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# Planning Statement Energy Assessment Ellerdale Road: Single Basement Scheme

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## Executive Summary Energy Assessment Ellerdale Road

#### About the Scheme:

The project consists of the new construction of a 2 storey dwelling at the rear of land at 1 Ellerdale Road in the London Borough of Camden, with one basement level and a small garden. The dwelling has a total Gross Internal Area of  $154 \, \text{m}^2$ .

#### **Planning Policy**

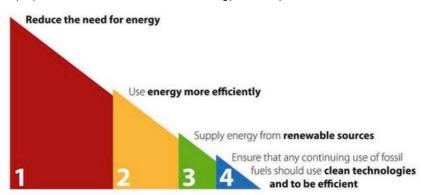
The scheme does not have to comply with the London Plan Policy based on the floor area, however the aspiration of the scheme is to achieve a 35% carbon reduction target (beyond Part L 2013) as set out in The London Plan Policy 5.2.

The scheme complies with the 2013 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

 New build (Part L1A) – The actual building CO<sub>2</sub> emissions rate (DER) is no greater than the notional building CO<sub>2</sub> target emissions rate.

#### The Energy Hierarchy:

The proposed scheme has followed the energy hierarchy that is illustrated below:



The resulting energy savings are shown below in accordance with the GLA's Energy Hierarchy:

GLA's Energy Hierarchy – Regulated Carbon Emissions						
Baseline: Be Lean: Be Clean: Be Green:						
CO <sub>2</sub> emissions (Tonnes CO <sub>2</sub> /yr)	2.51	2.46	-	1.49		
CO <sub>2</sub> emissions saving (Tonnes CO <sub>2</sub> /yr)	-	0.04	-	0.97		
Saving from each stage (%)	-	1.8	-	38.9		
Total CO <sub>2</sub> emissions saving (Tonnes CO <sub>2</sub> /yr)	1.02					

40.6% Total carbon emissions savings over Part L of the Building Regulations 2013 achieved

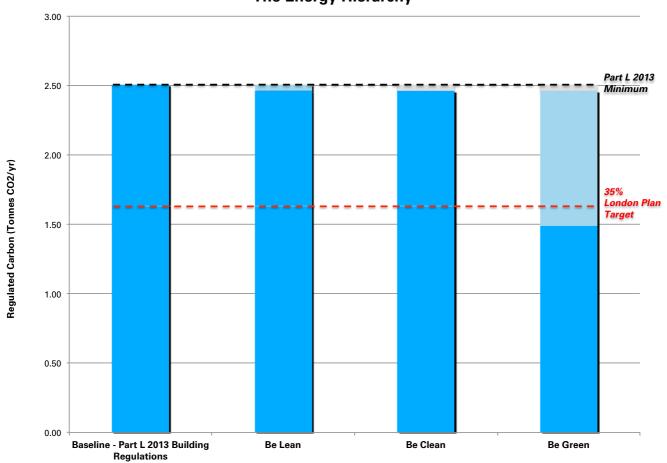
## Executive Summary Energy Assessment Ellerdale Road

GLA's Energy Hierarchy – Regulated Carbon Emissions:

A graphical illustration of how the scheme performs in relation to Building Regulations and the Energy Hierarchy is shown below.

Figure:

#### The Energy Hierarchy



Summary:

As demonstrated above the development will reduce carbon emissions by 1.8% from the fabric energy efficiency measures described in the 'Be Lean' section, and will reduce total carbon emissions by 40.6% over Building Regulations with the further inclusion of low and zero carbon technologies (PV panels).

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## **Executive Summary**

## Energy Assessment Ellerdale Road

#### **Shortfall in Emissions:**

As set out in Policy 5.2 of the London Plan, if the development fails to meet the 35% target, the annual shortfall is determined by subtracting the overall regulated carbon dioxide savings from the target savings. The result is then multiplied by the assumed lifetime of the development's services (e.g. 30 years) to give the cumulative shortfall. The cumulative shortfall is multiplied by the carbon dioxide off-set price to determine the required cash-in-lieu contribution, as shown below.

Carbon Dioxide Emissions – Regulated (Tonnes CO <sub>2</sub> /yr)					
	(Tonnes CO <sub>2</sub> /yr)	%			
Savings from 'Be Lean-After energy demand reduction	0.04	1.8%			
Savings from 'Be Clean-After CHP	0.00	0.0%			
Savings from 'Be Green-After renewable energy	0.97	38.9%			
Total Cumulative Savings	1.02	40.6%			
Total Target Savings	0.88	35%			
Annual Surplus	0.14				
	Annual Shortfall (Tonnes CO2/yr)	Cumulative Shortfall (Tonnes CO2)			
Shortfall	-	-			

#### Carbon offset contribution required: £0

#### **Total Carbon Emissions:**

As required by the GLA both the regulated and unregulated emissions of the development must be quantified and demonstrated. The total emissions for the scheme are shown below.

Carbon Dioxide Emissions – Regulated and Unregulated (Tonnes CO <sub>2</sub> /yr)							
Regulated Unregulated Tota Emissions Emissions Emissi							
Baseline: Part L 2013	2.51	1.42	3.93				
Be Lean: After demand reduction	2.46	1.42	3.88				
Be Clean: After CHP	-	-	-				
Be Green: After Renewable energy	1.49	1.42	2.91				

# Introduction Energy Assessment Ellerdale Road

#### Aim of this study:

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the development's design and evolution.

#### Methodology:

The methodology in this report follows the guidance set out by the Greater London Authority (GLA) for developing energy strategies as detailed in the document "ENERGY PLANNING: Greater London Authority guidance on preparing energy assessments (April 2014)"

This report has followed these documents and comprises the following components:

- BASELINE: A calculation of the Part L 2013 Building Regulations complaint CO<sub>2</sub> emission baseline using approved software. The baseline assumes a gas boiler would provide heating and any active cooling would be electrically powered.
- LEAN: A calculation of the impact of demand reduction measures. For example,
  passive design measures, including optimising orientation and site layout, natural
  ventilation and lighting, thermal mass and solar shading, and active design measures
  such as high efficacy lighting and efficient mechanical ventilation with heat recovery.
- COOLING HIERARCHY: in accordance with Policy 5.9 of London Plan, measures
  that are proposed to reduce the demand for cooling have been set out such as
  minimisation of solar and internal gains and night cooling strategies.
- CLEAN: in accordance with Policy 5.6 of London Plan, this report has demonstrated how the scheme has selected heating, cooling and power systems to minimise carbon emissions. This comprises an evaluation of the feasibility of connecting to existing low carbon heat networks, planned networks, site-wide and communal heat networks and CHP.
- GREEN: in accordance with Policy 5.7 of London Plan, this report has conducted a
  feasibility assessment of renewable energy technologies. This comprised a sitespecific analysis of the technologies and if applicable how they would be integrated
  into the heating and cooling strategy for the scheme.

Please note that these findings are currently subject to a detailed analysis from a building services design engineer and qualified quantity surveyor.

## Establishing Emissions: The Carbon Profile

### Energy Assessment Ellerdale Road

Building Regulations Part L 2013 Minimum Compliance:

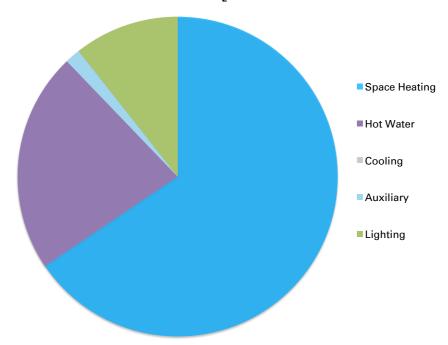
The 'baseline' carbon emissions for the development are 2.51 Tonnes  $\rm CO_2/yr.$ 

The pie chart below provides a breakdown of the scheme's baseline carbon emissions by system over the course of one year.

Carbon Emissions in Tonnes CO<sub>2</sub>/yr

Heating	Hot Water	Cooling	Auxiliary	Lighting
1.64	0.56	0.00	0.04	0.27

#### Baseline CO<sub>2</sub> Breakdown



Overview:

The chart above shows that space heating is the primary source of carbon emissions, and domestic hot water is the second largest, across the scheme as a whole.

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## 'Be Lean': Demand Reduction Measures Energy Assessment Ellerdale Road

Be Lean - Summary:

Demand reduction measures have reduced the scheme's carbon emissions by 1.8% over the minimum Part L 2013 Building Regulations baseline.

Site Layout Passive Design measures: The development is located at the rear of land at 1 Ellerdale Road and is protected by other developments on two sides. The compact shape of the dwelling means that the external area is minimised and consequently the heat losses through the building envelope are reduced. Windows (total glazing area is 27.4% of the external wall) are mainly placed towards the south (22.5%) to exploit the passive solar heat gains and reduce the heating demand. However, there are few openings that are placed towards the north (4.9%) in order to enable cross ventilation, resulting in more effective air change rate and reducing the overheating risk.

Building Fabric Passive Design measures:

Element	Minimum Building Regulations <sup>2</sup> U-value	Proposed U-value
	W/m²K	W/m²K
External Wall	0.30	0.18
Basement Wall	0.30	0.18
Ground Floor	0.25	0.11
Flat Roof	0.20	0.11
Glazing (window)	2.00	1.20
Glazing (rooflight)	2.00	1.20
Doors	2.00	1.20

#### Airtightness:

The target air permeability for the scheme has been modelled as 3 m³/(hr.m²) @ 50 pa.

This will require careful attention to two key areas:

- Structural leakage
- Services leakage

Structural leakage occurs at joints in the building fabric and around window and door openings, loft hatches and access openings. There will also be some diffusion through materials such and cracks in masonry walls typically this is caused by poor perpends in blockwork inner leafs. Structural leakage is hard to remedy retrospectively. Good detailing at the design stage is therefore essential.

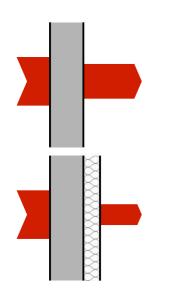
Services leakage occurs at penetrations from pipes and cables entering the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be telecommunication cables. Attention therefore, needs to be paid to sealing all penetrations during constriction.

#### Thermal Bridging:

The scheme has been indicatively modelled with the default thermal bridge y-values for all junction types, 0.15W/m²K.

#### Thermal Mass:

The thermal mass of the scheme has been indicatively modelled as 250 kJ/m<sup>2</sup>K (medium).

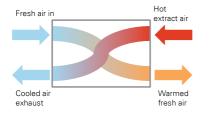


Graphic illustrations of the heat flow through a wall and how is it minimized with low uvalue (consequence of the additional insulation).



## 'Be Lean': Demand Reduction Measures Energy Assessment Ellerdale Road

#### Energy Efficient Services Active Design measures:



Graphic illustration of a heat recovery unit, which exploits the extract hot air of the room to heat the cold supply air.

#### Heating:

Heating will be provided by a gas boiler, featuring time and temperature zone control by suitable arrangement of plumbing and electrical services, delayed thermostat and a weather compensator. The heat will be distributed via radiators. The gas boiler will have a minimum efficiency of 89.5%.

#### Ventilation:

Balanced mechanical ventilation with heat recovery (90% efficiency) will be provided to dwellings and wet rooms with a specific fan power of 0.52 W/l/s.

#### Air Conditioning

Cooling will be provided to the principle four rooms by split systems, the systems will have an energy label class of A.

#### Lighting:

All lightings of the development have been specified to be high efficient.

## 'Be Clean': Heating Infrastructure & CHP

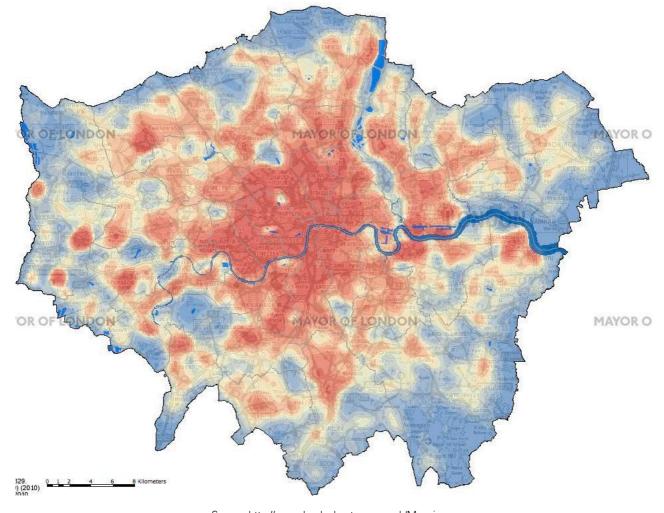
### Energy Assessment Ellerdale Road

Heating Infrastructure including CHP:

Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy 5.6B of London Plan. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

**Heating Infrastructure:** 

The London Heat Map (shown below) has been consulted to establish the possibility of connecting to heating infrastructure.



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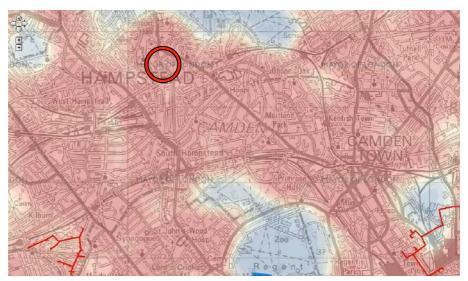
# 'Be Clean': Connection to Existing and Planned Networks

## Energy Assessment Ellerdale Road

**Existing and Planned Networks:** 

#### Existing networks:

A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. A map of the existing and potential networks in the scheme's location is shown below.



Existing DH NetworksPotential DH Networks

There are no existing or potential networks within the vicinity of the scheme, therefore a connection is not possible.

## 'Be Clean': Site Wide Networks and CHP Energy Assessment Ellerdale Road

#### Site-wide Heat Networks:

In accordance with section 8.2 of the GLA guidance for Energy Planning, where it is demonstrable that a site wide network is not feasible then an individual heating strategy can be implemented. A site wide network will not be adopted because the dwellings on site will not have adequate density and local conditions are not favourable to centralised distribution. Therefore, it is considered that distribution losses would be relatively large and the effectiveness and carbon reducing potential would be undermined when compared to an individual servicing strategy.

