	4)m x (84	4)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)
Month	nly aver	age exte	rnal tem	perature	e from Ta	able 8	i	i	r	i	i			
(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	e for mea	an interr	al tempe	erature,	Lm,W:	=[(39)m	x [(93)m I	– (96)m]			1	(07)
(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	I	(97)
Space	e heatin	g require	$\frac{1}{12652}$	or each n	107.26	/Vh/mon 0	th = 0.02	24 x [(97])m – (95)m] x (4'	1)m	617.22		
(90)11=	007.01	494.29	420.52	247.71	107.30	0	0	Tota		250.5	+444.40	017.23	2202.01	(98)
0								TULA	i per year	(KWII/yeai) = Sum(9	0)15,912 =		
Space	e neatin	g require	ement in	KVVN/M ²	year								51.66	(99)
9a. En	ergy rec	luiremer	nts – Ind	ividual h	eating sy	ystems i	ncluding	j micro-C	CHP)					
Space Fracti	e heatir on of sr	1g: bace hea	nt from s	econdar	v/sunnle	mentary	system					I	0	(201)
Fracti	on of sr		at from m	nain evet	om(s)	montary	oyotom	(202) = 1 -	- (201) =				1	
Fracti	on of to	tal boati	ng from	main syst	etom 1			(204) - (2)	(_01) = [1 _]	(203)] -				
Fidu				ing over				(204) - (2	02) ~ [1	(200)] –				(204)
EIIICIE	ency of r	nain spa		ing syste									93.5	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heating	g systen	ז, % ו	1					0	(208)
_	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Space	e heatin	g require	ement (c		d above))			0	050.0	444.40	047.00		
/ _ · · · ·	607.01	494.29	426.52	247.71	107.36	U	0	0	U	258.3	444.48	617.23	i	
(211)m	n = {[(98)m x (20	4)] } x 1	$00 \div (20)$)6)				0	070.00	475.00	000.44		(211)
	649.21	528.65	456.17	264.93	114.82	U	0			2/6.26	475.38	bbU.14	0.405	
								TOIA		un =oun(2	···/ _{15,10} 12	-	3425.57	(211)

Space heating fuel (secondary), kWh/month

= {[(98])m x (20	01)] } x 1	00 ÷ (20)8)										
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
				-				Tota	l (kWh/yea	ar) =Sum(2	2 15) _{15,1012}	<u>_</u>	0	(215)
Water	heating	9												-
Output	from w	ater hea	ter (calc	ulated a	bove)	400.07	407.00	400.00	400.54	450.07	405.05	477.07	ı	
Efficien	181.33	159.92	168.19	151.1	148.31	132.87	127.93	139.93	139.54	156.67	165.25	177.07		
Efficier		ater nea		00.40	00.07	70.0	70.0	70.0	70.0	00.44	07.00	07.07	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)
(219)m	r water 1 = (64)	meating, m x 100	кууп/m) ÷ (217)	ontn)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		
							-	Tota	l = Sum(2	19a) ₁₁₂ =			2183.66	(219)
Annua	I totals	i								k	Wh/year		kWh/year	-
Space	heating	fuel use	ed, main	system	1								3425.57	
Water	heating	fuel use	d										2183.66]
Electric	city for p	oumps, fa	ans and	electric	keep-ho	t								
centra	al heatir	ng pump										30		(230c)
boiler	with a f	an-assis	ted flue									45]	(230e)
Total o	lectricit	v for the	abovo	k\Mb\uoo	r			sum	of (230a)	(230g) =			75)] ₍₂₃₁₎
			above, i	yea	.1			oum	01 (2004).	(2009) –			/5	
Electric	city for I	ighting											281.38	(232)
12a. (CO2 em	issions -	– Individ	ual heat	ing syste	ems inclu	uding mi	cro-CHF)					
						En	ergy			Emiss	ion fac	tor	Emissions	
						kW	/h/year			kg CO	2/kWh		kg CO2/yea	ır
Space	heating	(main s	ystem 1)		(211	1) x			0.2	16	=	739.92	(261)
Space	heating	(second	dary)			(215	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.2	16	=	471.67	(264)
Space	and wa	ter heati	ng			(261	1) + (262)	+ (263) + (264) =				1211.6	(265)
Electric	city for p	oumps, fa	ans and	electric	keep-ho	t (231	1) x			0.5	19	=	38.93	(267)
Electric	city for I	ighting				(232	2) x			0.5	19	=	146.04	(268)
Total C	:O2, kg	/year							sum o	of (265)(2	271) =		1396.56	(272)

TER =

22.53 (273)

			User D	etails:						
Assessor Name:	Chris Armstrong			Strom	a Num	ber:		STRO	002044	
Software Name:	Stroma FSAP 207	12		Softwa	are Ver	sion:		Versio	on: 1.0.4.16	
		Pr	operty A	Address:	A G01					
Address :	GRD Medium									
1. Overall dwelling dimen	isions:		_							
Ground floor			Area	1 (m²) 6.15	(1a) x	Av. Hei	i ght(m) 5	(2a) =	Volume(m ³) 190.38	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e	e)+(1n) 70	6.15	(4)]		_
Dwelling volume		,	/ <u> </u>		(3a)+(3b)	+(3c)+(3d)+(3e)+	.(3n) =	190.38	(5)
2. Ventilation rate:										_
Number of chimneys	main s heating l	econdary neating	у , Т + Г	other	7 = Г	total	x 4	40 =	m ³ per hour	
Number of open flues	0 +	0	」 (] + 「	0	」	0	×2	20 =	0	(6b)
Number of intermittent fan	s					0	x ′	10 =	0	(7a)
Number of passive vents						0	x /	10 =	0	_](7b)
Number of flueless gas fire	es					0	x 4	40 =	0	
<u>j</u>					L	0			Ū	
								Air ch	anges per ho	ur
Infiltration due to chimneys	s, flues and fans = (6)	6b)+(6b)+(7a	a)+(7b)+(7	7c) =	Г	0		÷ (5) =	0	(8)
If a pressurisation test has be	en carried out or is intend	ed, proceed	l to (17), o	otherwise c	ontinue fro	om (9) to (16)			-
Number of storeys in the	e dwelling (ns)						[(0)	11-0.4	0	(9)
Structural infiltration: 0.2	25 for steel or timber	frame or	0 35 for	masonr	v constr	uction	[(9)	-1]x0.1 =	0	(10)
if both types of wall are pre deducting areas of opening	sent, use the value corres s); if equal user 0.35	sponding to	the greate	er wall area	a (after	uotion			0	
If suspended wooden flo	oor, enter 0.2 (unsea	led) or 0.	1 (seale	d), else	enter 0				0	(12)
If no draught lobby, ente	er 0.05, else enter 0								0	(13)
Percentage of windows	and doors draught s	tripped				0.01			0	(14)
Window infiltration				0.25 - [0.2	$X(14) \div 1$	(00] =	(15) -		0	(15)
Air permechility value	50 overessed in sul	oio motros	nor ho	(0) + (10)	+(1)+(1)	2) + (13) + (1	r(15) =	aroa	0	(16)
If based on air permeabilit	y value then $(18) = [(10)]$	17) ÷ 20]+(8), otherwis	ui pei si se (18) = (16)		nvelope	alea	3	(17)
Air permeability value applies	if a pressurisation test ha	s been done	e or a deg	ree air pei	rmeability i	is being us	sed		0.15	
Number of sides sheltered	1								2	(19)
Shelter factor				(20) = 1 - [0.075 x (1	9)] =			0.85	(20)
Infiltration rate incorporatin	ng shelter factor			(21) = (18)	x (20) =				0.13	(21)
Infiltration rate modified fo	r monthly wind spee	b b						1	1	
Jan Feb M	Mar Apr May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_	
Monthly average wind spe	ed from Table 7	,							1	
(22)m= 5.1 5 4	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		

Adjust	ed infiltra	ation rat	e (allowi	ng for sh	nelter an	d wind s	peed) =	(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			
Calcul	late effec	ctive air	change i tion:	rate for t	he appli	cable ca	se								
lf ovh	eurariica		using Anne	andix N (2	(23a) – (23a) × Emv (e	auation (N	(15)) othe	rwise (23h) - (23a)			0.8) 	
lf bal	anced with	heat reco	werv: effic	iency in %	allowing f	or in-use f	actor (from	n Table 4h) –) = (200)			0.8	, 	
a) If		d moch			with hor) = (2)	2b)m i (22b) v [[,]	1 (220)	/6. · · 1001	5	(230)
a) II (24a)m=	0.28	0.28		0.26	0.25	0.24		0.24	0.24	0.25	0.26	0.27]]		(24a)
(2-10)11-	halance	d mach		ntilation	without	boot roc		(1)(1)(24h)	$\int_{-0.24}^{0.24}$	$\frac{0.20}{2}$	23b)	0.27]		()
(24b)m=												0	1		(24b)
c) If	whole h		tract ver	tilation (l ventilatio	n from c	<u> </u>	Ĵ	, °	, , , , , , , , , , , , , , , , , , ,]		
0) 11	if (22b)m	ין < 0.5 א ו < 0.5 א	(23b), t	hen (24	c) = (23b); other	vise (24	c) = (22t	b) m + 0.	.5 × (23b))				
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0]		(24c)
d) If	natural	ventilatio	on or wh	ole hous	se positiv	/e input	ventilatio	on from I	oft		-	-	-		
	if (22b)m	า = 1, th	en (24d)	m = (22l	o)m othe	erwise (2	4d)m =	0.5 + [(2	2b)m² x	0.5]			1		(- · · ·
(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0			(24d)
Effe	ctive air	change	rate - er	nter (24a) or (24b	o) or (24	c) or (24	d) in boy	(25)				1		(05)
(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	J		(25)
3. He	at losse	s and he	eat loss p	paramet	er:										
ELEN	IENT	Gros area	ss (m²)	Openin rr	gs 1 ²	Net Ar A ,r	rea m²	U-valı W/m2	ue K	A X U (W/I	K)	k-value kJ/m²⊷	e K	A X kJ/ł	k K
Doors						2.1	x	1.4	=	2.94					(26)
Windo	ws Type	e 1				2.46	x1.	/[1/(1.4)+	0.04] =	3.26					(27)
Windo	ws Type	2				8.07	x1.	/[1/(1.4)+	0.04] =	10.7					(27)
Floor						77.49) x	0.15	=	11.623	5				(28)
Walls	Type1	61.6	51	10.5	3	51.08	3 X	0.2	=	10.22	ו ר		- -		(29)
Walls	Type2	4.2	4	2.1		2.14	x	0.2	=	0.43	ז ר		ΞĒ		(29)
Walls	Туре3	20.4	6	0		20.46	3 X	0.2		4.09	ז ד		Ξ F		(29)
Walls	Type4	6.1	5	0		6.15	x	0.2		1.23	ז ד		= F		(29)
Total a	area of e	lements	, m²	L		169.9	5								(31)
Party	wall					4.98	x	0	=	0					(32)
* for wir ** includ	ndows and de the area	roof wind as on both	ows, use e sides of in	ffective wi nternal wal	ndow U-va Is and part	alue calcul titions	ated using	formula 1	/[(1/U-valu	ıe)+0.04] a	as given in	paragraph	in 3.2		_
Fabric	heat los	s, W/K :	= S (A x	U)				(26)(30)	+ (32) =				44.4	19	(33)
Heat c	apacity	Cm = S((Axk)						((28).	(30) + (32	2) + (32a).	(32e) =	0		(34)
Therm	al mass	parame	ter (TMF	P = Cm -	- TFA) in	n kJ/m²K			Indica	tive Value	: Medium		25	0	(35)
For des can be i	ign assess used instea	ments wh ad of a de	ere the de tailed calci	tails of the ulation.	constructi	ion are noi	t known pr	ecisely the	e indicative	e values of	TMP in Ta	able 1f			_
Therm	al bridge	es : S (L	x Y) cal	culated	using Ap	pendix l	<						12.8	39	(36)
<i>if details</i> Total f	s of therma abric hea	al bridging at loss	are not kn	own (36) =	= 0.05 x (3	1)			(33) +	(36) =			57 5	38](37)
Ventila	ation hea	at loss ca	alculated	l monthly	y				(38)m	= 0.33 × ((25)m x (5))			」 ` ′
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec]		
													-		

(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 tr	ansfer c	coefficier	nt, W/K						(39)m	= (37) + (3	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		
Heatle	es nara	motor (H		/m²k					(40)m	Average =	Sum(39)	12 /12=	73.52	(39)
(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		
(10)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	Average =	Sum(40)1		0.97	(40)
Numbe	er of day	vs in moi	nth (Tab	le 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. Wa	iter heat	ting ene	rgy requi	irement:								kWh/ye	ear:	
Assum if TF	ed occu A > 13.9	ipancy, l 9, N = 1	N + 1.76 x	: [1 - exp	(-0.0003	849 x (TF	-13.9)2)] + 0.()013 x (TFA -13.	<u>2</u> . 9)	39		(42)
	A £ 13.9 Laverad	θ , N = 1	aterusar	ne in litre	e ner da	ve hV ve	erane –	(25 x N)	+ 36		00			(43)
Reduce	the annua	al average	hot water	usage by	5% if the a	lwelling is	designed i	to achieve	a water us	se target o	f 90	.00		(43)
not more	e that 125	litres per j	person per	r day (all w	vater use, l	hot and co	ld)		-	-	-			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage II	n litres pei	r day for ea	ach month T	Vd,m = fa T	ctor from 1	l able 1c x	(43) 1	r	r	r			
(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		-
Energy o	content of	hot water	used - cal	culated me	onthly $= 4$.	190 x Vd,r	n x nm x D)))))))))))))))))))) kWh/mor	Total = Su hth (see Ta	m(44) ₁₁₂ = ables 1b, 1	= c, 1d)	1090.34	(44)
(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		
lf instan	aneous w	ator hoati	na et point	t of use (no	hot water	r storage)	enter () in	boyes (46) to (61)	Total = Su	m(45) ₁₁₂ =	=	1429.61	(45)
(46)~		40.45		17.40	46.70	3.0/2gc),	42.42		15.50	10.10	10.02	24 52		(46)
Water	storage	loss:	20.07	17.49	16.79	14.40	13.42	15.4	15.59	10.10	19.63	21.53		(40)
Storag	e volum	e (litres)) includir	ng any se	olar or W	/WHRS	storage	within sa	ame ves	sel		0		(47)
If comr	nunity h	eating a	and no ta	ank in dw	velling, e	nter 110	litres in	(47)						
Otherw	ise if no	stored	hot wate	er (this ir	ncludes i	nstantar	neous co	ombi boil	ers) ente	er '0' in (47)			
vvater	storage	loss: urer's de	aclarad I	oss fact	or is kno	wn (k\//	n/dav).					0		(49)
Tempe	anulaci	actor fro	m Table	2h			vuay).					0		(40)
Energy	lost fro	m water	storade	× k\//h/v	ar			(48) x (49) –			10		(49)
b) If m	anufact	urer's de	eclared of	cylinder	loss fact	or is not	known:	(40) X (40)	/ –		1	10		(50)
Hot wa	ter stora	age loss	factor fr	rom Tabl	le 2 (kW	h/litre/da	ay)				0.	02		(51)
If comr	nunity h	eating s	ee secti	on 4.3										
Volum	e factor	from 1a	ble 2a m Table	2h							1.	03		(52)
Tempe				: ZU				(47) (54)	··· (FO) ··· (50)		.6		(53)
Energy	(50) or (m water (54) in (5	storage	e, Kvvn/ye	ear			(47) X (51)) X (52) X (53) =	1.	.03 02		(54)
Water	storage	loss cal	culated f	for each	month			((56)m = (55) × (41)	m	L			(00)
(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 cylinde	er contains	s dedicate	d solar sto	rage, (57)	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	ix H	(20)
(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)
()			1		1	L			1 - 0.00					· · /

Primar	y circui	t loss (an	inual) fro	om Table	e 3 month (59)m - ((58) · 36	S5 v (11)	m			0		(58)
(mod	dified b	v factor fi	om Tab	le H5 if t	here is s	solar wat	er heati	ng and a	u cvlinde	r thermo	stat)			
(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 ca	alculated	for each	month ((61)m =	(60) ÷ 36	65 × (41)m						
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat rec	uired for	water h	eating ca	ı alculatec	l for eacl	h month	(62)m =	0.85 x ((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 DH		calculated	usina App	endix G or	Appendix	H (negativ	ve quantity	/) (enter '0	if no sola	r contribut	ion to wate	er heating)		
(add ad	dditiona	al lines if	FGHRS	and/or V	WWHRS	applies	, see Ap	pendix (G)					
、 (63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from w	vater hea	ter		ļ		ļ		<u> </u>	ļ				
(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		
. ,								LOutp	L but from wa	L ater heate	r (annual)₁	12	2080.45	(64)
Heat a	ains fro	om water	heating.	kWh/m	onth 0.2	5 ´ [0.85	x (45)m	1 + (61)m	n] + 0.8 x	([(46)m	+ (57)m	+ (59)m	1	1
(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)
inclu	do (57))m in calc		of (65)m	only if c	l vlinder i	s in the	l	or hot w	l ator is fr		munity h	eating	
5 Jot					0111y 11 0	yin acr is	5 11 110 0	awening	or not w			internity in	cating	
5. III	emarg	ans (see		o anu baj).									
Metabo	olic gai	ns (Table	5), Wat	ts A m r	Max	luna	11	A	Can	Oct	Next	Dee		
(00)	Jan	Feb	Mar	Apr		Jun	JUI	Aug	Sep		140.00	Dec		(66)
(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		(00)
Lightin	g gains	s (calcula	ted in Ap	opendix	L, equat	ion L9 oi	r L9a), a	lso see	Table 5					(07)
(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)
Appliar	nces ga	ains (calc	ulated ir	n Append	dix L, eq	uation L	13 or L1	3a), alsc	see Ta	ble 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)
Cookin	ig gains	s (calcula	ted in A	ppendix	L, equat	ion L15	or L15a), also se	e 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 fa	ins gains	(Table 5	ōa)										
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0		(70)
Losses	s e.g. e	vaporatio	n (nega	tive valu	es) (Tab	le 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	, g gains (T	able 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 i	nterna	l gains =				(66)	m + (67)m	n + (68)m +	⊦ (69)m + ((70)m + (7	1)m + (72)	m	I	
(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. Sol	lar gain	IS:												
Solar g	ains are	calculated	using sola	r flux from	Table 6a	and assoc	iated equa	itions to co	onvert to th	e applicat	le orientat	ion.		
Orienta	ation:	Access F Table 6d	actor	Area m²		Flu Tal	x ole 6a	Т	g_ able 6b	Т	FF able 6c		Gains (W)	