#### Combined Heat and Power (CHP)

In accordance with section 8.3 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion, or the development is of such a scale that it could be the catalyst for an area wide heat network, applicants should evaluate the feasibility of on-site CHP

GLA guidance stipulates that small, or purely residential developments of less than 350 dwellings will not be expected to include on-site CHP. CHP systems are best utilised where there is a consistent and high demand for heat. Because of the small electricity supplies and demand of this scheme, a CHP installed to meet the base heat load would typically require the export of electricity to the grid. The administrative burden of managing CHP electricity sales at a small scale without an active energy service companies (ESCOs) is prohibitive for smaller operators of residential developments.

The heat demand profile of this residential scheme is not suitable to CHP. The implemented fabric improvements from the 'Be Lean' scenario have also reduced the energy demand from space heating to hot water. For CHP systems to be economically viable they need to run for at least 5,000 hours per year. Therefore, a CHP system would most likely be oversized, and as a result less efficient and economic.

## 'Be Clean': Cooling

## Energy Assessment Ellerdale Road

#### Policy 5.9 Overheating and Cooling:

The aim of this policy is to reduce the impact of the urban heat island effect in London and encourage the design of spaces to avoid overheating and excessive heat generation, and to mitigate overheating due to the impact of climate change.

Where design measures and the use of natural and/or mechanical ventilation are not enough to guarantee the occupant's comfort, in line with the cooling hierarchy the development's cooling strategy must include details of the active cooling plant being proposed, including efficiencies, and the ability to take advantage of free cooling and/or renewable cooling sources.

Where appropriate, the cooling strategy should investigate the opportunities to improve cooling efficiencies through the use of locally available sources such as ground cooling and river/dock water-cooling.

#### The Cooling Hierarchy:

Major developments should reduce potential overheating and reliance on air conditioning systems and demonstrate this with the Cooling Hierarchy:

- 1) Minimise internal heat generation through energy efficient design
- 2) Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)
- Manage the heat within the building through thermal mass, room height and green roofs
- 4) Passive ventilation
- 1
- 5) Mechanical ventilation
- 6) Active cooling systems (ensuring the lowest carbon option)

#### Avoiding Overheating Measures taken:



LED bulbs can emit 80% less heat compared to an incandescent bulb and their life span is up to 41 times more.

The following measures have been taken in accordance with the cooling hierarchy to reduce overheating and the need for cooling:

#### 1) Minimise internal heat generation through energy efficient design

Internal heat gains have been minimised where possible. Energy Efficient appliances will help reduce internal heat gain and reduce the cooling requirement.

Energy efficient lighting will also be specified (>45 lumens per circuit watt). LED lighting will be specified and a lumen per circuit watt figure of 9W/m² will be targeted.

## 'Be Clean': Cooling Energy Assessment

## Energy Assessment Ellerdale Road

#### Avoiding Overheating Measures taken:

#### 2) Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)

Direct solar gains will be controlled in the following ways:

- Solar control all methods controlling solar gain to within tolerable limits have been considered. The location, size, design and type of window openings and glazing have been optimised, and reduced solar gain factors from low emissivity windows with a g-value of 0.55 have been specified.
- Dark-coloured curtain/roller blinds will be specified to limit solar gain. The shading has also been optimised to avoid substantially reducing daylighting or increasing the requirement for electric lighting.

Heat transfer and infiltration has been controlled in the following ways:

- Insulation levels have been maximised and the resulting u-values are lower than required by Building Regulations. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target u values.
- A reduced air permeability rate of 3 m³/(hr.m²) @ 50 pa has been targeted to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.

#### Manage the heat within the building through thermal mass, room height and green roofs.

The following measures have been specified to manage heat accumulation within the building:

High thermal mass – exposed building fabric materials such as masonry or concrete have been utilised in the form of concrete floors and dense masonry external walls. These materials act as 'thermal batteries'; they absorb heat gains during the day when the building is occupied and 'store' it for an extended period, thereby helping to stabilise daytime temperatures. At night this heat can be dissipated, which 'resets' the heating cycle. Ventilation will also be used at night to purge the stored heat within the structure. A 'ground coupled' system that uses the thermal storage capacity of the ground has not been specified as the passive ventilation option has been selected instead.



Examples of how the thermal mass absorbs heat during day and emits it during night.

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## 'Be Clean': Cooling Energy Assessment Ellerdale Road

#### Avoiding Overheating Measures taken:

- Room heights high ceilings are traditionally used in hot climates to allow thermal stratification so that occupants can inhabit the lower cooler space, and to decrease the transfer of heat gain through the roof. The existing building has floor to ceiling heights of approximately 2.8m. As the roof will be well insulated to achieve a U-value of 0.11 W/m²K, there will be minimal penetration of heat through the roof.
- Green roofs a green roof has been specified for the scheme. This will
  act as an insulation barrier and the ecological processes will reduce the
  amount of solar energy absorbed by the roof membrane, so will reduce
  temperatures below the surface and cool the building areas directly
  below.

## Fresh air Stale, warm air

Typical building section demonstrating passive cross ventilation.

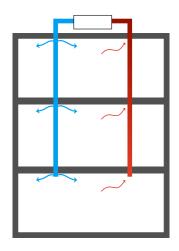
#### 4) Passive ventilation

Ventilation that does not use fans or mechanical system has been specified to reduce the cooling load.

> Openable windows are specified on the two main external facades of the building. Cross ventilation will be achieved by opening windows on two facades and ensuring there is a clear path for airflow.

## 'Be Clean': Cooling Energy Assessment Ellerdale Road

#### Avoiding Overheating Measures taken:



Typical building section demonstrating a simple method of supply and extract ventilation system.

#### 5) Mechanical ventilation

Passive ventilation will not be adequate to cool the building to the required temperature. Mechanical ventilation will be utilised in the following forms:

- A mixed mode system will be implemented. This will be complimentary
  to the passive cooling measures taken. During summer months,
  mechanical ventilation using fans will circulate and remove hot air from
  the building. The building will also adopt a zoned design to allow natural
  ventilation where possible and mechanical ventilation where there are
  increased cooling loads.
- Fan powered ventilation: single point extracts will be used in WCs and kitchen. A whole building system will be specified which will use air handling units with separate supply and extract fans. Heat recovery units will also be specified to reduce energy demand, optimal performance will be achieved by the reduced air permeability rate of 3 m³/(hr.m²) @ 50 pa.
- The mechanical systems will have the following efficiencies which are in compliance with the Domestic Building Services Compliance Guide:
  - ✓ Specific fan power of 0.52 W/l/s for whole ventilation systems
    with heat recovery
  - ✓ Heat recovery efficiency of 90%

#### **Overheating Risk:**

The overheating risk considering all the above strategies, described passive measures, has been assessed for the development and is presented in the table below:

Dwellings	Overheating risk according to SAP
1 Ellerdale Road	Slight

According to the GLA guidance on preparing energy assessments (April 2015), Section 11, a dynamic modelling to assess the risk of overheating should be carried out. However, due to the overheating results of SAP showing that there is no significant risk of overheating, it has been considered that a dynamic modelling is not required.



## 'Be Clean': Cooling Energy Assessment Ellerdale Road

#### Efficiency Measures taken:

#### 6) Active cooling systems (ensuring the lowest carbon option)

Passive design measures and the use of natural and mechanical ventilation result in slightly overheating risk. In order to guarantee the occupant's comfort, an air conditioning system has been specified for. Following the methodology of the cooling hierarchy has significantly reduced the demand for cooling.

The monthly cooling requirements of the dwelling are presented in the table below.

	Monthly Cooling Requirement (kWh/m²/year)				
Dwellings	June July August Annual				
1 Ellerdale Road	0.92	1.11	0.88	2.91	

To ensure the cooling system is the most carbon efficient possible the following parameters have been selected:

- Location: Indoor cooling units have been specified on a localised basis where internal gains are too high. The units will be fully fitted with local temperature controls for optimal usage.
- The location of the outdoor units that 'dump' the heat has been carefully
  considered so as not to cause problems for people and the environment,
  and not to add to the urban heat island effect. They will be located on the
  roof space and will allow adequate air movement around the condensing
  units, this will ensure maximum operating efficiency and will limit the
  impacts of dumped heat on people and the environment.
- The AC systems will have the following efficiencies which are in compliance with the Domestic Building Services Compliance Guide:
  - ✓ Energy label class of A.

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## 'Be Green': Renewable Energy

### Energy Assessment Ellerdale Road

Renewable Energy Feasibility:

In line with Policy 5.7 of the London Plan the feasibility of renewable energy technologies has been considered. A detailed site-specific analysis and associated carbon saving calculations have also been provided for renewable energy technologies for the feasible options.

Renewable Energy Technology Comparison:

Each technology has been assessed under 5 broader categories. There are key criteria for each category on which the technology is evaluated. The key criteria have been given a weighting based on a tick-system, a graphical representation of this is shown below:

✓ ✓ ✓ ✓ ✓ = 1 scored out of a possible 5

The weighting of each of the criteria within the categories is shown below:

- Local, site-specific impact: (Maximum score of 4)
  - o Local planning criteria = ✓ ✓
  - o Land used by all components = ✓
  - o Noise impact from operation = ✓
- Suitability and design impact: (Maximum score of 4)
  - o Interaction on the current building design = **V**
  - Building orientation suitability =
  - Buildability of installation =
- Economic viability: (Maximum score of 5)
  - Capital cost of all components = ✔ ✔
  - Grants and funding available =
  - o Payback periods (years) 3-5, 5-10, 10-15 = ✓ ✓ ✓
- Operation and maintenance: (Maximum score of 3)
  - o Servicing requirements (low or high) = ✓
  - o Maintenance costs (low or high) = ✓
  - o Resource use from future maintenance (low or high) = ✔
- CO<sub>2</sub> and sustainability: (Maximum score of 10)
  - o Carbon saving per year = V V V V
  - o Impact of future grid decarbonisation (gas vs. electric) = 🗸 🗸
  - b Local air quality/pollution = ✓ ✓
  - Resource use of installation = ✓ ✓

Key comments on each of the criteria and the corresponding score will be provided in a table (example below) for each of the technologies. The score for each of the criteria will be summed and each of the technologies will then be ranked. The assessment of each technology is undertaken on the following pages.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO₂ and sustainability
	V V V V	V V V V	<b>VVVV</b>	V V V	V V V V V V V V V V V V V V V V V V V

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## 'Be Green': Renewable Energy Energy Assessment Ellerdale Road

#### Biomass & Biofuel:

#### Rejected



Biomass is normally considered a carbon 'neutral' fuel, as the carbon dioxide emitted on burning has been recently absorbed from the atmosphere by photosynthesis. Although some form of fossil fuel derived inputs are required in the production and transportation of the fuel.

Wood is seen as a by-product of other industries and the small quantity of energy for drying, sawing, pelleting and delivery are typically discounted. Biomass from coppicing is likely to have external energy inputs from fertiliser, cutting, drying etc. and these may need to be considered. In this toolkit, all biomass fuels are considered to have zero net carbon emissions.

Biomass can be burnt directly to provide heat in buildings. Wood from forests, urban tree pruning, farmed coppices or farm and factory waste, is the most common fuel and is used commercially in the form of wood chips or pellets. Biomass boilers can also be designed to burn smokeless to comply with the Clean Air Acts.

Boilers can be fed automatically by screw drives from fuel hoppers. This typically involves daily addition of bagged fuels.

A biomass boiler could be installed on site for supplementary LTHW heating; however, a major factor influencing the suitability of a biomass boiler is the availability of the biomass fuel. A local and reliable fuel source would be essential for the biomass boiler to be an efficient replacement for a conventional boiler system. Therefore, a very comprehensive feasibility assessment needs to be undertaken to understand the practicalities of such a system.

It is estimated that the heating and hot water demand of the site is too small to meet the required  $\mathrm{CO}_2$  emissions reduction if a biomass boiler was a standalone system. Therefore a biomass boiler would need to be combined with energy demand reduction measures and/or CHP. In order to meet the 35%  $\mathrm{CO}_2$  emissions reduction a biomass boiler would need to be installed. The likely installed cost would be circa £15,000. The additional cost of providing and storing the bio-fuel also needs to be accounted for. The site is likely to be unsuitable for biomass boilers due to site constraints such as limited transport/access issues, and storage of the biomass fuel. A detailed feasibility study will be required to investigate the suitability.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO <sub>2</sub> and sustainability
Biomass Boiler	<b>V</b> V V V	<b>///</b>	<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	<b>V</b> V V	V V V V V V V V V V V V V V V V V V V
	Local air quality impacts, increased transport usage on the restricted site, increased plant space.	Increase in plant space required, orientation fine, slightly increased buildability issues.	Increased capital costs of installation, typical payback of 8 years	Increased maintenance relative to gas boiler, resource use not significantly increased if well serviced.	Very low carbon intensity of feedstock if properly procured. Decarbonisation impact not applicable, air quality issues.



## 'Be Green': Renewable Energy Energy Assessment Ellerdale Road

#### Photovoltaic (PV):

#### Accepted



Photovoltaic systems convert energy from the sun into electricity through semi conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn the direct current (DC) output into alternating current (AC) electricity for use in buildings.

Photovoltaic systems can be discreet through being designed as an integral part of the roof. An 'invisible' design using slates or shingles as opposed to an architectural statement could be preferable in a sensitive area.

Photovoltaics supply electricity to the building and are attached to electricity gird or to any other electrical load. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

The cost of PV cells is heavily dependent on the size of the array. There are significant cost reductions available for larger installations.

The most suitable location for mounting photovoltaic panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a potential useable roof area of approximately 65 m² and is orientated southwest.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO₂ and sustainability
Photovoltaic	V V V V	<b>///</b> /	<b>///</b> ///	VVV	V V V V V
	No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues.	Can be added to the roof, good orientation, and slightly increased buildability issues for wiring and metering.	Increased capital costs of installation, typical payback of 8 years, Feed in Tariff available.	Limited servicing and maintenance i.e. 1 visit per year, inverter will require replacement.	High carbon saving from electricity, uses minimal grid electricity, no local air impact, high embodied energy of panels.