	Table 6d		m²		Table 6a		Table 6b		Table 6c		(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)

Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	8	35.75]	().5	x	0.8		=	191.83	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	06.25	i	().5	x	0.8		=	237.69	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	19.01	1	().5	x	0.8		=	266.23	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	18.15	Ī	().5	x	0.8		=	264.3	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	13.91	i	().5	x	0.8		=	254.82	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	1	04.39	1	().5	x	0.8		=	233.52	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	g	2.85]	().5	x	0.8		=	207.71	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	6	9.27	Ī	().5	x	0.8		=	154.95	(79)
Southw	est <mark>0.9x</mark>	0.77		x	8.0	7	x	4	4.07	1	().5	x	0.8		=	98.59	(79)
Southw	est <mark>0.9</mark> x	0.77		x	8.0	7	x	3	31.49]	().5	x	0.8		=	70.44	(79)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	1	1.28	x	().5	x	0.8		=	7.69	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	2.97	x	().5	x	0.8		=	15.66	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	X	().5	x	0.8		=	28.22	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	6	67.96	x	().5	x	0.8		=	46.34	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	91.35	x	().5	x	0.8		=	62.29	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	g	97.38	x	().5	x	0.8		=	66.41	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	91.1	×	().5	x	0.8		=	62.12	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	2.63	x	().5	x	0.8		=	49.53	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	5	50.42	x	().5	x	0.8		=	34.38	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	28.07	x	().5	x	0.8		=	19.14	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		14.2	x	().5	x	0.8		=	9.68	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		9.21	x	().5	x	0.8		=	6.28	(81)
Solar g	ains in	watts, ca	lcula	ted	for eac	n mont	h			(83)m	n = Sum	(74)m	(82)m		1			
(83)m=	90	155.86	220.0	05	284.03	328.52	2 3	30.71	316.94	283	8.05 2	42.09	174.09	108.27	76.7	72		(83)
l otal g	ains – i	nternal a		biar	(84)m =	: (73)n) + (83)m	, watts			<u></u>		49.4.40	1 101			(0.4)
(84)m=	505.37	569.12	620.7	15	662.99	686.08	3 6	67.65	640.5	612	2.52 5	82.45	535.8	494.46	481.	.22		(84)
7. Me	an intei	rnal temp	eratu	ire (heating	seaso	on)									-		
Temp	erature	during h	eatin	g pe	eriods ir	the liv	ving	area	from Tal	ble 9	, Th1 ((°C)					21	(85)
Utilisa	ation fac	ctor for ga	ains f	or li	ving are	a, h1,	m (s	ee Ta	ible 9a)	<u> </u>								
(00)	Jan	Feb	Ma	ar	Apr	May	4	Jun	Jul	A	ug	Sep	Oct	Nov	De	ec		(00)
(86)m=	1	0.99	0.98	3	0.95	0.85		0.67	0.49	0.5	54	0.78	0.96	0.99	1			(00)
Mean	interna	al tempera	ature	in li	iving are	ea T1	follo	ow ste	ps 3 to 7	7 in T	Table 9)))		-	I			
(87)m=	20.05	20.19	20.4	1	20.66	20.87	2	20.98	21	20.	.99 2	20.94	20.68	20.32	20.0	02		(87)
Temp	erature	during h	eatin	g pe	eriods ir	rest o	of dv	velling	from Ta	able 9	9, Th2	(°C)						
(88)m=	20.1	20.1	20.′	1	20.11	20.11	2	20.12	20.12	20.	.13 2	20.12	20.11	20.11	20.′	11		(88)
Utilisa	ation fac	ctor for ga	ains f	or re	est of d	welling	, h2	,m (se	e Table	9a)				-				
(89)m=	1	0.99	0.98	3	0.93	0.8		0.59	0.4	0.4	44	0.71	0.94	0.99	1			(89)
Mean	interna	al tempera	ature	in t	he rest	of dwe	lling	<u>T2</u> (f	ollow ste	eps 3	8 to 7 ii	n Table	9c)					
(90)m=	18.83	19.03	19.3	4	19.72	19.99	2	20.11	20.12	20.	.12 2	20.08	19.75	19.23	18.	.8		(90)
												fL	A = Liv	ring area ÷ (4) =		0.5	(91)

Mean	interna	l temper	ature (fo	r the wh	ole dwe	llina) = fl	LA × T1	+ (1 – fL	A) × 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	adjustr	nent to t	he mean	interna	temper	ature fro	m Table	4e, whe	ere appro	opriate				
(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. Spa	ace hea	ting requ	uirement		• • •					/	>			
Set Ti the ut	i to the i ilisation	nean int factor fo	ernal ter	nperatui using Ta	re obtain Ible 9a	ed at ste	ep 11 of	Table 9	b, so tha	t Ti,m=(76)m an	d re-calc	ulate	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, 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)
Usefu	Il gains,	hmGm	, W = (94	4)m x (84	4)m	440.40	005.44	000.44		505.00	400.50			(05)
(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)
(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	e for mea	an intern	al tempe	erature,	Lm , W =	[(39)m :	x [(93)m	– (96)m	1				
(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	e heatin	g require	ement fo	r each n	nonth, k\	Nh/mont	th = 0.02	24 x [(97)m – (95)m] x (4	1)m			
(98)m=	470.78	361.23	292.55	154.3	57.05	0	0	0	0	149.4	321.72	483.22		_
								Tota	l per year	(kWh/yea	r) = Sum(9	8)15,912 =	2290.24	(98)
Space	e heatin	g require	ement in	kWh/m ²	/year								30.08	(99)
9b. En	ergy red	quiremer	nts – Cor	nmunity	heating	scheme)							
This pa	art is us	ed for sp	ace hea	ting, spa	ace cooli	ng or wa	ater heat	ing prov	rided by	a comm	unity sch	neme.	0	(201)
Fractio			nom se	conuary/	supplen				1) 0 11 11	one		l	0	
Fractio	n or spa	ace neat	from col	mmunity	system	1 – (301	1) =					l	1	(302)
The com includes	nmunity so boilers, h	cheme mag leat pumps	y obtain he s, geotherr	eat from se nal and wa	everal sour aste heat f	rces. The p rom power	orocedure r stations.	allows for See Appel	CHP and ı ndix C.	up to four	other heat	sources; th	ne latter	
Fractio	n of hea	at from C	Commun	ity boiler	S								1	(303a)
Fractio	n of tota	al space	heat fro	m Comn	nunity bo	oilers				(3	02) x (303	a) =	1	(304a)
Factor	for cont	rol and o	charging	method	(Table 4	4c(3)) fo	r commu	unity hea	ating sys	tem			1	(305)
Distrib	ution los	s factor	(Table 1	2c) for c	commun	ity heatir	ng syste	m					1.05	(306)
Space	heating	9										•	kWh/yea	
Annua	l space	heating	requirem	nent									2290.24	
Space	heat fro	om Comr	munity b	oilers					(98) x (30	04a) x (30	5) x (306) :	= [2404.75	(307a)
Efficier	ncy of s	econdar	y/supple	mentary	heating	system	in % (fro	m Table	e 4a or A	ppendix	: E)	[0	(308
Space	heating	require	ment froi	m secon	dary/sup	plemen	tary syst	em	(98) x (30	01) x 100 ·	÷ (308) =	[0	(309)
Water	heating	J												_
Annua	l water l	neating r	equirem	ent									2080.45	
If DHW Water	/ from c heat fro	ommuni m Comr	ty scherr nunity bo	ne: pilers					(64) x (30	03a) x (30	5) x (306) :	= [2184.47	(310a)
Electric	city use	d for hea	at distribu	ution				0.01	× [(307a).	(307e) +	- (310a)(310e)] =	45.89	(313)
Coolin	g Syste	m Energ	y Efficiei	ncy Rati	D							[0	(314)
Space	cooling	(if there	is a fixe	d cooling	g systen	n, if not e	enter 0)		= (107) ÷	(314) =		ĺ	0	(315)