## 'Be Green': Renewable Energy Energy Assessment Ellerdale Road

#### Solar Thermal:

#### Rejected



Solar water heating systems use the energy from the sun to heat water for domestic hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or a twin coil hot water cylinder inside the building. The systems work very successfully in all parts of the UK, as they can work in diffuse light conditions.

Like photovoltaic panels the most suitable location for mounting solar hot water panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a potential useable roof area of approximately 65 m<sup>2</sup> and is orientated southwest.

It is estimated that the  $\mathrm{CO}_2$  emissions reduction that would be produced by solar hot water as a standalone system would not be adequate to achieve the required  $\mathrm{CO}_2$  emissions reduction target. Therefore a solar hot water system would need to be combined with more energy efficiency strategies, a CHP or additional renewable technologies to achieve the carbon reduction target.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO <sub>2</sub> and sustainability
Solar Thermal	<b>V V V V</b>	<b>///</b>	VVVV	<b>///</b>	V V V V V
	No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues.	Can be added to the roof, good orientation, and slightly increased buildability issues for piping and cylinders.	Increased capital costs of installation, typical payback of 8 years, Renewable Heat Incentive available.	Limited servicing and maintenance i.e. 1 visit every two years, heat transfer fluid requires replacing every 10 years.	Lower carbon saving as primarily displacing gas, uses minimal grid electricity, no local air impact, medium embodied energy of panels.

## 'Be Green': Renewable Energy

## Energy Assessment Ellerdale Road

#### Wind Energy:

#### Rejected



Wind energy is a cost effective method of renewable power generation. Wind turbines can produce electricity without carbon dioxide emissions in ranges from watts to megawatt outputs. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower.

The blades drive a generator either directly or via a gearbox to produce electricity. The electricity can either be linked to the grid or charge batteries. An inverter is required to convert the electricity from direct current (DC) to alternating current (AC) for feeding into the grid.

Modern quiet wind turbines are becoming viable in low density areas where ease of maintenance and immediate connection to the grid or direct use of the electricity in a building, may make them cost effective, despite lower wind speeds than open areas.

Wind turbines are generally less suited to dense urban areas as their output will be affected by potentially lower and more disrupted wind speeds, and their use of much more cost effective machines may be prohibited by their proximity to some building types. Small turbines can be used in inner city areas mounted on buildings, although there are relatively few installations.

Typically a 1.5 kW turbine can provide 4,000 kWh of electrical power annually. To achieve the required  $CO_2$  emissions reduction target approximately 1 turbines would be required as a standalone solution. The indicative cost of a smaller roof mounted turbine is £2,000/kW so achieving the required  $CO_2$  emissions reduction would cost approximately £3,000.

A detailed wind resource evaluation would be required for the site to fully understand the generation potential and payback period. Also, it is likely that planning restrictions and resistance from small groups within the local community could also affect the viability of wind energy for the project.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO <sub>2</sub> and sustainability
Wind Energy	No local air quality impacts, use of unutilised roof space, conservation officer will have concerns for the site, minor noise issues.	Can be added to the roof, relatively limited wind speeds in local area, increased buildability issues for wiring and metering.	Medium capital costs of installation, typical payback < 5 years, Feed in Tariff available.	Very limited servicing and maintenance, costs of 2-3% typical.	High carbon saving from electricity, output limited from urban installation, consumes little grid electricity, no local air impact, low embodied energy of panels.

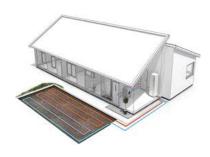


## 'Be Green': Renewable Energy

## Energy Assessment Ellerdale Road

#### Ground Source Heat Pump (GSHP):

#### Rejected



Geo-thermal energy is essentially heat collected from the ground. Heat obtained from the ground may be considered it as a source of heating and cooling within the UK by the use of a geo-thermal heat pump or ground source heat pumps.

A ground source heat pump is a device for converting energy in the form of low level heat to heat at a usable temperature. The heat pump consists of five main parts; ground collector loop/or bores, heat exchanger, compressor, condenser heat exchanger and expansion valve.

At approximately 1.2-1.5 metres down below ground level the temperature is a constant 10 to 12°C. Any bores would need to be sunk to an effective depth of 50 – 120m and a ground feasibility report would be required to ascertain if this method of heat source was viable.

From the bores pre-insulated pipework is laid in the ground to the heat exchanger device. The system is filled with water and antifreeze. The cooled water is pumped around the loop / bore gathering energy as it circulates. The water that has been heated to 10-12°C is returned to the ground source heat exchanger where the energy is transferred to the refrigerant gas. For every 1kW of energy used to compress the refrigerant, the process 'gives up' 4 kW of energy for use in the system being used to heat the building.

Typical costs for an installation this are in the region of £16,000-20,000 for a smaller commercial or domestic size installation, with general installation costs at £1200 /kW of energy produced.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO₂ and sustainability
GSHP	No local air quality impacts, not visible so conservation friendly, no noise issues, however the constrained site may prohibit its installation.	Can be added to the roof, good airflow on roof, increased buildability issues for pipework and heating emitters internally.	High capital costs of installation, typical payback of 15 years where gas is displaced, Renewable Heat Incentive available.	Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	Limited carbon saving from gas displacement, consumes some electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.



## 'Be Green': Renewable Energy Energy Assessment

Ellerdale Road

#### Air Source Heat Pump (ASHP):

#### Rejected



Air source heat pump systems work on the same principle as a ground source heat pump although they use the outside air as the heat source.

The coefficients of performance given by air source heat pump systems are inferior to that of ground source systems due to varying air temperatures. In the depth of winter the energy efficiency of an air source system will be lower than that of a ground source system, and it is likely that more back-up heat will be required if an air source unit is fitted. This back-up heat often comes from a direct electric heater. They operate over a varying temperatures range of -15°C to +25°C, however, the performance will reduce to below the required 3 to 1 carbon saving ratio in winter, and the also require a defrosting mechanism to melt ice that forms on the air heat exchanger.

ASHPs are cheaper to install than ground source heat pumps but are only available on a relatively small scale. If applied across a larger site a number of plant zones would be required for generation of heat, leading to increased plant space requirements. Typical costs for an installation this are in the region of £10,000 for a smaller commercial or domestic size installation.

Carbon dioxide emissions savings will typically be less than that of the ground source heat pump. Air source heat pumps may be more suitable as an HVAC solution.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO₂ and sustainability
ASHP	V V V V	<b>VVV</b>	<b>//</b> ////	V V V	V V V V V
	No local air quality impacts, conservation officer may have minor concerns over visual impact, no noise issues.	Can be added to the roof, good air- flow on roof, increased buildability issues for pipework and heating emitters internally.	Medium- high capital costs of installation, typical payback >15 years where gas is displaced, Renewable Heat Incentive available.	Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	Limited carbon saving from gas displacement, less efficient in winter, consumes electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.



## 'Be Green': Summary of Renewable Technologies

### Energy Assessment Ellerdale Road

**Summary Comparison Matrix:** 

An assessment of the feasibility of each of the technologies is shown below.

Renewable Technology	Local, site- specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO₂ and sustainability	Total Score
Biomass Boiler	<b>V</b> V V V	<b>///</b>	<b>VVV</b> V	<b>V</b> V V	V V V V V	15 out of 26
Photovoltaic	V V V V	<b>VVV</b>	<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	V V V	V V V V V	17 out of 26
Solar Thermal	VVVV	V V V V	<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	VVV	VVVVV	16 out of 26
Wind Energy	<b>V</b> V V V	<b>VV</b> V	<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	VVV	V V V V V	17 out of 26
GSHP	VVVV	V V V V	<b>V</b> V V V V	V V V	VVVVV VVVVV	15 out of 26
ASHP	VV VV	V V V V	<b>V V V V</b>	V V V	V V V V V	15 out of 26

Renewable Technology Conclusion & Specification:

Photovoltaic panels and wind energy have scored the best. It is assumed that wind energy would be considered unsuitable for the area by conservation criteria and that the local residents would raise concerns over potential noise and turbulence. Therefore, photovoltaic panels in combination have been considered to be the optimum balance of sustainable and economic objectives.

### 'Be Green': Photovoltaic

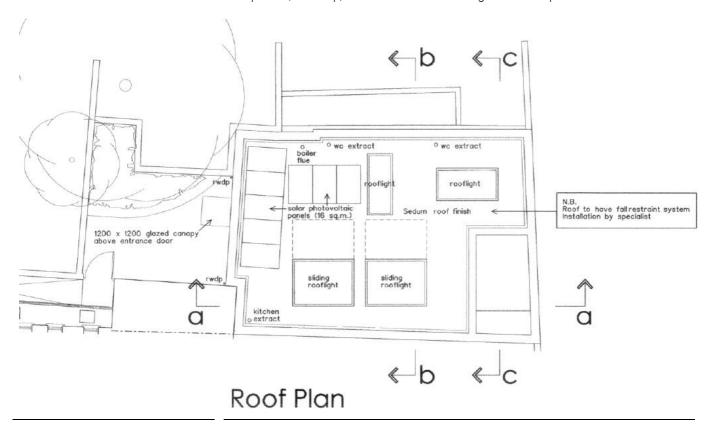
## Energy Assessment Ellerdale Road

#### Summary:

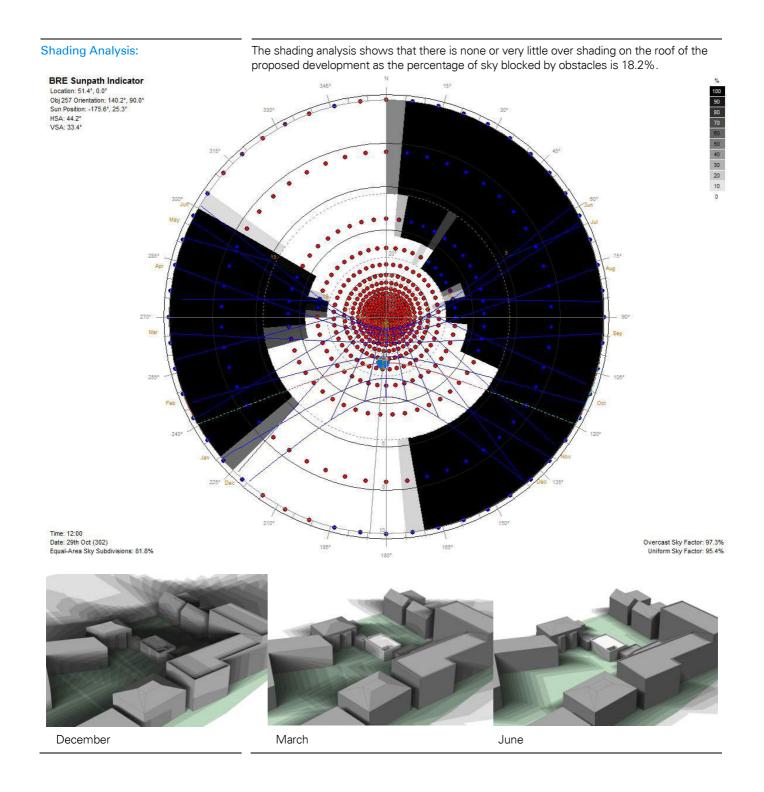
A photovoltaic panel system of 2.6 kWp has been specified (approximately 8 high efficient photovoltaic panels) for the development and detailed summary of the lifecycle cost, revenue and payback for the photovoltaic panels is presented in this section.

#### Location:

The following drawing shows that there is  $65\text{m}^2$  of available roof area that could be used to install photovoltaic modules. PV panels will be oriented southeast and southwest, with 15 degrees tilt, covering  $16\text{m}^2$  of the roof. The shading analysis of the roof confirms that there is no over shading on the roof, however in the proposed PV panel arrangement, the two top-left corner PV panels will experience some shading by the adjacent PV panels. To account for this potential shading, 6 PV panels (1.95 kWp) with 'none or very little' over shading and 2 PV panels (0.65 kWp) with 'modest' over shading have been specified in the SAP model.



## 'Be Green': Photovoltaic Energy Assessment Ellerdale Road



### 'Be Green': Photovoltaic

### Energy Assessment Ellerdale Road

#### Lifecycle Cost:

The lifecycle of the proposed high efficiency panels is 25 years. To calculate the lifecycle cost of the panels, the maintenance of the system and replacement cost will be included.

The total costs for the proposed system's lifetime is:

- Capital Cost = £5,200
- Maintenance Cost = £1,500
- Operation Cost = £900 (replacement inverters etc.)
- Total Costs = £7,600

#### Revenue and Payback Parameters:

- The cost of electricity to be displaced is 12p/kWh.
- The 2.6kWp system is estimated to generate 1,878 kWh/yr. Based on the assumption that 50% of the electricity will be used on site, an offset saving of £113/yr will be achieved.
- With the current Feed in Tariff, a tariff of 14.77p/kWh will be received for generation, and 4.77p/kWh will be received for export, which gives an additional saving of £322 per year.

#### **Summary Performance Calculations:**

The following tables summarise the reduction in carbon emissions and the life cycle cost of the photovoltaic system.

Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	1,878
Annual Carbon Emissions Reductions (kg CO <sub>2</sub> /year)	975
CO <sub>2</sub> Emissions Reduction (%)	38.9

Cost Performance Criteria	Value
Total Cost Over Life Cycle (£)	7,600
Predicted Annual Savings (£)	435
Payback Period (yeas)	17.5



# Conclusion Energy Assessment Ellerdale Road

#### Summary

The baseline carbon emissions for the scheme are 2.51 Tonnes CO<sub>2</sub>/yr.

As demonstrated, the development will reduce carbon emissions by 1.8% from the fabric energy efficiency measures described in the "Be Lean" section, and will reduce total carbon emissions by 40.6% over Building Regulations with the further inclusion of low and zero carbon technologies.

GLA's Energ	y Hierarchy – Reg	ulated Carbon Emiss	sions	
	Baseline:	Be Lean:	Be Clean:	Be Green:
CO <sub>2</sub> emissions (Tonnes CO <sub>2</sub> /yr)	2.51	2.46	-	1.49
CO <sub>2</sub> emissions saving (Tonnes CO <sub>2</sub> /yr)	-	0.04	-	0.97
Saving from each stage (%)	-	1.8	-	38.9
Total CO <sub>2</sub> emissions saving (Tonnes CO <sub>2</sub> /yr)		1.	02	

40.6% Total carbon emissions savings over Part L of the Building Regulations 2013 achieved

## Appendix Energy Assessment Ellerdale Road

#### **Further Information:**

As required by the GLA, the emission figures and details of the calculations and methodology used to determine the figures provided within the report can be found in the following pages:

Baseline - TER from the Lean SAP TER Worksheets.

Lean – DER from the Lean SAP DER Worksheets.

Clean - There in no CHP scenario.

Green - DER from the Green SAP DER Worksheets.

## Appendix Energy Assessment Ellerdale Road

#### Baseline Scenario

		U:	ser Deta	ils:						
Assessor Name: Software Name:	Stroma FSAP 2012	Davis	So	ftwa	a Num are Vei	sion:		Versio	n: 1.0.1.25	
Address :	1 Ellerdale Road	Ргор	erty Add	ress.	House	I-LEAN				
1. Overall dwelling dime	ensions:									
			Area(m	<sup>2</sup> )		Av. Hei	ight(m)		Volume(m <sup>3</sup>	)
Basement		[	67		(1a) x		2.6	(2a) =	174.2	(3a)
Ground floor		Ī	87.44		(1b) x		3	(2b) =	262.32	(3b)
Total floor area TFA = (1	a)+(1b)+(1c)+(1d)+(1e)+	(1n)	154.4	4	(4)			•		
Dwelling volume		-			(3a)+(3b)	)+(3c)+(3d	)+(3e)+	.(3n) =	436.52	(5)
2. Ventilation rate:										
		ondary	oth	er		total			m³ per hou	r
Number of chimneys	heating hea	oting	+	)	] = [	0	X ·	40 =	0	(6a)
Number of open flues	0 +	0	+	)	j = F	0	x	20 =	0	(6b)
Number of intermittent fa	ans				'  -	4	x	10 =	40	(7a)
Number of passive vents	3				F	0	X	10 =	0	(7b)
Number of flueless gas f	ires				\	0	X ·	40 =	0	(7c)
										_
								Air ch	anges per ho	ur
	eys, flu <mark>es an</mark> d fans = (6a)+					40		÷ (5) =	0.09	(8)
Number of storeys in t	been carried out or is intended,	proceed to	(17), otnei	wise c	continue in	om (9) to (	16)		0	(9)
Additional infiltration	and amounting (i.e.)						[(9)	-1]x0.1 =	0	(10)
Structural infiltration: 0	0.25 for steel or timber fra	me or 0.3	35 for ma	asonr	y constr	uction			0	(11)
if both types of wall are p deducting areas of openi	present, use the value correspon	nding to the	e greater w	all are	a (after			<u>'</u>		
=	floor, enter 0.2 (unsealed	) or 0.1 (	sealed),	else	enter 0				0	(12)
If no draught lobby, er	•	,	, ,,						0	(13)
Percentage of window	s and doors draught strip	ped							0	(14)
Window infiltration			0.25	5 - [0.2	x (14) ÷ 1	00] =			0	(15)
Infiltration rate			(8)	+ (10)	+ (11) + (1	2) + (13) +	+ (15) =		0	(16)
Air permeability value,	q50, expressed in cubic	metres p	er hour p	oer so	quare m	etre of e	nvelope	area	5	(17)
If based on air permeabi	lity value, then (18) = [(17)	÷ 20]+(8), o	otherwise (	18) = (	16)				0.34	(18)
	es if a pressurisation test has be	een done o	r a degree	air pei	meability	is being us	sed	ı		_
Number of sides shelter	ed		(20)	- 1 1	0.075 x (1	0)1 -			2	(19)
Shelter factor	tion obolton footon					9)] -			0.85	(20)
Infiltration rate incorpora Infiltration rate modified	-		(21)	- (10)	) x (20) =				0.29	(21)
Jan Feb	Mar Apr May	Jun ,	Jul /	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp		- <del> </del>	<u>   '</u>	·- B			1	1 200	I	
(22)m= 5.1 5	4.9 4.4 4.3	3.8	3.8	3.7	4	4.3	4.5	4.7		
` '								L		

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		
										!	ļ.	•		
Adjusted T			e (allowi	<del></del>	ı —	ı —	<del>`                                    </del>	<del>`</del>	<del>`´</del>	T 0 04	0.00	0.04	I	
Calcula	0.37 te effec	0.36 ctive air	0.36 change i	0.32 rate for t	0.31 he appli	0.28 cable ca	0.28 <b>se</b>	0.27	0.29	0.31	0.33	0.34		
If med	chanica	ıl ventila	ition:										0	(23
If exha	ust air he	eat pump i	using Appe	endix N, (2	(3b) = (23a	a) × Fmv (e	equation (N	N5)) , othe	rwise (23b	) = (23a)			0	(23
If balar	ced with	heat reco	overy: effic	iency in %	allowing f	or in-use f	actor (from	n Table 4h	) =				0	(23
a) If b	alance	d mecha	anical ve	entilation	with he	at recov	ery (MVI	HR) (24a	a)m = (22)	2b)m + (	23b) × [	1 – (23c)	÷ 100]	
24a)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24
· · -			anical ve		i	i	<del></del>		ŕ	<del> </del>	<del></del>	ı	ı	
24b)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24
,			tract ven		•	•				E v (00h				
اا  24c)m	0	0.5 ×	(23b), t	nen (24)	(230) = (230)		wise (24)	C) = (220)	0) m + 0.	.5 × (231	0	0	I	(24
				<u> </u>				<u> </u>				0		(2.
,			on or wh en (24d)		•	•				0.5]				
24d)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56		(24
Effect	ive air	change	rate - er	nter (24a	) or (24k	o) or (24	c) or (2 <mark>4</mark>	d) in box	(25)					
25)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56		(25
3 Hea	t losses	s and he	eat loss p	naramet	er.									_
ELEM		Gros		Openir		Net Ar	ea	U-valı	ue	AXU		k-value	,	ΑXk
		area		n	_	A ,r		W/m2		(W/I	K)	kJ/m²·l		kJ/K
Doo <mark>rs</mark>			Í			1.76	X	1	=	1.76				(26
Vindow	s Type	1				0.57	x1	/[1/( 1.4 )+	0.04] =	0.76				(27
Vindow	s Type	2				4.25	x1	/[1/( 1.4 )+	0.04] =	5.63				(27
Vindow	s Type	3				6.8	x1	/[1/( 1.4 )+	0.04] =	9.02				(27
Vindow	s Type	4				7.75	x1	/[1/( 1.4 )+	0.04] =	10.27				(27
Vindow	s Type	5				3.68	x1	/[1/( 1.4 )+	0.04] =	4.88				(27
Vindow	s Type	6				3.97	x1,	/[1/( 1.4 )+	0.04] =	5.26				(27
Roofligh	its Type	e 1				2.0097	08 x1	/[1/(1.7) +	0.04] =	3.41650	3			(27
Roofligh	its Type	e 2				2.0097	08 x1	/[1/(1.7) +	0.04] =	3.41650	3			(27
Roofligh	its Type	e 3				2.9020	18 x <sup>1</sup> /	/[1/(1.7) +	0.04] =	4.93343	1			(27
						87.44	x x	0.13	─	11.3672	<u></u>			(28
loor	ype1	81.4	4	0		81.4	x	0.18	_ =	14.65	≓ i		<b>-</b>	(29
	-			28.7	8	94.01	=	0.18	= =	16.92	<b>=</b>		<b>-</b>	(29
Floor Walls Ty Walls Ty	ype2	122					=	0.13	_ :	10.09	╡ ┆		-	(30
Walls Ty Walls Ty	ype2	87.4		9.82	,	77.63	· · ·							
Walls Ty Walls Ty Roof		87.4	14	9.82	2	77.62 379.0	=	0.10						(31
Valls Ty Valls Ty Roof Total are	ea of e		14	9.82	2	379.0	7		—				_	(3
alls Ty alls Ty oof otal are	ea of e	87.4 lements	, m²			379.0 12.41	7 x	0	=   	0	as given in	paragraph	] [	

(26) (30) + (32) =

Fabric heat loss, W/K = S (A x U)

106.25

(33)