Electricity for pumps and fans within dw	velling (Table 4f)	:		_	450.07	
mechanical ventilation - balanced, extra	act or positive inp	Sut 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/yea	r	=(330a) + (330b)) + (330g) =		150.97	(331)
Energy for lighting (calculated in Apper	dix L)				347.78	(332)
12b. CO2 Emissions – Community hea	ting scheme					
		Energy kWh/year	Emission fact kg CO2/kWh	tor Er kg	nissions CO2/year	
CO2 from other sources of space and v Efficiency of heat source 1 (%)	vater heating (no If there is	ot CHP) CHP using two fuels repeat (363) to ((366) for the second	d 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 (se	condary)	(309) x	0	=	0	(374)
CO2 associated with water from immer	sion heater or in	stantaneous heater (312) x	0.22	=	0	(375)
Total CO2 associated with space and v	ater heating	(373) + (374) + (375) =			1067.26	(376)
CO2 associated with electricity for pum	ps and fans with	in dwelling (331)) x	0.52	=	78.35	(378)
CO2 associated with electricity for light	ng	(332))) x	0.52	=	180.5	(379)
Total CO2, kg/year	sum of (376)(38	2) =			1326.11	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				17.41	(384)
El rating (section 14)					85.33	(385)

			User	Details:						
Assessor Name:	Chris Arms	trong		Strom	a Num	ber:		STRO	002044	
Software Name:	Stroma FS	AP 2012		Softwa	are Ver	sion:		Versio	n: 1.0.4.16	
			Property	Address	: A 208					
Address :	Mid Medium									
1. Overall dwelling dimer	nsions:									
Ground floor			Are	e a(m²) 62	(1a) x	Av. He i	i ght(m) .48	(2a) =	Volume(m ³) 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:	.								<u> </u>	
Number of chimneys	heating	secor heati	ng 	0 Other] = [total	X 4	40 =	m ³ per nour	(6a)
Number of open flues	0	+ 0	, +	0] = [0	x 2	20 =	0	(6b)
Number of intermittent far	IS					0	x ^	10 =	0	(7a)
Number of passive vents					Г	0	x ′	10 =	0	(7b)
Number of flueless gas fir	es					0	x 4	40 =	0](7c)
								Air ch	anges per ho	ur
Infiltration due to chimney	s, flues and fa	ans = (6a)+(6b)	b)+(7a)+(7b)+	(7c) =	continue fro	0 om (9) to ((16)	÷ (5) =	0	(8)
Number of storeys in the	e dwelling (ns)	,			(-) (,		0	(9)
Additional infiltration							[(9)-	-1]x0.1 =	0	(10)
Structural infiltration: 0.2	25 for steel or	timber fram	e or 0.35 fo	or masoni	y constr	uction			0	(11)
if both types of wall are pre	esent, use the val	ue correspondi 0 35	ing to the grea	ter wall are	a (after					
If suspended wooden fle	oor, enter 0.2	(unsealed)	or 0.1 (seal	ed), else	enter 0				0	(12)
If no draught lobby, ente	er 0.05, else e	enter 0							0	(13)
Percentage of windows	and doors dra	aught strippe	əd						0	(14)
Window infiltration				0.25 - [0.2	x (14) ÷ 1	= [00			0	(15)
Infiltration rate				(8) + (10)	+ (11) + (1	2) + (13) +	+ (15) =		0	(16)
Air permeability value, o	q50, expresse	d in cubic m	etres per h	our per s	quare m	etre of e	nvelope	area	3	(17)
If based on air permeabilit	ty value, then	$(18) = [(17) \div 2]$	20]+(8), otherv	vise (18) = (16)				0.15	(18)
Air permeability value applies	i it a pressurisatio	n test has beer	n done or a de	egree air pe	rmeability	is being us	sed		0	
Shelter factor	A			(20) = 1 -	[0.075 x (1	9)] =			0.85	(19)
Infiltration rate incorporation	ng shelter fact	tor		(21) = (18) x (20) =				0.13	(21)
Infiltration rate modified fo	or monthly win	d speed								
Jan Feb I	Mar Apr	May Ju	un Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind spe	ed from Table	e 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 0.9	95 0.95	0.92	1	1.08	1.12	1.18		

Adjust	ed infiltr	ation rat	e (allowi	ng for sl	nelter an	d wind s	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			
Calcul	late effec	ctive air	change i	rate for t	he appli	cable ca	se								
lf ext	naust air he	ai veriuic eat numn	using Appe	endix N (2	(23a) = (23a	i) x Fmv (e	equation (N	N5)) othe	rwise (23h) = (23a)			0.5		a)
lf hal	anced with	heat rec	overv: effic	iency in %	allowing f	or in-use f	actor (from	n Table 4h) –	<i>(</i> 200)			0.5		D)
a) If		d moob			with ho) = (2)	2b)m i ('	226) v [/	1 (220)	/6.	5 (23	C)
a) II (24a)m-				0.26				(24a)	a) = (2)	20)11 + (.)	230) × [1 - (230)]]	(24	a)
(2-40)11-		0.20		ntilation	without	boot roc			$\int_{-\infty}^{0.24} (2)$	2b)m + ('	0.20 22h)	0.21	J	(~,
0) II								VIV) (24L	D = (22)	$\frac{20}{1}$		0	1	(24	h)
(240)III-			tractiver							0	0	0	J	(2 -	2)
C) II	if (22b)n	n < 0.5 >	(23b), t	hen (24	c) = (23b)); other	wise (24	c) = (22t	butside b) m + 0.	.5 × (23b)				
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24	c)
d) If	natural if (22b)n	ventilati n = 1, th	on or wh en (24d)	ole hous m = (22l	se positiv c)m othe	/e input erwise (2	ventilatio 4d)m =	on from 0.5 + [(2	oft 2b)m² x	0.5]					
(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24	d)
Effe	ctive air	change	rate - er	nter (24a) or (24t	o) or (24	c) or (24	d) in bo	x (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 He	at losse	s and he	aat loes r	haramet	≏r.								-		
		Gro	2011033	Onenin		Not Ar	22	LI-val		ΔΧΠ		k-value	2	ΔXk	
		area	(m²)	n	93 1 ²	A,r	n²	W/m2	?K	(W/I	<)	kJ/m ² ·	ĸ	kJ/K	
Doors						2.1	x	1.4	=	2.94				(26)
Windo	ws Type	e 1				2.46	x1.	/[1/(1.4)+	0.04] =	3.26				(27)
Windo	ws Type	2				2.46	x1.	/[1/(1.4)+	0.04] =	3.26				(27)
Windo	ws Type	93				7.85	x1.	/[1/(1.4)+	0.04] =	10.41				(27)
Walls	Type1	36.7	72	12.7	7	23.95	5 X	0.2	=	4.79				(29)
Walls	Type2	4.9	8	2.1		2.88	x	0.2	=	0.58	ז ר		$\exists $	(29)
Walls	Туре3	20.4	45	0		20.45	5 X	0.2		4.09	i F		7 7	(29)
Walls	Type4	10.0)5	0		10.05	5 X	0.2		2.01	i T		- -	(29)
Total a	area of e	lements	, m²			72.2		L						(31)
Party	wall					16.18	3 X	0		0				(32	.)
* for wir ** includ	ndows and de the area	roof wind as on both	ows, use e sides of ir	ffective wi	ndow U-va Is and part	alue calcul titions	ated using	formula 1	/[(1/U-valu	ıe)+0.04] a	ns given in	paragraph	n 3.2		
Fabric	heat los	s, W/K	= S (A x	U)				(26)(30)) + (32) =				31.3	34 (33)
Heat o	capacity	Cm = S	(Axk)						((28).	(30) + (32	2) + (32a).	(32e) =	0	(34)
Therm	nal mass	parame	eter (TMF	P = Cm -	- TFA) ir	n kJ/m²K			Indica	tive Value:	Medium		250) (35)
For des can be	ign assess used inste	sments wh ad of a de	ere the de tailed calci	tails of the ulation.	construct	ion are noi	t known pr	recisely the	e indicative	e values of	TMP in Ta	able 1f			
Therm	nal bridge	es : S (L	x Y) cal	culated	using Ap	pendix l	<						10.7	'9 <mark>(36</mark>)
if details	s of therma	al bridging	are not kn	own (36) =	= 0.05 x (3	1)									
Total f	abric he	at loss							(33) +	(36) =			42.1	2 (37)
Ventila	ation hea	at loss c	alculatec	monthl	y I		r		(38)m	= 0.33 × (25)m x (5))	1		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	J		