Heat capacity Cm = S	(Axk)						((28)	(30) + (32	2) + (32a)	(32e) =	45878.65	(34)
Thermal mass parame	,	P = Cm ÷	- TFA) ir	n kJ/m²K				tive Value:	, , ,	, ,	250	(35)
For design assessments wi	`		,			ecisely the				able 1f	230	(00)
can be used instead of a de	etailed calc	ulation.										
Thermal bridges : S (L	x Y) cal	culated (	using Ap	pendix I	K						18.95	(36)
if details of thermal bridging	are not kn	own (36) =	= 0.15 x (3	1)			(22)	(20) -				
Total fabric heat loss	-11-4	l 41 <sub>2</sub> 1 <sub>2</sub>						(36) =	05) (5)		125.2	(37)
Ventilation heat loss of	1	<del> </del>		1	1	<b>1 A</b>	·	= 0.33 × (	, , ,		1	
(38)m= 81.9 81.52	Mar 81.14	Apr 79.37	79.04	Jun 77.51	Jul 77.51	77.22	Sep 78.1	Oct 79.04	Nov 79.71	Dec 80.41	-	(38)
, ,		19.51	79.04	11.51	17.51	11.22	<u> </u>			00.41		(50)
Heat transfer coefficie	· ·						<u> </u>	= (37) + (3			1	
(39)m= 207.1 206.72	206.34	204.58	204.25	202.71	202.71	202.43	203.3	204.25	204.92	205.61	004.50	(20)
Heat loss parameter (	HLP), W/	m²K						Average = = (39)m ÷	` '	12 /12=	204.58	(39)
(40)m= 1.34 1.34	1.34	1.32	1.32	1.31	1.31	1.31	1.32	1.32	1.33	1.33	]	
							,	Average =	Sum(40) <sub>1</sub>	12 /12=	1.32	(40)
Number of days in mo	<del>1 ` </del>	le 1a)		i		i	i	i -		i	7	
Jan Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m= 31 28	31	30	31	30	31	31	30	31	30	31		(41)
4. Water heating ene	rgy requi	irement:						_		kWh/y	ear:	
Assumed occupancy,	NI										_	
Assultied Occupation.	IN								2	94		(42)
if $TFA > 13.9$ , $N = 1$		[1 - exp	(-0.0003	349 x (TF	FA -13.9	)2)] + 0.0	0013 x (	ΓFA -13.		94		(42)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1	+ 1.76 x					, , <u>-</u>		ΓFA -13.	9)			` '
if $TFA > 13.9$ , $N = 1$	+ 1.76 x ater usag	ge in litre	es per da	ay Vd,av	erage =	(25 x N)	+ 36		9)	4.05		(42)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w	+ 1.76 x ater usage hot water	ge in litre	es per da	ay Vd,av	erage =	(25 x N)	+ 36		9)			` '
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average	+ 1.76 x ater usage hot water	ge in litre	es per da	ay Vd,av	erage =	(25 x N)	+ 36		9)			` '
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per	+ 1.76 x ater usage hot water person per	ge in litre usage by a day (all w	es per da 5% if the d vater use, I	y Vd,av welling is not and co	erage = designed i ld) Jul	(25 x N) to achieve	+ 36 a water us	se target o	9)	4.05		` '
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb	+ 1.76 x ater usage hot water person per	ge in litre usage by a day (all w	es per da 5% if the d vater use, I	y Vd,av welling is not and co	erage = designed i ld) Jul	(25 x N) to achieve	+ 36 a water us	se target o	9)	4.05		` '
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29	+ 1.76 x ater usage hot water person per Mar r day for ea	ge in litre usage by a day (all w Apr ach month	es per da 5% if the da vater use, I May Vd,m = fac 97.8	y Vd,av lwelling is not and co Jun ctor from	erage = designed and and and and and and and and and an	(25 x N) to achieve Aug (43) 97.8	+ 36 a water us Sep	Oct  106.13  Total = Sui	Nov  110.29  m(44) <sub>1 12</sub> =	4.05 Dec	1248.56	` '
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water	ater usage hot water person per Mar 106.13	ge in litre usage by a day (all w Apr ach month 101.97	es per da 5% if the da vater use, I May Vd,m = fac 97.8	y Vd,av lwelling is not and co Jun ctor from 93.64	erage = designed and and and and and and and and and an	(25 x N) to achieve Aug (43) 97.8	+ 36 a water us  Sep  101.97	Oct  106.13  Total = Suith (see Tail	Nov  110.29  m(44) <sub>1 12</sub> = ables 1b, 1	1.05 Dec 114.45 c, 1d)	1248.56	(43)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29	+ 1.76 x ater usage hot water person per Mar r day for ea	ge in litre usage by a day (all w Apr ach month	es per da 5% if the da vater use, I May Vd,m = fac 97.8	y Vd,av lwelling is not and co Jun ctor from	erage = designed and and and and and and and and and an	(25 x N) to achieve Aug (43) 97.8	+ 36 a water us Sep 101.97 0 kWh/mor	Oct  106.13  Total = Sun oth (see Ta	Nov 110.29 m(44) <sub>1 12</sub> = 1bles 1b, 1 151.37	114.45 c, 1d)		(43)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45	ter usage hot water person per Mar 106.13 153.18	ge in litre usage by a day (all w Apr ach month 101.97  culated mo 133.55	es per da 5% if the a sater use, I May Vd,m = factor 97.8  onthly = 4.	y Vd,av welling is not and co Jun ctor from 1 93.64 190 x Vd,r	erage = designed id)  Jul Table 1c x  93.64  m x nm x E  102.47	(25 x N) to achieve Aug (43) 97.8  97.7 117.58	+ 36 a water us  Sep  101.97  0 kWh/more 118.99	Oct  106.13  Total = Suith (see Tail	Nov 110.29 m(44) <sub>1 12</sub> = 1bles 1b, 1 151.37	114.45 c, 1d)	1248.56	(43)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water  (45)m= 169.73 148.45	ater usage hot water person per Mar 106.13 153.18 ing at point	Apr ach month 101.97 culated mo 133.55	es per da 5% if the orater use, I May Vd,m = factor on the factor of the	y Vd,av lwelling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58	erage = designed and designed a	(25 x N) to achieve  Aug (43)  97.8  DTm / 3600  117.58  boxes (46)	+ 36 a water us Sep 101.97 118.99 ) to (61)	Oct  106.13  Total = Sun  138.67  Total = Sun	Nov 110.29 m(44) <sub>1 12</sub> = ables 1b, 1 151.37 m(45) <sub>1 12</sub> =	114.45 c, 1d)		(43) (44) (45)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45	ter usage hot water person per Mar 106.13 153.18	ge in litre usage by a day (all w Apr ach month 101.97  culated mo 133.55	es per da 5% if the a sater use, I May Vd,m = factor 97.8  onthly = 4.	y Vd,av welling is not and co Jun ctor from 1 93.64 190 x Vd,r	erage = designed id)  Jul Table 1c x  93.64  m x nm x E  102.47	(25 x N) to achieve Aug (43) 97.8  97.7 117.58	+ 36 a water us  Sep  101.97  0 kWh/more 118.99	Oct  106.13  Total = Sun oth (see Ta	Nov 110.29 m(44) <sub>1 12</sub> = 1bles 1b, 1 151.37	114.45 c, 1d)		(43)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27	ater usage hot water person per Mar 106.13 153.18 153.18	ge in litre usage by a day (all w Apr ach month 101.97  culated ma 133.55  of use (no	es per da 5% if the 6 65% if th	y Vd,av lwelling is not and co Jun ctor from 1 93.64 190 x Vd,r 110.58	erage = designed id)  Jul Table 1c x  93.64  m x nm x E  102.47  enter 0 in  15.37	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64	+ 36 a water us Sep 101.97 118.99 1 to (61) 17.85	Oct  106.13  Total = Sunth (see Tall 138.67)  Total = Sunth 20.8	Nov  110.29  m(44) <sub>1 12</sub> =  sibles 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	114.45 c, 1d)		(43) (44) (45)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water  (45)m= 169.73 148.45  If instantaneous water heat  (46)m= 25.46 22.27  Water storage loss:	ter usage hot water person pei Mar 106.13 153.18 153.18 22.98	Apr Apr ach month 101.97  culated mo 133.55  of use (no	es per da 5% if the da 5% if the da 97.8 97.8 97.8 128.14 19.22 plar or W	y Vd,av welling is not and co Jun ctor from 1 93.64 190 x Vd,r 110.58 storage),	erage = designed id)  Jul Table 1c x  93.64  n x nm x E  102.47  enter 0 in  15.37  storage	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64  within sa	+ 36 a water us Sep 101.97 118.99 1 to (61) 17.85	Oct  106.13  Total = Sunth (see Tall 138.67)  Total = Sunth 20.8	Nov  110.29  m(44) <sub>1 12</sub> =  sibles 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	114.45 = c, 1d) 164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27  Water storage loss: Storage volume (litres If community heating a Otherwise if no stored	ater usage hot water person per Mar 106.13 153.18 153.18 22.98	ge in litre usage by day (all w Apr ach month 101.97  culated mo 133.55  of use (no 20.03  and any so ank in dw	es per da 5% if the da 5% if the da 97 May Vd,m = fac 97.8 128.14 19.22 Dlar or Water velling, e	Jun ctor from 193.64 190 x Vd,r 110.58 storage),	erage = designed in d)  Jul Table 1c x  93.64  m x nm x E  102.47  enter 0 in  15.37  storage ) litres in	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess	Oct  106.13  Total = Sun  138.67  Total = Sun  20.8	Nov  110.29  m(44) <sub>1 12</sub> =  22.7	114.45 = c, 1d) 164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27  Water storage loss: Storage volume (litres If community heating a Otherwise if no stored Water storage loss:	ter usage hot water person pei Mar 106.13 153.18 153.18 122.98	Apr Apr Ach month 101.97  culated mo 133.55  of use (no 20.03  ng any so ank in dw er (this in	es per da 5% if the da 5% if the da 5% if the da May Vd,m = fal 97.8 128.14 19.22 Dlar or Water velling, eacludes i	y Vd,av welling is not and co Jun ctor from 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed id)  Jul Table 1c x  93.64  102.47  enter 0 in  15.37  storage 0 litres in neous co	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess	Oct  106.13  Total = Sun  138.67  Total = Sun  20.8	Nov  110.29  m(44) <sub>1 12</sub> = sbles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	4.05  Dec  114.45  c, 1d)  164.37  24.66		(43) (44) (45) (46) (47)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27  Water storage loss: Storage volume (litres If community heating a Otherwise if no stored Water storage loss: a) If manufacturer's design of the storage loss: a) If manufacturer's design of the storage loss: a)	ater usage hot water person per Mar 106.13 153.18 153.18 22.98	Apr ach month 101.97  culated mo 133.55  of use (no 20.03  and any so ank in dw er (this in	es per da 5% if the da 5% if the da 5% if the da May Vd,m = fal 97.8 128.14 19.22 Dlar or Water velling, eacludes i	y Vd,av welling is not and co Jun ctor from 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed id)  Jul Table 1c x  93.64  102.47  enter 0 in  15.37  storage 0 litres in neous co	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess	Oct  106.13  Total = Sun  138.67  Total = Sun  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	114.45 c, 1d) 164.37 24.66		(43) (44) (45) (46) (47)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27 Water storage loss: Storage volume (litres If community heating a Otherwise if no stored Water storage loss: a) If manufacturer's d Temperature factor from	ter usage hot water person per Mar 106.13 153.18 153.18 1 22.98 ing at point 22.98 including and no tall hot water person per mand no tall hot water person per mand no tall hot water person Table per Table	ge in litre usage by day (all w Apr ach month 101.97  culated mo 133.55  for use (no 20.03  and any so ank in dw er (this in oss facto 2b	es per da 5% if the da 5% if the da 5% if the da 97.8  97.8  97.8  128.14  19.22  Dlar or Water  19.22  Dlar or Water  controlling, each of the control	y Vd,av welling is not and co Jun ctor from 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed in do designed in do designed in do designed in d	(25 x N) to achieve  Aug (43)  97.8  77.58  27.64  17.64  within sa (47)  27.64	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess ers) enter	Oct  106.13  Total = Sun  138.67  Total = Sun  20.8	Nov  110.29  m(44) <sub>1 12</sub> =  ables 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	4.05  Dec  114.45  c, 1d)  164.37  24.66  0		(43) (44) (45) (46) (47) (48) (49)
if TFA > 13.9, N = 1 if TFA £ 13.9, N = 1 Annual average hot w Reduce the annual average not more that 125 litres per  Jan Feb Hot water usage in litres per  (44)m= 114.45 110.29  Energy content of hot water (45)m= 169.73 148.45  If instantaneous water heat (46)m= 25.46 22.27  Water storage loss: Storage volume (litres If community heating a Otherwise if no stored Water storage loss: a) If manufacturer's design of the storage loss: a) If manufacturer's design of the storage loss: a)	ater usage hot water person per Mar 106.13 153.18 153.18 22.98 ) including and no tale hot water eclared learn Table r storage	ge in litre usage by day (all w Apr ach month 101.97  culated mo 133.55  of use (no 20.03  ng any so ank in dw er (this in oss facto 2b , kWh/ye	es per da 5% if the orater use, I May Vd,m = factor 128.14  128.14  19.22  Dolar or Water 19.22	y Vd,av welling is not and co Jun ctor from 1 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110 nstantar	erage = designed and designed a	(25 x N) to achieve  Aug (43)  97.8  07m / 3600  117.58  boxes (46)  17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess ers) enter	Oct  106.13  Total = Sun  138.67  Total = Sun  20.8	Nov  110.29  m(44) <sub>1 12</sub> =  ables 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	114.45 c, 1d) 164.37 24.66		(43) (44) (45) (46) (47)

Hot water storage loss factor from Table 2 (kWh/	/litre/day)					0		(51)
If community heating see section 4.3							I	
Volume factor from Table 2a  Temperature factor from Table 2b					-	0		(52)
·		(47) (54)	(50) (	-0)		0	] 	(53)
Energy lost from water storage, kWh/year Enter (50) or (54) in (55)		(47) x (51)	x (52) x (	53) =		0		(54)
, , , , ,		((56)m = (	55) v (41)r	m		0		(55)
Water storage loss calculated for each month		((56)m = (56)m = (56					l	(50)
(56)m= $\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ & 0 & \text{solar storage, (57)m = (56)m x} \end{bmatrix}$	0 0	0	0	0 m whore (	0	0 m Annond	iv L	(56)
$(57)\text{m} = \begin{array}{ c c c c c c c c c c c c c c c c c c c$	0 0	0), else (37	0	0	0	0		(57)
				0			 	. ,
Primary circuit loss (annual) from Table 3	0)m = (E9) : 36	SE ~ (41)	<b>~</b>			0		(58)
Primary circuit loss calculated for each month (59 (modified by factor from Table H5 if there is so				· thermo	etat)			
(59)m= 0 0 0 0 0	0 0		0	0	0	0		(59)
	20) - 205 - (44)	<u> </u>				-	I	` '
Combi loss calculated for each month (61)m = (6	<del></del>		40.00	50.00	40.00	50.00	1	(61)
` '	46.18 47.72	49.84	49.32	50.96	49.32	50.96		` '
Total heat required for water heating calculated for	1	<del>`´</del>	i			<del>`</del>	(59)m + (61)n ı	
` '	156.76   150.19	167.42	168.3	189.63	200.68	215.33		(62)
Solar DHW input calculated using Appendix G or Appendix H				contribut	on to wate	er heating)		
(add additional lines if FGHRS and/or WWHRS a							ı	(00)
(63)m= 0 0 0 0 0	0 0	0	0	0	0	0		(63)
Output from water heater								
(64)m= 220.69 194.47 204.14 182.86 177.98	156.76 150.19	167.42	168.3	189.63	200.68	215.33		_
		Outp	ut from wa	ater heater	(annual)₁	12	2228.45	(64)
Heat gains from water heating, kWh/month 0.25	[0.85 × (45)m	+ (61)m	] + 0.8 x	[(46)m	+ (57)m	+ (59)m	]	
(65)m= 69.17 60.86 63.67 56.73 55.07	48.31 46	51.56	51.89	58.85	62.66	67.39		(65)
include (57)m in calculation of (65)m only if cyl	linder is in the o	dwelling	or hot w	ater is fr	om com	munity h	eating	
5. Internal gains (see Table 5 and 5a):								
Metabolic gains (Table 5), Watts								
Jan Feb Mar Apr May	Jun Jul	Aug	Sep	Oct	Nov	Dec		
(66)m= 147.05 147.05 147.05 147.05 147.05	147.05 147.05	147.05	147.05	147.05	147.05	147.05		(66)
Lighting gains (calculated in Appendix L, equation	on L9 or L9a), a	Iso see 7	able 5					
(67)m= 29 25.76 20.95 15.86 11.86	10.01 10.81	14.06	18.87	23.96	27.96	29.81		(67)
Appliances gains (calculated in Appendix L, equa	ation L13 or L1	3a), also	see Tal	ole 5				
	257.73 243.37	240	248.5	266.61	289.47	310.96		(68)
Cooking gains (calculated in Appendix L, equation	on L15 or L15a	). also se	e Table	5				
(69)m= 37.7 37.7 37.7 37.7 37.7	37.7 37.7	37.7	37.7	37.7	37.7	37.7		(69)
Pumps and fans gains (Table 5a)		<u> </u>					I	
(70)m= 3 3 3 3 3 3	3 3	3	3	3	3	3	I	(70)
Losses e.g. evaporation (negative values) (Table			-	-			I	. ,
	-117.64 -117.64	-117.64	-117.64	-117.64	-117.64	-117.64		(71)
				. 17.04	1	. 17.04	I	\*- */
Water heating gains (Table 5) (72)m= 92.98 90.57 85.58 78.8 74.02	67.1 61.83	69.3	72.07	79.09	87.02	90.58		(72)
(12)111- 92.90 90.01 00.00 10.0 14.02	01.1 01.03	08.3	12.01	1 9.09	07.02	9U.U6	I	(12)