(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 tr	ansfer c	coefficier	nt, W/K						(39)m	= (37) + (3	38)m	<u> </u>		
(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 Ic	ss para	meter (H	HLP), W/	/m²K				0.07	(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	0.80	
Numbe	er of day	rs in moi	nth (Tab	le 1a)					,	Average =	Sum(40)1	12 / 12=	0.09	(40)
	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. Wa	iter heat	ing ene	rgy requi	irement:								kWh/ye	ear:	
Accum	od occu		N											(40)
if TF	A > 13.9	9, N = 1	+ 1.76 x	[1 - exp	(-0.0003	849 x (TF	- A -13.9)2)] + 0.0	0013 x (⁻	TFA -13.	.9) <u>2.</u>	.04		(42)
if TF	A £ 13.9	9, N = 1						(· · ·						
Annua Reduce	l averag the annua	e hot wa al average	ater usag hot water	ge in litre usage by	es per da 5% if the d	ay Vd,av Iwelling is	erage = designed t	(25 x N) to achieve	+ 36 a water us	se target o	62 f	2.59		(43)
not more	e that 125	litres per j	person pei	r day (all w	ater use, l	hot and co	ld)			0				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage il	n litres per	day for ea	ach month	Vd,m = fa	ctor from T	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		
-						100		T (000)	-	Total = Su	m(44) ₁₁₂ =	=	991.11	(44)
Energy o	content of	not water	usea - cai I	culated mo I	ontniy = 4. I	190 x Va,r I	n x nm x L I	1 m / 3600) kvvn/mor I	nth (see Ta	adies 1d, 1 I	c, 1a)		
(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		
lf instant	aneous w	ater heatii	ng at point	of use (no	o hot water	^r storage),	enter 0 in	boxes (46) to (61)	l otal = Su	m(45) ₁₁₂ =	= [1299.5	(45)
(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:												
Storag	e volum	e (litres)	includir	ng any so	olar or W	/WHRS	storage	within sa	ame ves	sel		0		(47)
If comr	nunity h	eating a	ind no ta	nk in dw	velling, e	nter 110	litres in	(47)						
Otherw	ise if no	o stored	hot wate	er (this in	icludes i	nstantar	neous co	mbi boil	ers) ente	er '0' in (47)			
a) If m	anufact	urer's de	eclared I	oss facto	or is kno	wn (kWł	n/dav):					0		(48)
Tempe	rature fa	actor fro	m Table	2b		,	27					0		(49)
Energy	lost fro	m water	· storage	, kWh/ye	ear			(48) x (49)) =		1	10		(50)
b) If m	anufact	urer's de	eclared o	cylinder l	oss fact	or is not	known:				L			
Hot wa	ter stora	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ıy)				0.	.02		(51)
Volume	nunity n e factor	from Ta	ble 2a	on 4.3							1	03		(52)
Tempe	rature fa	actor fro	m Table	2b							0	.03 .6		(53)
Energy	lost fro	m water	· storage	, kWh/ye	ear			(47) x (51)) x (52) x (53) =	1.	.03		(54)
Enter	(50) or ((54) in (5	55)								1.	.03		(55)
Water	storage	loss cal	culated f	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 cylinde	er contains	dedicate	d solar sto	rage, (57)	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Appendi	ix 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)

Primar	y circuit	loss (ar	nual) fro	om Table	e 3							0		(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(moo	dified by	/ factor fi	rom Tab	le H5 if t	here is s	olar wat	er heati	ng and a	cylinde	r thermo	stat)			
(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 ca	lculated	for each	month ((61)m =	(60) ÷ 36	65 × (41)m						
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat req	uired for	water h	eating ca	alculated	for eacl	n 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 DH	W input	calculated	using App	endix G or	Appendix	H (negati	ve quantity	y) (enter '0	if no sola	r contribut	ion to wate	er heating)	I	
(add a	dditiona	l lines if	FGHRS	and/or \	WWHRS	applies	, see Ap	pendix C	G)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from w	ater hea	ter	•				•						
(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		
			1					Outp	ut from w	ater heate	r (annual)₁	12	1950.34	(64)
Heat q	ains fro	m water	heating	. kWh/m	onth 0.2	5 ´ [0.85	× (45)m	n + (61)m	n] + 0.8 x	(46)m	+ (57)m	+ (59)m	1	-
(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)
inclu	de (57)	n m in calo	culation	L of (65)m	only if c	vlinder i	s in the a	dwelling	nr hot w	ı ater is fr	om com	ı munitv h	eating	
5 Int				and 5a	\.	ymraer k	5 11 110 0	awoning	or not w		on com	indincy i	louing	
J. III	ernar ya	anis (see).									
Metabo	olic gair	IS (Table	<u>5), Wat</u>	ts Apr	Mov	lup	lul	Aug	Son	Oct	Nov	Dee	l	
(66)m	Jan		101.00	Api	101.00	JUN	JUI	Aug			101.00	101.99		(66)
(00)11=	. 101.86	/ 101.88	101.00	101.88	101.00	101.00	101.00	101.88	101.00	101.00	101.00	101.88		(00)
Lightin	g gains		ted in Ap	opendix	L, equat	ION L9 OI	r L9a), a	lso see	l able 5		45.0	40.04	I	(07)
(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)
Applia	nces ga	ins (calc	ulated ir	n Append	dix L, eq	uation L	13 or L1	3a), alsc	see Ta	ble 5	i	1	I	()
(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)
Cookin	ig gains	(calcula	ted in A	ppendix	L, equat	ion L15	or L15a)), also se	e 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 fa	ns gains	(Table \$	5a)	-			_	-		-			
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0		(70)
Losses	s e.g. ev	vaporatio	on (nega	tive valu	es) (Tab	le 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 (T	able 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 i	nternal	qains =				(66)	m + (67)m	י 1 + (68)m +	⊦ (69)m + i	(70)m + (7	1)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. <u>So</u>	lar gains	S:		1								I		
Solar g	ains are o	calculated	using sola	r flux from	Table 6a	and assoc	ated equa	ations to co	onvert to th	e applicat	le orientat	ion.		
Orienta	ation: /	Access F	actor	Area		Flu	X	-	g_	Ŧ	FF		Gains	

•	Table 6d		m²		Table 6a		Table 6b		Table 6c		(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)

Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	1	1.28	x	0.5	x	0.8		=	24.55	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	2.97	x	0.5	×	0.8		=	15.66	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	2.97	x	0.5	x	0.8	\neg	=	15.66	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	2	2.97	x	0.5	x	0.8	_	=	49.98	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	x	0.5	x	0.8		=	28.22	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	4	1.38	×	0.5	x	0.8	一	=	28.22	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	4	1.38	x	0.5	x	0.8	_	=	90.04	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	6	7.96	x	0.5	×	0.8	\neg	=	46.34	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	6	7.96	x	0.5	x	0.8	\neg	=	46.34	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	6	7.96	x	0.5	x	0.8		=	147.87	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	1.35	x	0.5	x	0.8		=	62.29	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	1.35	x	0.5	x	0.8		=	62.29	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	9	1.35	x	0.5	x	0.8		=	198.77	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	7.38	x	0.5	x	0.8		= [66.41	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	7.38	x	0.5	x	0.8		= [66.41	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	9	7.38	x	0.5	x	0.8		=	211.91	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	Ģ	91.1	x	0.5	x	0.8		=	62.12	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	Ģ	91.1	x	0.5	x	0.8		=	62.12	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	Ģ	91.1	x	0.5	x	0.8		= [198.24	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	2.63	x	0.5	x	0.8		=	49.53	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	7	2.63	x	0.5	x	0.8		=	49.53	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	7	2.63	x	0.5	x	0.8		=	158.04	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	5	0.42	x	0.5	x	0.8		= [34.38	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	5	0.42	x	0.5	x	0.8		= [34.38	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	5	0.42	x	0.5	x	0.8		= [109.72	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	8.07	x	0.5	x	0.8		= [19.14	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	2	8.07	x	0.5	x	0.8		=	19.14	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	2	8.07	x	0.5	x	0.8		=	61.07	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x		14.2	x	0.5	x	0.8		=	9.68	(81)
Northwe	est <mark>0.9</mark> x	0.77		x	2.4	6	x		14.2	x	0.5	x	0.8		=	9.68	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x		14.2	x	0.5	x	0.8		=	30.89	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	9.21	x	0.5	x	0.8		= [6.28	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	2.4	6	x	9	9.21	x	0.5	x	0.8		= [6.28	(81)
Northwe	est <mark>0.9x</mark>	0.77		x	7.8	5	x	ę	9.21	x	0.5	x	0.8		=	20.05	(81)
Solar g	ains in	watts, ca	alcula	ted	for each	n mont	h	44.70	000.40	(83)m	= Sum(74)m .	(82)m	50.05				(02)
(83)m=	39.94 aine – i	81.3	146.4	4/ Jar	240.55 (84)m -	323.35	$\frac{3}{3}$	44.73 83)m	322.48 watte	257	.09 178.48	99.35	50.25	32.	.62		(63)
(84)m-	406.98	446.5	500 4	13	576.43	641.04		44 73	610.89	550	78 481 37	420 5	392.4	390	35		(84)
	+00.00		L 300.2		0.0.40	541.04	. 1 .	14.15	010.03						,		
7. Me	an inter	mal temp	peratu	ire (neating	Seaso	n) ~	orea	rom Tel						ſ	24	
i emp		ouring r		y pe			/ing m /c			JIE 9,	нн (°С)					21	(85)
UtillSa		LIOP TOP G				a, n1,i	n (S ,		ые эа)	<u>۸</u>		0~	Nov				
	Jali			21	лμ	ivia	′	Juli	Jui		ug l Seb						