Total internal	<del>-</del>				·	1		)m + (69)m +	·	, , , ,		İ	/70
(73)m= 517.4	515.13	496.82	466.84	435.19	404.9	386.13	393.	46 409.56	439.78	3 474.57	501.46		(73)
6. Solar gains Solar gains are of		ieina eola	r flux from	Table 6a	and acc	ociated equa	tions t	o convert to th	ne annlic	able orientat	ion		
Orientation: A		•	Area			Flux	1110113 1		іс аррііс	FF	ЮП.	Gains	
	Table 6d	actor	m <sup>2</sup>			Γable 6a		g_ Table 6b		Table 6c		(W)	
Southeast <sub>0.9x</sub>	0.77	x	6.	8	х	36.79	] <sub>x</sub> [	0.63	×	0.7		76.46	(77)
Southeast <u>0.9x</u>	0.77	X	7.7		x -	36.79	] <sub>x</sub> [	0.63	×	0.7	=	87.15	(77)
Southeast <sub>0.9x</sub>	0.77	X	6.		x 🗀	62.67	] <sub>x</sub> [	0.63	x	0.7		130.25	(77)
Southeast <sub>0.9x</sub>	0.77	x	7.7	75	x	62.67	x	0.63	x	0.7	=	148.44	(77
Southeast <sub>0.9x</sub>	0.77	x	6.	8	x	85.75	x	0.63	x	0.7	=	178.21	(77
Southeast <sub>0.9x</sub>	0.77	x	7.7	75	x	85.75	x	0.63	x	0.7	<b>=</b>	203.11	(77)
Southeast <sub>0.9x</sub>	0.77	X	6.	8	x	106.25	x	0.63	x	0.7	=	220.81	(77
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	x	106.25	x	0.63	x	0.7	=	251.66	(77)
Southeast <sub>0.9x</sub>	0.77	X	6.	8	x	119.01	х	0.63	x	0.7	=	247.32	(77)
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	x	119.01	х	0.63	x	0.7	=	281.88	(77)
Southeast <sub>0.9x</sub>	0.77	X	6.	8	x	118.15	Х	0.63	X	0.7		245.54	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	X	7.7	75	x	118.15	_ x [	0.63	x	0.7	=	279.84	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	X	6.	8	x	113.91	] ×	0.63	x	0.7	=	236.72	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	X	7.	75	x	113.91	] /x [	0.63	x	0.7	=	269.79	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	X	6.	8	x	104.39	x	0.63	x	0.7	=	216.94	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	X	7.7	75	x	104.39	х	0.63	X	0.7	=	247.25	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	х	6.	8	x	92.85	_ x	0.63	x	0.7	=	192.96	(77
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	x	92.85	_ x [	0.63	X	0.7	=	219.92	(77
Southeast <sub>0.9x</sub>	0.77	X	6.	8	x	69.27	x	0.63	X	0.7	=	143.95	(77
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	x	69.27	х	0.63	X	0.7	=	164.06	(77
Southeast <sub>0.9x</sub>	0.77	X	6.	8	X	44.07	x	0.63	X	0.7	=	91.59	(77
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	X	44.07	x	0.63	X	0.7	=	104.38	(77
Southeast <sub>0.9x</sub>	0.77	X	6.	8	X	31.49	x	0.63	X	0.7	=	65.44	(77
Southeast <sub>0.9x</sub>	0.77	X	7.7	75	X	31.49	x	0.63	X	0.7	=	74.58	(77
Southwest <sub>0.9x</sub>	0.77	X	3.6	88	X	36.79	] [	0.63	X	0.7	=	41.38	(79
Southwest <sub>0.9x</sub>	0.77	X	3.9	97	X	36.79	] [	0.63	X	0.7	=	44.64	(79
Southwest <sub>0.9x</sub>	0.77	X	3.6	88	x	62.67	] [	0.63	X	0.7	=	70.49	(79
Southwest <sub>0.9x</sub>	0.77	X	3.9	97	X	62.67	] [	0.63	X	0.7	=	76.04	(79
Southwest <sub>0.9x</sub>	0.77	X	3.6	88	x	85.75	[	0.63	x	0.7	=	96.44	(79
Southwest <sub>0.9x</sub>	0.77	X	3.9	97	x	85.75	[	0.63	x	0.7	=	104.04	(79
Southwest <sub>0.9x</sub>	0.77	X	3.6	88	×	106.25	[	0.63	X	0.7	=	119.5	(79
Southwest <sub>0.9x</sub>	0.77	X	3.9	97	×	106.25	] [	0.63	X	0.7	=	128.91	(79
Southwest <sub>0.9x</sub>	0.77	X	3.6	88	×	119.01	[	0.63	×	0.7	=	133.85	(79
Southwest <sub>0.9x</sub>	0.77	x	3.9	97	x	119.01		0.63	X	0.7	=	144.39	(79)

Southwosto		1		1		1		l		1		7,70
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	118.15	] 1	0.63	X	0.7	] =	132.88	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	118.15	<u> </u>	0.63	X	0.7	] =	143.35	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	113.91	<u> </u>	0.63	X	0.7	] =	128.11	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	113.91	<u> </u>	0.63	X	0.7	=	138.2	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	104.39	<u> </u>	0.63	X	0.7	=	117.4	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	104.39	<u> </u>	0.63	X	0.7	=	126.66	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	92.85	<u> </u>	0.63	X	0.7	=	104.43	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	92.85	[	0.63	X	0.7	=	112.66	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	69.27	_	0.63	X	0.7	=	77.9	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	69.27	_	0.63	X	0.7	=	84.04	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	x	44.07	<u> </u>	0.63	X	0.7	=	49.56	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	44.07	<u> </u>	0.63	X	0.7	=	53.47	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.68	X	31.49	]	0.63	X	0.7	=	35.41	(79)
Southwest <sub>0.9x</sub>	0.77	X	3.97	X	31.49	]	0.63	X	0.7	=	38.2	(79)
Northwest <sub>0.9x</sub>	0.77	X	0.57	X	11.28	X	0.63	X	0.7	=	1.97	(81)
Northwest 0.9x	0.77	X	4.25	x	11.28	X	0.63	X	0.7	=	14.65	(81)
Northwest <sub>0.9x</sub>	0.77	X	0.57	X	22.97	X	0.63	X	0.7	=	4	(81)
Northwest 0.9x	0.77	X	4.25	X	22.97	Х	0.63	X	0.7	] =	29.83	(81)
Northwest 0.9x	0.77	x	0.57	x	41.38	] x	0.63	x	0.7	=	7.21	(81)
Northwest 0.9x	0.77	x	4.25	x	41.38	x	0.63	X	0.7	] =	53.75	(81)
Northwest 0.9x	0.77	x	0.57	X	67.96	<b>x</b>	0.63	x	0.7	] =	11.84	(81)
Northwest 0.9x	0.77	X	4.25	х	67.96	Х	0.63	x	0.7	=	88.26	(81)
Northwest 0.9x	0.77	X	0.57	Х	91.35	Х	0.63	X	0.7	=	15.91	(81)
Northwest 0.9x	0.77	X	4.25	х	91.35	X	0.63	X	0.7	=	118.65	(81)
Northwest 0.9x	0.77	X	0.57	X	97.38	X	0.63	X	0.7	=	16.96	(81)
Northwest 0.9x	0.77	X	4.25	X	97.38	X	0.63	X	0.7	=	126.49	(81)
Northwest 0.9x	0.77	X	0.57	X	91.1	X	0.63	X	0.7	=	15.87	(81)
Northwest 0.9x	0.77	X	4.25	X	91.1	X	0.63	X	0.7	=	118.33	(81)
Northwest 0.9x	0.77	X	0.57	X	72.63	X	0.63	X	0.7	=	12.65	(81)
Northwest 0.9x	0.77	X	4.25	X	72.63	X	0.63	X	0.7	=	94.33	(81)
Northwest <sub>0.9x</sub>	0.77	X	0.57	x	50.42	x	0.63	x	0.7	=	8.78	(81)
Northwest <sub>0.9x</sub>	0.77	X	4.25	x	50.42	x	0.63	x	0.7	=	65.49	(81)
Northwest 0.9x	0.77	x	0.57	x	28.07	x	0.63	x	0.7	=	4.89	(81)
Northwest <sub>0.9x</sub>	0.77	X	4.25	X	28.07	x	0.63	x	0.7	=	36.46	(81)
Northwest <sub>0.9x</sub>	0.77	X	0.57	x	14.2	x	0.63	X	0.7	=	2.47	(81)
Northwest 0.9x	0.77	x	4.25	x	14.2	x	0.63	x	0.7	=	18.44	(81)
Northwest <sub>0.9x</sub>	0.77	×	0.57	x	9.21	x	0.63	x	0.7	=	1.61	(81)
Northwest <sub>0.9x</sub>	0.77	×	4.25	x	9.21	x	0.63	x	0.7	] =	11.97	(81)
Rooflights <sub>0.9x</sub>	1	×	2.01	×	26	×	0.63	x	0.7	j =	20.74	(82)
Rooflights <sub>0.9x</sub>	1	x	2.01	x	26	x	0.63	x	0.7	j =	20.74	(82)
Rooflights <sub>0.9x</sub>	1	×	2.9	×	26	×	0.63	x	0.7	j =	59.89	(82)
_		•		•		•		•		•		_

Rooflights 0.9x 1	1		1		1		¬ г		_		¬(00)
D (1)	X	2.01	X	54	X	0.63	_	0.7	=	43.07	(82)
Rooflights 0.9x 1	X	2.01	X	54	X	0.63	_	0.7	=	43.07	(82)
Rooflights 0.9x 1	X	2.9	Х	54	X	0.63	_  ×	0.7	=	124.4	(82)
Rooflights 0.9x 1	X	2.01	X	96	X	0.63	_ x [	0.7	=	76.57	(82)
Rooflights 0.9x	X	2.01	X	96	X	0.63	_ x [	0.7	=	76.57	(82)
Rooflights 0.9x	X	2.9	X	96	X	0.63	x [	0.7	=	221.15	(82)
Rooflights 0.9x 1	X	2.01	X	150	X	0.63	x	0.7	=	119.65	(82)
Rooflights 0.9x 1	X	2.01	X	150	X	0.63	] x [	0.7	=	119.65	(82)
Rooflights <sub>0.9x</sub> 1	X	2.9	X	150	X	0.63	x [	0.7	=	345.54	(82)
Rooflights 0.9x 1	X	2.01	x	192	X	0.63	] x [	0.7	=	153.15	(82)
Rooflights 0.9x 1	X	2.01	X	192	x	0.63	x	0.7	=	153.15	(82)
Rooflights 0.9x 1	X	2.9	X	192	x	0.63	x	0.7	=	442.3	(82)
Rooflights <sub>0.9x</sub> 1	x	2.01	х	200	x	0.63	- x	0.7	_ =	159.53	(82)
Rooflights 0.9x 1	x	2.01	х	200	х	0.63	ī x [	0.7	=	159.53	(82)
Rooflights 0.9x 1	x	2.9	x	200	x	0.63		0.7	=	460.72	(82)
Rooflights 0.9x 1	X	2.01	x	189	x	0.63	זֿ × דֿ	0.7	=	150.76	(82)
Rooflights 0.9x 1	X	2.01	х	189	x	0.63		0.7		150.76	(82)
Rooflights 0.9x	X	2.9	X	189	Х	0.63	Х	0.7		435.38	(82)
Rooflights 0.9x	i x	2.01	Х	157	)   X	0.63	X	0.7	= 4	125.23	(82)
Rooflights 0.9x	X	2.01	x	157	1 x	0.63	x	0.7	= =	125.23	(82)
Rooflights <sub>0.9x</sub>	X	2.9	X	157	] ]	0.63	X	0.7	_	361.67	(82)
Rooflights 0.9x	] ] x	2.01	X	115	] 	0.63	X	0.7	_	91.73	(82)
Rooflights 0.9x 1	)	2.01	X	115	) ^ ] <sub>X</sub>	0.63	l x	0.7	= =	91.73	(82)
Rooflights 0.9x	]	2.9	X	115	] ^ ] x	0.63	l x	0.7	= =	264.92	(82)
Rooflights 0.9x 1	]	2.01	X	66	] ^ ] <sub>x</sub>	0.63	] × [	0.7	= =	52.65	(82)
Rooflights 0.9x	]	2.01	l ^	66	] ^ ] x	0.63	」^L ] x 「	0.7	= =	52.65	(82)
Rooflights 0.9x 1	]	2.9	l ^ l x	66	] ^ ] x	0.63	」^L ] x 「	0.7	╡ -	152.04	(82)
Rooflights 0.9x	1		! !	33	] ^ ] x		╡		<b>=</b>	26.32	(82)
Daafiinkta	X	2.01	X		1	0.63	」 ×	0.7	╡ -		(82)
D. G. G. Li	] X	2.01	X	33	] X ] ,	0.63	_	0.7	╡ -	26.32	≓
D . (i) . L .	X	2.9	X I	33	X 1	0.63	X	0.7	<b>=</b>	76.02	(82)
D . (i) . l . l	X	2.01	X	21	X	0.63	_  ×	0.7	=	16.75	(82)
Rooflights 0.9x 1	X	2.01	X	21	X	0.63	_  ×	0.7	=	16.75	(82)
Rooflights 0.9x 1	X	2.9	X	21	X	0.63	x [	0.7	=	48.38	(82)
					(2.2)	- (= t)	(22)				
Solar gains in watts, calcul- (83)m= 367.62 669.59 101		1405.82 1690.5		724.84 1643.92	<del>`</del>	7.36 1152.61	(82)m 768.63	448.58	309.08		(83)
Total gains – internal and s					142	.30 1132.01	700.03	440.36	309.00		(00)
<u> </u>		1872.66 2125.7	<u> </u>	29.79 2030.05	1820	0.83 1562.17	1208.4	923.15	810.55		(84)
		!		2000.00	1020	7.00 1302.17	1200.4	323.13	010.00		(01)
7. Mean internal temperat						<b>-</b> 1 4 (0.0)					<b>7</b>
Temperature during heating	•		•		ole 9	, In1 (°C)				21	(85)
Utilisation factor for gains	$\overline{}$	<del></del>	Ť	<u> </u>				1 1		I	
Jan Feb M	lar	Apr May	y	Jun Jul	<u> </u>	ug Sep	Oct	Nov	Dec		