(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)
Mear	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	in Table	e 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)
Temp	erature	during h	eating p	eriods ir	n rest of	dwelling	from Ta	ble 9, Tl	h2 (°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)
Utilis	ation fac	tor for g	ains for	rest of d	welling,	h2,m (se	e 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)
Mear	interna	l temper	ature in	the rest	of dwelli	ng T2 (f	ollow ste	eps 3 to 7	7 in Tabl	e 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)
			_			-			f	iLA = Livin	g area ÷ (4	4) =	0.41	(91)
Mear	interna	l temper	ature (fo	or the wh	ole dwe	lling) = fl	LA × T1	+ (1 – fL	.A) × 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	adjustn	nent to tl	he mear	internal	temper	ature fro	m Table	4e, whe	ere appro	opriate				
(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. Sp	ace hea	ting requ	uirement							· T ' · · · · /·	70)		1	
the u	i to the r tilisation	nean int factor fo	ernal ter or gains	mperatur using Ta	re obtain Ible 9a	ied at ste	ep 11 of	l able 9	o, so tha	t II,m=(76)m and	d re-calc	ulate	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilis	ation fac	tor for g	ains, 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)
Usefu	ul gains,	hmGm ,	W = (94	4)m x (84	4)m	i	i		·	·				
(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)
Mont	hly avera	age exte	rnal tem		e from 1a		16.6	16.4	14.1	10.6	71	12		(96)
Heat	4.3	for me	o.s an intern	o.9		lm W-	-[(39)m ·	v [(93)m	_ (96)m	1	7.1	4.2		(00)
(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)
Spac	e heatin	g require	ement fo	r each m	L nonth, k\	I Nh/moni	h = 0.02	24 x [(97]	ı)m – (95)m] x (4′	1)m			
(98)m=	335.68	259.65	197.82	80.67	17.48	0	0	0	0	100.19	227.43	343.62		
								Tota	l per year	(kWh/year) = Sum(9	8)15,912 =	1562.55	(98)
Spac	e heatin	g require	ement in	kWh/m²	/year								25.2	(99)
9b. En	ergy rec	luiremer	nts – Cor	mmunity	heating	scheme)					L		1
This p	art is use	ed for sp	ace hea	ting, spa	ace cooli	ing or wa	ater heat	ing prov	ided by	a comm	unity sch	neme.		
Fractio	on of spa	ace heat	from se	condary/	/supplen	nentary l	heating (Table 1	1) '0' if n	one			0	(301)
Fractio	on of spa	ace heat	from co	mmunity	y system	1 – (30′	1) =						1	(302)
The con	nmunity so	heme may	y obtain he	eat from se	everal sour	rces. The p	procedure	allows for	CHP and u	up to four o	other heat	sources; tł	ne latter	-
Fractio	on of hea	at from C	commun	ity boiler	'S	rom power	r stations.	See Appel	iuix C.			[1	(303a)
Fractio	on of tota	al space	heat fro	m Comn	nunity bo	oilers				(3	02) x (303a	a) =	1	(304a)
Factor	for cont	rol and o	charging	method	(Table 4	4c(3)) fo	r commu	unity hea	ating sys	tem		[1	(305)
Distrib	ution los	s factor	(Table 1	I2c) for c	commun	ity heatii	ng syste	m				[1.05	(306)
Space	heating	9										ľ	kWh/year	
Annua	l space	heating	requiren	nent								[1562.55]

Space heat from Community boilers		(98) x (304a) x	(305) x (306) =	164	0.68	(307a)
Efficiency of secondary/supplementary	heating system in % (fro	om Table 4a or Appen	dix E)	()	(308
Space heating requirement from second	dary/supplementary sys	tem (98) x (301) x 1	00 ÷ (308) =	()	(309)
Water heating						
Annual water heating requirement				1950	0.34	
If DHW from community scheme: Water heat from Community boilers		(64) x (303a) x	(305) x (306) =	204	7.86	(310a)
Electricity used for heat distribution		0.01 × [(307a)(307	e) + (310a)(310e)] =	36.	.89	(313)
Cooling System Energy Efficiency Ratio)			()	(314)
Space cooling (if there is a fixed cooling	system, if not enter 0)	= (107) ÷ (314)	=	()	(315)
Electricity for pumps and fans within dw mechanical ventilation - balanced, extra	elling (Table 4f): ct or positive input from	outside		122	2.18	(330a)
warm air heating system fans				()	(330b)
pump for solar water heating				()	(330g)
Total electricity for the above, kWh/year		=(330a) + (330	b) + (330g) =	122		(331)
Energy for lighting (calculated in Appen	dix L)			280).19	(332)
12b. CO2 Emissions – Community heat	ing scheme					
		Energy kWb/year	Emission factor	Emissio	ons /vear	
	veter hereting (and OUD)	KWW year	kg 002/km		ycai	
Efficiency of heat source 1 (%)	If there is CHP usin	g two fuels repeat (363) to	(366) for the second fue	el	95	(367a)
CO2 associated with heat source 1	[(307b)+	-(310b)] x 100 ÷ (367b) x	0.22	- 83	38.66	(367)
Electrical energy for heat distribution		[(313) x	0.52	= 19	9.14	(372)
Total CO2 associated with community s	ystems	(363)(366) + (368)(372	2)	= 8	57.8	(373)
CO2 associated with space heating (se	condary)	(309) x	0	-	0	(374)
CO2 associated with water from immers	sion heater or instantant	eous heater (312) x	0.52	=	0	(375)
Total CO2 associated with space and w	ater heating	(373) + (374) + (375) =		8	57.8	(376)
CO2 associated with electricity for pum	os and fans within dwell	ing (331)) x	0.52	= 6	3.41	(378)
CO2 associated with electricity for lighti	ng	(332))) x	0.52	= 14	15.42	(379)
Total CO2, kg/year	sum of (376)(382) =			10	66.63	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =			1	7.2	(384)
El rating (section 14)				8	6.64	(385)

User Details	
Assessor Name:Chris ArmstrongStroSoftware Name:Stroma FSAP 2012Soft	ma Number:STRO002044ware Version:Version: 1.0.4.16
Property Addre	ss: A 406
Address : Top Medium	
1. Overall dwelling dimensions:	
Ground floor 62	Av. Height(m) Volume(m ³) (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:	
Number of chimneys	= 0 x40 = 0 (6a)
Number of open flues 0 + 0 + 0	$=$ 0 $\times 20 =$ 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 = $(6a)+(6b)+(7a)+(7b)+(7c) =$	$0 \div (5) = 0 (8)$
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise	se continue from (9) to (16)
Number of storeys in the dwelling (ns)	
Additional inititation	[(9)-1]x0.1 = 0 (10)
if both types of wall are present, use the value corresponding to the greater wall deducting areas of openings); if equal user 0.35	area (after
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), els	se 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 -	$0.2 \times (14) \div 100] = 0$ (15)
Infiltration rate (8) + (1	0) + (11) + (12) + (13) + (15) = 0 (16)
Air permeability value, q50, expressed in cubic metres per hour pe	r square metre of envelope area 3 (17)
If based on air permeability value, then $(18) = [(17) \div 20] + (8)$, otherwise (18)	= (16) 0.15 (18)
Number of sides sheltered	
Shelter factor (20) =	$1 - [0.075 \times (19)] = 0.85$ (20)
Infiltration rate incorporating shelter factor (21) =	$(18) \times (20) = 0.13$ (21)
Infiltration rate modified for monthly wind speed	
Jan Feb Mar Apr May Jun Jul Au	g 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 \div 4	
(22a)m= 1.27 1.25 1.23 1.1 1.08 0.95 0.95 0.92	2 1 1.08 1.12 1.18

Adjust	ed infiltr	ation rat	te (allowi	ng for sł	nelter an	d wind s	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		
Calcul	ate effe	ctive air	change	rate for t	he appli	cable ca	ise					г		
lf exh	aust air h	eat numn	using App	endix N (2	(23a) = (23a	a) x Emv (e	equation (I	N5)) othe	rwise (23h	(23a) = (23a)		L	0.5	(23a)
lf bal	anced with	n heat rec	overv: effic	iencv in %	allowing f	for in-use f	actor (fron	n Table 4h) =) = (200)		L	0.5	
a) If	balance	nd moch		ntilation	with ho	ot rocov			$(2)^{-1}$	2h)m i (22h) v [/	_ ۱ (22م)	76.5 • 1001	(230)
a) 11 (24a)m-				0.26	0.25				a) = (2)	0.25	0.26	1 - (230)	÷ 100]	(24a)
(2-10)11-	balance				without	hoat roo		(1)/) (24k	$\int_{-\infty}^{\infty} - (2^{2})$	$\frac{1}{2}$	23b)	0.27		(=)
(24b)m=											230)	0		(24b)
c) If	whole h		tract ver	tilation of	n nositiv		l ventilatio	n from (, î	<u> </u>			· · ·
0) 11	if (22b)n	n < 0.5 x	< (23b), 1	then (24	c) = (23k)	b); other	wise (24	c) = (22	m + 0	.5 × (23t))			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural	ventilati	on or wh	ole hous	e positiv	ve input	ventilatio	on from	loft	1				
Í	if (22b)n	n = 1, th	en (24d)	m = (22	o)m othe	erwise (2	24d)m =	0.5 + [(2	2b)m² x	0.5]				
(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24d)
Effe	ctive air	change	rate - er	nter (24a) or (24b	o) or (24	c) or (24	d) in bo	x (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. He	at losse	s and he	eat loss	paramete	er:									
ELEN	IENT	Gro	SS	Openin	gs	Net Ar	ea	U-val	ue	ΑXU		k-value		A X k
		area	(m²)	m	1 ²	A ,r	m²	W/m2	2K	(W/	K)	kJ/m²∙K		kJ/K
Doors						2.1	×	1.4	=	2.94				(26)
Windo	ws Type	91				2.46	x1	/[1/(1.4)+	0.04] =	3.26				(27)
Windo	ws Type	e 2				7.85	x1	/[1/(1.4)+	0.04] =	10.41				(27)
Windo	ws Type	e 3				2.46	x1	/[1/(1.4)+	0.04] =	3.26				(27)
Walls 7	Type1	44.9	94	12.7	7	32.17	7 X	0.2	=	6.43				(29)
Walls 7	Type2	5.2	2	2.1		3.12	x	0.2	=	0.62				(29)
Walls 7	ТуреЗ	21.3	39	0		21.39	e x	0.2	=	4.28				(29)
Walls	Type4	10.5	51	0		10.5	1 X	0.2	=	2.1	ו ר			(29)
Roof		62.3	34	0		62.34	4 X	0.2	=	12.47	ו ר		ī —	(30)
Total a	area of e	elements	s, m²			144.4	4							(31)
Party v	wall					10.4	1 X	0	=	0				(32)
* for win	dows and	roof wind	lows, use e	effective wi	ndow U-va	alue calcui	lated using	formula 1	/[(1/U-valu	ue)+0.04] a	as given in	paragraph	3.2	
** inclua	le the area	as on both	sides of ir	nternal wal	ls and par	titions						-		
Fabric	heat los	ss, W/K	= S (A x	U)				(26)(30) + (32) =			Ļ	45.78	(33)
Heat c	apacity	Cm = S	(Axk)				_		((28).	(30) + (3	2) + (32a).	(32e) =	0	(34)
Therm	al mass	parame	eter (TMF	^D = Cm ÷	- TFA) ir	ו kJ/m²K			Indica	ative Value	: Medium	L	250	(35)
For desi can be u	ign assess used inste	sments wh ad of a de	nere the de etailed calc	tails of the ulation.	construct	ion are no	t known pi	recisely the	e indicative	e values of	TMP in Ta	able 1f		
Therm	al bridg	es : S (L	. x Y) cal	culated u	using Ap	pendix l	K					Γ	14.51	(36)
if details	of therma	al bridging	are not kr	nown (36) =	= 0.05 x (3	1)			(00)	(20)		- -		
	abiic ne	atioss							(33) +	= (30) =		L	60.28	(37)

Ventila	tion hea	at loss ca	alculated	d monthl	у				(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 tr	ansfer c	coefficie	nt, W/K						(39)m	= (37) + (3	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		
Heat lo	oss nara	meter (H	HP) W	/m²K					(40)m	Average = = (39)m ÷	Sum(39) _{1.}	12 /12=	73.95	(39)
(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)
Numbe	er of day	rs in mo	nth (Tab	ole 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. Wa	ater heat	ing ene	rgy requ	irement:								kWh/ye	ear:	
A			NI											(10)
if TF	A > 13.9	ipancy, i 9, N = 1	N + 1.76 >	([1 - exp	(-0.0003	849 x (TF	- A -13.9)2)] + 0.() 013 x (⁻	TFA -13.	<u>2.</u> .9)	04		(42)
if TF	A £ 13.9	9, N = 1			(- (, ,,	(- /			
Annua	l averag	e hot wa	ater usa	ge in litre	es per da	ay Vd,av	erage =	(25 x N)	+ 36	a targat a	82	.59		(43)
not more	e that 125	litres per	person pe	r day (all w	/ater use, l	hot and co	ld)	lo acriieve	a waler ut	se largel o	1			
	lan	Eab	Mor	Apr	May	lun		Δυα	Son	Oct	Nov	Dec		
Hot wate	er usage in	n litres per	day for e	Api ach month	Vd,m = fa	ctor from T	Table 1c x	(43)	Sep		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		
(++)11-	50.00	07.00	04.24	00.04	11.04	74.00	74.00	//.04		Total – Su	m(44),	50.00	991 11	(44)
Energy	content of	hot water	used - ca	lculated m	onthly = 4.	190 x Vd,r	m x nm x E	OTm / 3600) kWh/mor	nth (see Ta	ables 1b, 1	c, 1d)	001111	
(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		_
lf instan	taneous w	ater heati	na at poin	t of use (no	o hot wate	r storage).	enter 0 in	boxes (46) to (61)	Total = Su	m(45) ₁₁₂ =	-	1299.5	(45)
(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:	10.24	13.3	10.20	15.17	12.2	14	14.17	10.51	10.02	19.57		(40)
Storag	e volum	e (litres)	includii	ng any s	olar or W	/WHRS	storage	within sa	ame ves	sel		0		(47)
If com	munity h	eating a	ind no ta	ank in dw	velling, e	nter 110) litres in	(47)						
Otherv	vise if no	stored	hot wate	er (this ir	ncludes i	nstantar	neous co	ombi boil	ers) ente	er '0' in (47)			
Water	storage	loss: uror'o de	alarad	laga faat	or io kno		dov)							(40)
a) II II Tamma						wii (Kvvi	i/uay).					0		(48)
rempe –		actor Iro	m radie					(10) (10)				0		(49)
Energy b) If m	/ lost fro hanufact	m water urer's de	storage	e, KVVh/y cylinder	ear Ioss fact	or is not	known:	(48) x (49)) =		1	10		(50)
Hot wa	ater stora	age loss	factor f	rom Tab	le 2 (kW	h/litre/da	ay)				0.	02		(51)
If com	munity h	eating s	ee secti	on 4.3	,		• /					-		
Volum	e factor	from Ta	ble 2a								1.	03		(52)
Tempe	erature fa	actor fro	m Table	e 2b							0	.6		(53)
Energy	/ lost fro	m water	storage	e, kWh/y	ear			(47) x (51)) x (52) x (53) =	1.	03		(54)
Enter	(50) or (54) in (5	55)								1.	03		(55)
Water	storage	loss cal	culated	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 cylinde	er contair	ns dedicated	d solar sto	rage, (57)r	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	ix 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)
Primar	y circui	t loss (an	inual) fro	om Table	93							0		(58)
Primar	y circui	t loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(moo	dified b	y factor fr	om Tab	le H5 if t	here is s	solar wat	er heatii	ng and a	cylinde	r thermo	stat)			
(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 ca	alculated	for each	month ((61)m =	(60) ÷ 36	65 × (41))m						
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat rec	uired for	water he	eating ca	alculated	for eacl	n 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 DH	-IW input	calculated	using App	endix G or	Appendix	H (negati	ve quantity	/) (enter '0	' if no sola	r contribut	on to wate	r heating)		
(add a	dditiona	al lines if	FGHRS	and/or V	WWHRS	applies	, see Ap	pendix C	G)					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from v	vater hea	ter											
(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		
								Outp	out from w	ater heate	r (annual)	12	1950.34	(64)
Heat g	ains fro	om water	heating,	kWh/mo	onth 0.2	5 ´ [0.85	× (45)m	+ (61)m	n] + 0.8 x	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)
inclu	ide (57)m in calc	culation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	vater is fr	om com	munity h	eating	
5. Int	ernal g	ains (see	Table 5	and 5a):									
Metab	olic dai	ns (Table	5) Wat	ts										
motab	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)
Lightin	g gains	(calculat	ted in Ar	pendix l	L, equat	ion L9 oi	r L9a), a	lso 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)
Applia	nces ga	ains (calc	ulated ir	Append	dix L, eq	uation L	13 or L1	3a), also	see Ta	ble 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)
Cookir	na aain:	s (calcula	ted in A	ppendix	L. equat	tion L15	or L15a), also se	e Table					
(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 fa	ins dains	(Table 5	шшы Ба)						I				
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0		(70)
Losses	se.a. e	vaporatio	n (nega	tive valu	es) (Tab	l le 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	L heating	L anins (T	able 5)							I				
(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 i	nterna	L gains –				(66)	m + (67)m) + (68)m +	- (69)m +	(70)m + (7	1)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. So	lar gain	S:												x = /
Solar o	ains are	calculated	using sola	r flux from	Table 6a	and associ	ated equa	tions to co	nvert to th	ne applicab	le orientat	ion.		
Orienta	ation:	Access F	actor	Area		Flu	X		g_		FF		Gains	
		Table 6d		m²		Tal	ole 6a	Т	able 6b	Та	able 6c		(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	×	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	×	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	×	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	×	0.5	x	0.8	=	46.34	(81)
Northwest 0.9x	0.77	x	7.85	x	67.96	×	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	×	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	×	0.5	x	0.8	=	62.29	(81)
Northwest 0.9x	0.77	x	2.46	x	97.38	×	0.5	x	0.8	=	66.41	(81)
Northwest 0.9x	0.77	x	7.85	x	97.38	×	0.5	x	0.8	=	211.91	(81)
Northwest 0.9x	0.77	x	2.46	×	97.38	×	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	×	9.21	×	0.5	x	0.8	=	6.28	(81)
Northwest 0.9x	0.77	x	7.85	x	9.21	×	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 $(83)m = Sum(74)m \dots (82)m$														
(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	(1	83)
Total g	ains – ii	nternal a	ind 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	(1	84)
7. Me	an inter	nal temp	erature	(heating	season)								
Temp	erature	during h	eating p	eriods ir	n the livir	ng area f	from Tab	ole 9, Th	1 (°C)				21 (85)
Utilisation factor for gains for living area, h1,m (see Table 9a)														
Stroma I	SAP 201	2 version:	1.0.4.96	SAP 9.52	- http://ww	vw.stroma	.comul	Aug	Sep	Oct	Nov	Dec	Page 5 of	7