(86)m=	1	0.99	0.98	0.91	0.77	0.58	0.43	0.5	0.77	0.96	1	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	in Tabl	e 9c)					
(87)m=	19.49	19.74	20.11	20.55	20.84	20.97	20.99	20.99	20.88	20.43	19.86	19.44		(87)
Temp	erature	during h	neating p	eriods ir	n rest of	dwelling	from Ta	able 9, T	h2 (°C)					
(88)m=	19.81	19.81	19.81	19.82	19.82	19.83	19.83	19.83	19.83	19.82	19.82	19.82		(88)
Utilisa	ation fac	tor for g	ains for	rest of d	welling,	h2,m (se	ee Table	9a)						
(89)m=	1	0.99	0.97	0.88	0.71	0.49	0.32	0.38	0.68	0.95	0.99	1		(89)
Mean	interna	l temper	ature in	the rest	of dwell	ing T2 (f	ollow ste	eps 3 to	7 in Tabl	e 9c)	-	-		
(90)m=	17.8	18.17	18.71	19.32	19.68	19.81	19.83	19.83	19.74	19.18	18.36	17.75		(90)
		-	-	-	-		-	-	f	LA = Livin	ig area ÷ (4	4) =	0.26	(91)
Mean	interna	l temper	ature (fo	r the wh	ole dwe	lling) = fl	LA × T1	+ (1 – fL	A) × T2					
(92)m=	18.25	18.58	19.08	19.64	19.99	20.11	20.13	20.13	20.04	19.51	18.76	18.19		(92)
Apply	adjustn	nent to t	he mear	interna	temper	ature fro	m Table	4e, whe	ere appro	priate			•	
(93)m=	18.25	18.58	19.08	19.64	19.99	20.11	20.13	20.13	20.04	19.51	18.76	18.19		(93)
			uirement											
			ernal ter or gains			ned at ste	ep 11 of	l able 9	b, so tha	t li,m=(	76)m an	d re-calc	culate	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa	ation fac	tor for g	ains, hm											
(94)m=	1	0.99	0.96	0.88	0.71	0.51	0.35	0.41	0.7	0.94	0.99	1		(94)
Us <mark>ef</mark> u	ı <mark>l g</mark> ains,		, W = (94	<u> </u>										
(95)m=	881.85			1641.99			712.23	747.14	1094.95	1136.61	915.17	808.54		(95)
		_	rnal tem		·		100			10.0				(00)
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1 (06)m	10.6	7.1	4.2		(96)
		2827.71		· -	1	1117.74	716.39	755.4	– (96)m 1208.12	1820.34	2388.54	2876.74		(97)
. ,		ļ		<u> </u>	<u> </u>	ļ			)m – (95					, ,
(98)m=		1113.74	848.9	399.88	128.9	0	0	0	0	508.69	1060.83	1538.74		
			•			•	•	Tota	l per year	(kWh/year	r) = Sum(9	8)15,912 =	7092.37	(98)
Space	e heatin	g require	ement in	kWh/m²	²/year								45.92	(99)
9a. En	erav red	uiremer	nts – Indi	ividual h	eating s	ystems i	ncludina	micro-C	CHP)					
	e heatir	•				,			,					
Fracti	on of sp	ace hea	at from s	econdar	y/supple	ementary	system						0	(201)
Fracti	on of sp	ace hea	at from m	nain syst	em(s)			(202) = 1	<b>- (201) =</b>				1	(202)
Fracti	on of to	tal heati	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								93.4	(206)
Efficie	ency of	seconda	ry/suppl	ementar	y heatin	g systen	ո, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/y	— ear
Space		<u> </u>	ement (c	<u> </u>			·							
	1492.7	1113.74	848.9	399.88	128.9	0	0	0	0	508.69	1060.83	1538.74		
(211)m	n = {[(98	)m x (20	4)] } x 1	00 ÷ (20	06)									(211)
	1598.18	1192.44	908.89	428.14	138.01	0	0	0	0	544.64		1647.47		
								Tota	ıl (kWh/yea	ar) =Sum(2	211),15,10. 12	=	7593.55	(211)

Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)							
(215)m= 0 0 0 0 0	0 0	0 0	0	0	0	]	
	!	Total (kWh/y	ear) =Sum(	215) <sub>15,10. 1</sub>	=	0	(215)
Water heating					'		
Output from water heater (calculated above)  220.69   194.47   204.14   182.86   177.98   194.47   194	56.76 150.19	167.42 168.3	189.63	200.68	215.33	]	
Efficiency of water heater	1	1	1			80.3	(216)
(217)m= 88.96 88.74 88.25 86.97 84.25 8	80.3 80.3	80.3 80.3	87.41	88.63	89.03		(217)
Fuel for water heating, kWh/month	•	•	•	•	•	•	
$(219)m = (64)m \times 100 \div (217)m$ (219)m = 248.08  219.15  231.33  210.27  211.25  19	95.21 187.03	208.49 209.59	216.93	226.43	241.88	1	
	1 .550	Total = Sum		1	1	2605.63	(219)
Annual totals			k	Wh/yea	r	kWh/yea	
Space heating fuel used, main system 1						7593.55	
Water heating fuel used						2605.63	
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						512.18	(232)
12a. CO2 emissions – Individual heating systems	s including mi	icro-CHP	_				
	Engrav		Emico	ion fac	+o#	Emissions	
	<b>Energy</b> kWh/year		kg CO		loi	kg CO2/ye	
Space heating (main system 1)	(211) x		0.2	16	=	1640.21	(261)
Space heating (secondary)	(215) x		0.5	19	=	0	(263)
Water heating	(219) x		0.2	16	=	562.82	(264)
Space and water heating	(261) + (262)	+ (263) + (264) =				2203.02	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.5	19	=	38.93	(267)
Electricity for lighting	(232) x		0.5	19	=	265.82	(268)
Total CO2, kg/year		sum	of (265)	271) =		2507.77	(272)
TER =						16.24	(273)



# Appendix Energy Assessment Ellerdale Road

## LEAN Scenario

			User D	etails:						
Assessor Name:				Strom	a Num	ber:				
Software Name:	Stroma FSAP	2012		Softwa	are Ve	rsion:		Versio	n: 1.0.1.25	
		Р	roperty i	Address	: House	1-LEAN				
Address :	1 Ellerdale Road	t								
1. Overall dwelling dime	ensions:									
			Area	a(m²)		Av. He	ight(m)		Volume(m <sup>3</sup>	)
Basement				67	(1a) x	2	2.6	(2a) =	174.2	(3a)
Ground floor			8	7.44	(1b) x		3	(2b) =	262.32	(3b)
Total floor area TFA = (1	a)+(1b)+(1c)+(1d)+	+(1e)+(1r	1) 1!	54.44	(4)			J		_
Dwelling volume					(3a)+(3b	)+(3c)+(3d	l)+(3e)+	.(3n) =	436.52	(5)
2. Ventilation rate:										_
	main	secondar	у	other		total			m³ per hou	r
Number of chimneys	heating	heating 0	+ [	0	] = [	0	X 4	40 =	0	(6a)
Number of open flues	0 +	0		0	j = [	0	x	20 =	0	(6b)
Number of intermittent fa	ns				 	0	x ·	10 =	0	(7a)
Number of passive vents					Ē	0	x .	10 =	0	(7b)
Number of flueless gas fi	res				\	0	X 4	40 =	0	(7c)
								∆ir ch	anges per ho	⊔ \lir
Infiltration due to chimne	vo flues and fone	- (6a)+(6b)+(7	(2)+(7h)+(	70) =						_
If a pressurisation test has b	7				continue fr	0 rom (9) to (		÷ (5) =	0	(8)
Number of storeys in the		σ, σ	(17),			(0) 10 (	. 5)		0	(9)
Additional infiltration							- [(9)	-1]x0.1 =	0	(10)
Structural infiltration: 0	.25 for steel or timb	ber frame or	0.35 for	masoni	y constr	ruction			0	(11)
if both types of wall are p		orresponding to	the great	er wall are	a (after					
deducting areas of openial If suspended wooden	•	sealed) or 0	1 (spale	معام (امر	antar ()				^	(12
If no draught lobby, en	,	,	. i (Scaic	.u), cisc	CITICI O				0	(13)
Percentage of windows									0	(14)
Window infiltration	o ana acoro araagi	it ourppou		0.25 - [0.2	: x (14) ÷ 1	100] =			0	(15)
Infiltration rate						- 12) + (13) -	+ (15) =		0	(16)
Air permeability value,	a50, expressed in	cubic metre	s per ho	our per s	guare m	etre of e	nvelope	area	3	(17)
If based on air permeabil	•		•	•	•				0.15	(18)
Air permeability value applie	•					is being us	sed		0.10	
Number of sides sheltere	ed								2	(19)
Shelter factor				(20) = 1 -	[0.075 x (	19)] =			0.85	(20)
Infiltration rate incorporat	ing shelter factor			(21) = (18	) x (20) =				0.13	(21)
Infiltration rate modified f	or monthly wind sp	eed								
Jan Feb	Mar Apr M	lay Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp	eed from Table 7									
(22)m= 5.1 5	4.9 4.4 4.3	3 3.8	3.8	3.7	4	4.3	4.5	4.7		

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		
		!				<u> </u>	<u> </u>	!	<u>!</u>	Į	<u> </u>		l	
Adjusted i						1	<u> </u>	<del>`´</del>	<del>ì ´</del>	1			Ī	
0 Calculate	· I	0.16 <i>ve air d</i>	0.16 Change i	0.14 rate for t	0.14 he appli	0.12 cable ca	0.12 se	0.12	0.13	0.14	0.14	0.15		
If mech			•		.,								0.5	(23
If exhaust	t air heat	t pump u	ısing Appe	endix N, (2	(23a) = (23a	a) × Fmv (e	equation (N	N5)) , othe	rwise (23b	o) = (23a)			0.5	(23
If balance	ed with h	eat reco	very: effic	iency in %	allowing f	or in-use f	actor (from	n Table 4h	) =				76.5	(23
a) If bal	anced	mecha	anical ve	ntilation	with hea	at recov	ery (MVI	HR) (24a	a)m = (2	2b)m + (	23b) × [	1 – (23c)	÷ 100]	
· L		0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27		(24
	anced	mecha	anical ve	ntilation	without	heat red	covery (N	ЛV) (24b	o)m = (2	2b)m + (	23b)		Ī	
24b)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24
,					•	•	ventilatio			F (00l-				
	2b)m <	< 0.5 ×	(23b), t	nen (24)	(230) = (230)	o); otner	wise (24)	C) = (220)	0) m + 0	.5 × (23b	ŕ		1	(24
24c)m=			-							ļ <sup>0</sup>	0	0		(24
							ventilatio !4d)m = (			0.5]				
24d)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24
Effective	e air ch	nange	rate - er	iter (24a	) or (24k	o) or (24	c) or (24	d) in box	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. Heat lo	neses :	and he	at loss r	naramet	er.									
		ariu ric	at 1000 h	Jai aii ict										
I EME	NT	Gros	is	Openin		Net Ar	ea	U-valı	ue	AXU		k-value	9	ΑΧk
ELEME	NT	Gros area		Openin m	gs	Net Ar A ,r		U-valı W/m2		A X U (W/I	<b>&lt;</b> )	k-value kJ/m²·l		A X k kJ/K
	NT	7			gs		m²				<) 			kJ/K
Doo <mark>rs</mark>		area			gs	A ,r	m² x	W/m2	2K =	(W/I	<) 			kJ/K (26
Doo <mark>rs</mark> Windows	Type 1	area			gs	A ,r	m <sup>2</sup> x x1/	W/m2	= 0.04] =	(W/l	<) 			
Doo <mark>rs</mark> Vindows Vindows	Type 1 Type 2	area			gs	A ,r	x1/	W/m2 1.2 /[1/( 1.2 )+	= 0.04] = 0.04] =	(W/l 2.112 0.81	<) 			kJ/K (26 (27
Doo <mark>rs</mark> Windows Windows	Type 1 Type 2 Type 3	area			gs	A ,r 1.76 0.71 5.29	x1/ x1/ x1/	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] =	0.81 6.06	<) 			(26 (27 (27 (27
Doo <mark>rs</mark> Windows Windows Windows Windows	Type 1 Type 2 Type 3 Type 4	area			gs	A ,r 1.76 0.71 5.29 8.46	x1/ x1/ x1/ x1/	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] = 0.04] =	0.81 6.06 9.69	<) 			kJ/K (26 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows	Type 1 Type 2 Type 3 Type 4 Type 5	area			gs	A ,r 1.76 0.71 5.29 8.46 9.64	x1/ x1/ x1/ x1/ x1/ x1/	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] = 0.04] = 0.04] =	2.112 0.81 6.06 9.69 11.04	<) 			kJ/K (26 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Windows Windows	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6	area			gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58	x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24	<)			kJ/K (26 (27 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Windows Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6	area			gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	0.81 6.06 9.69 11.04 5.24	<) 			kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
ELEMEI Doors Windows Windows Windows Windows Windows Rooflights Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6	area			gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66	<)			kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Rooflights Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6	area			gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3				kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Rooflights Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6 Type 5 Type 5	area	(m²)		gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5 3.61	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332				kJ/K (26 (27
Doors Windows Windows Windows Windows Windows Rooflights Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6 Type 5 Type 5	area 2 3 1 2 3 81.4	(m²)	m	gs l <sup>2</sup>	A ,r  1.76  0.71  5.29  8.46  9.64  4.58  4.94  2.5  2.5  3.61  87.44	x1/x1/x1/x1/x1/x1/x1/x1/x1/x1/x1/x1/x1/x	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840				kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Rooflights Rooflights Rooflights Rooflights Rooflights Rooflights	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6 Type 5 Type 5	area  2 3 1 2 3 81.4 122.7	(m²)	0 35.3	gs <sup>2</sup>	A ,r  1.76  0.71  5.29  8.46  9.64  4.58  4.94  2.5  2.5  3.61  87.44  87.41	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  0.11  0.18	2 (C ) = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65 15.73				kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Windows Windows Windows Windows Rooflights Rooflights Rooflights Floor Walls Typ	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 6 Type 6 Type 6	area  2 3 4 1 2 3 81.4 122.7 87.4	(m²)	0	gs <sup>2</sup>	A ,r  1.76  0.71  5.29  8.46  9.64  4.58  4.94  2.5  2.5  3.61  87.44  87.41  75.22	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/(1.2) +  /[1/(1.2) +  0.11  0.18	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65				kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Vindows Vindows Vindows Vindows Vindows Vindows Rooflights Rooflights Rooflights Typ Valls Typ	Type 1 Type 2 Type 3 Type 4 Type 5 Type 6 Type 5 Type 5 Type 2	area  2 3 4 1 2 3 81.4 122.7 87.4	(m²)	0 35.3	gs <sup>2</sup>	A ,r  1.76  0.71  5.29  8.46  9.64  4.58  4.94  2.5  2.5  3.61  87.44  87.41	x1/ x1/ x1/ x1/ x1/ x1/ x1/ x1/	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  0.11  0.18	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65 15.73				kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27