(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	interna	l tempera	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 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)
Temp	erature	during h	eating p	periods ir	n rest of	dwelling	from Ta	able 9, Tl	h2 (°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)
Utilisa	ation fac	tor for g	ains for	rest of d	welling,	h2,m (se	e 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	interna	l tempera	ature in	the rest	of dwelli	ng T2 (f	ollow ste	eps 3 to 7	7 in Tabl	e 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)
									f	iLA = Livin	g area ÷ (4	4) =	0.41	(91)
Mean	interna	l tempera	ature (fo	or the wh	ole dwe	lling) = f	LA x T1	+ (1 – fL	.A) × 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	adjustn	nent to th	ne mear	n internal	temper	ature fro	m Table	4e, whe	ere appro	opriate				
(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. Sp	ace hea	ting requ	uirement	t										
Set T	i to the r ilisation	mean int	ernal ter	mperatur	e obtair	ned at st	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
ine ui	lan	Feb	Mar		Mav	lun		Διια	Sen	Oct	Nov	Dec		
Utilisa	ation fac	tor for a	ains. hm	<u>יקר ן</u> ו:	Iviay	Jun		Aug			1100	Dee		
(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)
Usefu	l gains,	hmGm ,	W = (94	4)m x (84	4)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)
Month	nly aver	age exte	rnal tem	perature	e from Ta	able 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	e for mea	an intern	al tempe	erature,	Lm,W:	=[(39)m	x [(93)m I	– (96)m]				(07)
(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	e heatin	g require		or each m	1000000000000000000000000000000000000	/Vh/mon I	th = 0.02	24 x [(97)m – (95 I)m] x (4 202.42	1)m	520.07		
(90)11=	512.05	415.55	349.09	192.11	74.1	0	0	Tota		203.43	300.40	520.97	2634 54	(98)
0								TOLA	ii per year	(KWII/yeai) – Sum(3	0/15,912 -		
Space	e neatin	g require	ement in	KVVN/M ²	/year							l	42.49	(99)
9b. En	ergy rec	quiremen	its – Cor	mmunity	heating	scheme	;							
This pa Fractio	art is use on of spa	ed for sp ace heat	ace hea from se	ating, spa condarv/	ace cool /supplen	ing or wa nentary	ater heat heating (ting prov (Table 1 ⁻	rided by : 1) '0' if n	a comm one	unity sch	ieme.	0	(301)
Fractio	n of one		from co	mmunity	exetom	1 (20)	1)_	(., •			l I]`´´´
		ice neat			system	т — (30	1) —	- 11			- (((302)
includes	munity so boilers, h	cheme may leat pumps	/ obtain he s, geotheri	eat from se mal and wa	everal soul aste heat f	rces. The j rom powe	r stations.	allows for See Appel	CHP and I ndix C.	up to four (other heat	sources; tr	ie latter	
Fractio	on of hea	at from C	Commun	ity boiler	S								1	(303a)
Fractio	on of tota	al space	heat fro	m Comn	nunity bo	oilers				(3	02) x (303	a) =	1	(304a)
Factor	for cont	rol and o	charging) method	(Table	4c(3)) fo	r comm	unity hea	ating sys	tem		[1	(305)
Distrib	ution los	s factor	(Table 1	12c) for c	commun	ity heati	ng syste	m				[1.05	(306)
Space	heating	g										L	kWh/year	1
Annua	l space	heating I	requiren	nent									2634.54]
												L		-

Space heat from Community boilers		(98) x (304a) x	(305) x (306) =		2766.27	(307a)
Efficiency of secondary/supplementary l	neating system in % (from Table 4a or Appen	idix E)		0	(308
Space heating requirement from second	ary/supplementary s	ystem (98) x (301) x 1	00 ÷ (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)(307	'e) + (310a)(310e)] =		48.14	(313)
Cooling System Energy Efficiency Ratio					0	(314)
Space cooling (if there is a fixed cooling	system, if not enter (D) = (107) ÷ (314)	=		0	(315)
Electricity for pumps and fans within dw mechanical ventilation - balanced, extra	elling (Table 4f): ct or positive input fro	om 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) + (330	b) + (330g) =	Γ	127.83	(331)
Energy for lighting (calculated in Append	dix L)				280.19	(332)
12b. CO2 Emissions – Community heat	ng scheme					
		Energy kWh/year	Emission factor kg CO2/kWh	r Er kg	missions g CO2/year	
CO2 from other sources of space and w Efficiency of heat source 1 (%)	ater heating (not CHI If there is CHP u	P) sing two fuels repeat (363) to	(366) for the second fu	iel	95	(367a)
CO2 associated with heat source 1	[(307	b)+(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 s	ystems	(363)(366) + (368)(372	2)	=	1119.57	(373)
CO2 associated with space heating (see	condary)	(309) x	0	=	0	(374)
CO2 associated with water from immers	ion heater or instanta	aneous heater (312) x	0.52	=	0	(375)
Total CO2 associated with space and w	ater heating	(373) + (374) + (375) =			1119.57	(376)
CO2 associated with electricity for pump	s and fans within dw	elling (331)) x	0.52	=	66.34	(378)
CO2 associated with electricity for lighting	ng	(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)
El rating (section 14)					83.33	(385)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Commercial Unit - Use Less Energy

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 CO₂ 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-Limit	Ua-Calc	Ui-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-Limit} = Limiting area-weighted average U-values [W/(m ² K)] U _{a-Calc} = Calculated area-weighted average U-values [W/(m ² K)] U _{i-Calc} = Calculated maximum individual element U-values [W/(m ² K)]				

* 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		
m³/(h.m²) at 50 Pa	10	3		

Shell and Core

As designed

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			
Whole building electric power factor achieved by power factor correction	<0.9		

1- Main system BASE

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(I/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
В	Zonal supply system where the fan is remote from the zone
С	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
н	Fan coil units
1	Zonal extract system where the fan is remote from the zone with grease filter

Zone name		SFP [W/(I/s)]							HP officiency			
	ID of system type	Α	В	С	D	Е	F	G	Н		HR efficiency	
	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	Lumino	us effic		
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?			
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 ² K]	0.56	0.43
Alpha value* [%]	13.2	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Energy Consumption by End Use [kWh/m²]

	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/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO₂ 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.

Building Use

% Area	a 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

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

CFT

- = Heating fuel type
 - = 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 і-Тур	Ui-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-Typ} = Typical individual element U-values [W/(m ² K)]			U _{i-Min} = Minimum individual element U-values [W/(m ² K)]			
* There might be more than one surface where the minimum U-value occurs.						

Air PermeabilityTypical valueThis buildingm³/(h.m²) at 50 Pa53

BRUKL Output Document

Compliance with England Building Regulations Part L 2013

Project name

Commercial Unit - With ASHP

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 CO₂ 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-Limit	Ua-Calc	Ui-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-Limit} = Limiting area-weighted average U-values [W	//(m²K)]					
Ui-calc = Calculated area-weighted average U-values [W/(m ² K)] Ui-calc = Calculated maximum individual element U-values [W/(m ² K)]						

Ua-Calc = Calculated area-weighted average 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
m³/(h.m²) at 50 Pa	10	3

HM Government

Shell and Core

As designed

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			
Whole building electric power factor achieved by power factor correction	<0.9		

1- Main system Actual

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(I/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
В	Zonal supply system where the fan is remote from the zone
С	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
н	Fan coil units
1	Zonal extract system where the fan is remote from the zone with grease filter

Zone name		SFP [W/(I/s)]										
	ID of system type	Α	В	С	D	Е	F	G	Н		пке	inciency
	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	Lumino	us effica		
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?				
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 ² K]	0.56	0.43
Alpha value* [%]	13.2	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Energy Consumption by End Use [kWh/m²]

	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/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO₂ 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.

Building Use

% Area	a 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

HVAC Systems Performance										
Sys	stem 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

HFT

CFT

- 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
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Building fabric

Element	U і-Тур	Ui-Min	Surface where the minimum value occurs*		
Wall	0.23	0.2	CM000000:Surf[9]		
Floor	0.2	0.15	CM000000:Surf[7]		
Roof		-	UNKNOWN		
Windows, roof windows, and rooflights		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		-	No High usage entrance doors in building		
U _{i-Typ} = Typical individual element U-values [W/(m ² K)]			U _{i-Min} = Minimum individual element U-values [W/(m ² K)]		
* There might be more than one surface where the minimum U-value occurs.					

Air PermeabilityTypical valueThis buildingm³/(h.m²) at 50 Pa53