(26) (30) + (32) =

Fabric heat loss, W/K = S (A x U)

102.88

(33)

Heat capacity Cm = S(A	xk)						((28)	(30) + (32	2) + (32a)	(32e) =	44603.08	(34)
Thermal mass paramete	er (TMP =	= Cm ÷	TFA) in	ı kJ/m²K			Indica	tive Value:	Medium		250	(35)
For design assessments where can be used instead of a detail			constructi	ion are not	t known pr	ecisely the	indicative	values of	TMP in Ta	able 1f		
Thermal bridges : S (L x	Y) calcu	ılated ι	ısing Ap	pendix l	<						56.86	(36)
if details of thermal bridging ar	re not know	vn (36) =	: 0.15 x (3	1)								
Total fabric heat loss							(33) +	(36) =			159.74	(37)
Ventilation heat loss cald	culated m	nonthly	′				(38)m	= 0.33 × (	25)m x (5)		_	
Jan Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m= 40.34 39.88	39.43	37.13	36.67	34.37	34.37	33.92	35.29	36.67	37.59	38.51		(38)
Heat transfer coefficient,	, W/K	·					(39)m	= (37) + (3	38)m		_	
(39)m= 200.08 199.62	199.16 1	196.87	196.41	194.11	194.11	193.65	195.03	196.41	197.33	198.25		_
Heat loss parameter (HL	₋P), W/m²	ı²K						Average = = (39)m ÷	· /	12 /12=	196.75	(39)
(40)m= 1.3 1.29	1.29	1.27	1.27	1.26	1.26	1.25	1.26	1.27	1.28	1.28		
Number of days in montl	h (Table	1a)					,	Average =	Sum(40) <sub>1</sub>	12 /12=	1.27	(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. Water heating energy	v require	ement:						_		kWh/y	ear:	
Assumed occupancy, N if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1 Annual average hot wate Reduce the annual average ho not more that 125 litres per per	er usage ot water usa	in litre	s per da	ay Vd,av	erage = designed t	(25 x N)	+ 36		9)	94		(42)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot more that 125 litres per per	er usage ot water usa erson per da	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, f	y Vd,av welling is not and co	erage = designed t	(25 x N) o achieve	+ 36 a water us	se target of	9)	1.05		` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average ho	er usage ot water usa erson per da	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, F	y Vd,av welling is not and co	erage = designed t ld)	(25 x N) to achieve	+ 36		9)			` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage ot water usa erson per da Mar	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, F	y Vd,av welling is not and co	erage = designed t ld)	(25 x N) to achieve	+ 36 a water us	se target of	9)	1.05		` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage ot water usa erson per da Mar	in litre sage by s ay (all wa Apr n month	s per da 5% if the d ater use, t May Vd,m = fac	y Vd,av welling is not and co Jun ctor from	erage = designed t id)  Jul Fable 1c x	(25 x N) to achieve Aug (43)	+ 36 a water us Sep	oe ta <mark>rget of</mark> Oct	9) 10 <sup>4</sup> Nov 110.29	Dec 114.45	1248.56	` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage of water usa	in litre page by 5 ay (all wa Apr n month	s per da 5% if the d ater use, I May Vd,m = fac 97.8	y Vd,av welling is not and co Jun ctor from 1	erage = designed to do	(25 x N) o achieve  Aug (43)  97.8	+ 36 a water us Sep	Oct  106.13  Fotal = Sur	Nov 110.29 m(44) <sub>1 12</sub> =	Dec 114.45	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per per litres per per litres per de litr	er usage of water usage or son per da Mar alay for each 106.13 1	in litre page by 5 ay (all wa Apr n month	s per da 5% if the d ater use, I May Vd,m = fac 97.8	y Vd,av welling is not and co Jun ctor from 1	erage = designed to do	(25 x N) o achieve  Aug (43)  97.8	+ 36 a water us Sep	Oct  106.13  Fotal = Sur	Nov 110.29 m(44) <sub>1 12</sub> =	Dec 114.45	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de (44)m= 114.45 110.29  Energy content of hot water usage (45)m= 169.73 148.45	er usage of water usage erson per da Mar lay for each 106.13 1 seed - calculation 153.18 1	in litre lage by 5 ay (all wa Apr In month In 197 In 1933.55	s per da 5% if the dater use, t May Vd,m = fac 97.8 enthly = 4.	Jun 93.64 190 x Vd,r	erage = designed to do	(25 x N) o achieve Aug (43) 97.8 97.8	+ 36 a water us  Sep  101.97 0 kWh/more 118.99	Oct  106.13  Fotal = Sur th (see Ta	Nov  110.29  m(44) <sub>1 12</sub> = 15bles 1b, 1  151.37	1.05  Dec  114.45  c, 1d)  164.37	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per de la litres pe	er usage of water usa	in litre large by 8 ay (all wa Apr month 101.97 lated mo 133.55	s per da 5% if the dater use, I May Vd,m = fac 97.8 enthly = 4. 128.14	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58	erage = designed to	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46)	+ 36 a water us Sep 101.97 118.99 1 to (61)	Oct  106.13  Fotal = Sur  138.67  Fotal = Sur	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> =	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water usa	in litre lage by 5 ay (all wa Apr In month In 197 In 1933.55	s per da 5% if the dater use, t May Vd,m = fac 97.8 enthly = 4.	Jun 93.64 190 x Vd,r	erage = designed to do	(25 x N) o achieve Aug (43) 97.8 97.8	+ 36 a water us  Sep  101.97 0 kWh/more 118.99	Oct  106.13  Fotal = Sur th (see Ta  138.67	Nov  110.29  m(44) <sub>1 12</sub> = 15bles 1b, 1  151.37	1.05  Dec  114.45  c, 1d)  164.37		(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de (44)m= 114.45 110.29  Energy content of hot water us (45)m= 169.73 148.45  If instantaneous water heating (46)m= 25.46 22.27  Water storage loss:	er usage of water and water usage of	in litre lage by 8 ay (all wa Apr month 101.97 lated mo 133.55 f use (no 20.03	s per da 5% if the dater use, I May Vd,m = fac 97.8 enthly = 4. 128.14 hot water 19.22	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58	erage = designed to do	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64	+ 36 a water us  Sep  101.97  118.99  100 (61)  17.85	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per de la litres pe	er usage of water of the sed - calculation of the sed of the	in litre lage by 5 ay (all wa Apr In month In 101.97 In we (no 20.03 In any so	s per da 5% if the da ater use, the May Vd,m = factor of the second o	y Vd,av welling is not and co Jun 93.64 190 x Vd,r 110.58 storage), 16.59	erage = designed to do	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa	+ 36 a water us  Sep  101.97  118.99  100 (61)  17.85	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de (44)m= 114.45 110.29  Energy content of hot water us (45)m= 169.73 148.45  If instantaneous water heating (46)m= 25.46 22.27  Water storage loss:	er usage of water usage of water usage Mar Mar 106.13 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	in litre rage by 5 ay (all wa Apr 101.97 latted mo 133.55 fuse (no 20.03 any so	s per da 5% if the da ater use, the second of the second	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58 storage), 16.59	erage = designed to did)  Jul  Fable 1c x  93.64  102.47  enter 0 in  15.37  storage  litres in	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = sbles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water and usage of water usage of water usage of water (	in litre lage by Early (all was Apr 101.97)  lated moon 133.55  fuse (no 20.03)  any so k in dw (this in	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = sbles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de litres p	er usage of water and usage of water usage of water usage of water (	in litre lage by Early (all was Apr 101.97)  lated moon 133.55  fuse (no 20.03)  any so k in dw (this in	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = bles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water (as a first of the sed - calculation of the	in litre lage by 8 ay (all we hand) a month lated mo lated mo 20.03 any so k in dw (this in se factors)	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37  24.66		(43) (44) (45) (46) (47)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de litres p	er usage of water (all of the points of	in litre lage by 8 ay (all wa Apr In month I01.97  lated mo I33.55  f use (no I use (n	s per da 5% if the da ater use, I May Vd,m = fac 97.8 enthly = 4. 128.14 hot water 19.22 plar or W elling, e cludes in	y Vd,av welling is not and co Jun 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110 nstantar	erage = designed to designed t	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess ers) enter	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> =  sbles 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	1.05  Dec  114.45  c, 1d)  164.37  24.66		(43) (44) (45) (46) (47)

Hot water storage loss factor from Table 2 (kWh/	/litre/day)					0		(51)
If community heating see section 4.3							I	
Volume factor from Table 2a  Temperature factor from Table 2b					-	0		(52)
·		(47) (54)	(50) (	-0)		0	] 	(53)
Energy lost from water storage, kWh/year Enter (50) or (54) in (55)		(47) x (51)	x (52) x (	53) =		0		(54)
, , , , ,		((56)m = (	55) v (41)r	m		0		(55)
Water storage loss calculated for each month		((56)m = (56)m = (56					l	(50)
(56)m= $\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ & 0 & \text{solar storage, (57)m = (56)m x} \end{bmatrix}$	0 0	0	0	0 m whore (	0	0 m Annond	iv L	(56)
$(57)\text{m} = \begin{array}{ c c c c c c c c c c c c c c c c c c c$	0 0	0), eise (37	0	0	0	0		(57)
				0			 	. ,
Primary circuit loss (annual) from Table 3	0)m = (E9) : 36	SE ~ (41)	<b>~</b>			0		(58)
Primary circuit loss calculated for each month (59 (modified by factor from Table H5 if there is so				· thermo	etat)			
(59)m= 0 0 0 0 0	0 0		0	0	0	0		(59)
	20) - 205 - (44)	<u> </u>				-	I	` '
Combi loss calculated for each month (61)m = (6	<del></del>		40.00	50.00	40.00	50.00	1	(61)
` '	46.18 47.72	49.84	49.32	50.96	49.32	50.96		` '
Total heat required for water heating calculated for	1	<del>`´</del>	i			<del>`</del>	(59)m + (61)n '	
` '	156.76   150.19	167.42	168.3	189.63	200.68	215.33		(62)
Solar DHW input calculated using Appendix G or Appendix H				contribut	on to wate	er heating)		
(add additional lines if FGHRS and/or WWHRS a							ı	(00)
(63)m= 0 0 0 0 0	0 0	0	0	0	0	0		(63)
Output from water heater								
(64)m= 220.69 194.47 204.14 182.86 177.98	156.76 150.19	167.42	168.3	189.63	200.68	215.33		_
		Outp	ut from wa	ater heater	(annual)₁	12	2228.45	(64)
Heat gains from water heating, kWh/month 0.25	[0.85 × (45)m	+ (61)m	] + 0.8 x	[(46)m	+ (57)m	+ (59)m	]	
(65)m= 69.17 60.86 63.67 56.73 55.07	48.31 46	51.56	51.89	58.85	62.66	67.39		(65)
include (57)m in calculation of (65)m only if cyl	linder is in the o	dwelling	or hot w	ater is fr	om com	munity h	eating	
5. Internal gains (see Table 5 and 5a):								
Metabolic gains (Table 5), Watts								
Jan Feb Mar Apr May	Jun Jul	Aug	Sep	Oct	Nov	Dec		
(66)m= 147.05 147.05 147.05 147.05 147.05	147.05 147.05	147.05	147.05	147.05	147.05	147.05		(66)
Lighting gains (calculated in Appendix L, equation	on L9 or L9a), a	Iso see 7	able 5					
(67)m= 29 25.76 20.95 15.86 11.86	10.01 10.81	14.06	18.87	23.96	27.96	29.81		(67)
Appliances gains (calculated in Appendix L, equa	ation L13 or L1	3a), also	see Tal	ole 5				
	257.73 243.37	240	248.5	266.61	289.47	310.96		(68)
Cooking gains (calculated in Appendix L, equation	on L15 or L15a	). also se	e Table	5				
(69)m= 37.7 37.7 37.7 37.7 37.7	37.7 37.7	37.7	37.7	37.7	37.7	37.7		(69)
Pumps and fans gains (Table 5a)		<u> </u>					I	
(70)m= 3 3 3 3 3 3	3 3	3	3	3	3	3	I	(70)
Losses e.g. evaporation (negative values) (Table			-	-			I	. ,
	-117.64 -117.64	-117.64	-117.64	-117.64	-117.64	-117.64		(71)
				. 17.04	1	. 17.04	I	\*- */
Water heating gains (Table 5) (72)m= 92.98 90.57 85.58 78.8 74.02	67.1 61.83	69.3	72.07	79.09	87.02	90.58		(72)
(12)111- 92.90 90.01 00.00 10.0 14.02	01.1 01.03	08.3	12.01	1 9.09	07.02	9U.U6	I	(12)

otal internal	515.13	496.82	466.84	435.19	404.95	386.13	393.46	409.56	439.78	474.57	501.46	1	(73
6. Solar gains		490.02	400.04	433.19	404.93	300.13	393.40	709.50	459.70	7 474.57	301.40		(, )
Solar gains are o		using solar	r flux from	Table 6a	and asso	ciated equa	tions to	convert to th	e applica	able orientat	ion.		
rientation: A	Access F	actor	Area		FI	ux		g_		FF		Gains	
٦	Table 6d		m²		Ta	able 6a		Table 6b	-	Table 6c		(W)	
outheast 0.9x	0.77	x	8.4	16	x	36.79	x	0.55	х	0.8	=	94.91	(77
outheast 0.9x	0.77	x	9.6	64	x	36.79	x	0.55	x	0.8	=	108.15	(77
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	62.67	x	0.55	x	0.8	=	161.67	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	62.67	x	0.55	x	0.8		184.22	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	85.75	x	0.55	x	0.8	=	221.21	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	85.75	x	0.55	x	0.8		252.06	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	106.25	x	0.55	x	0.8	=	274.09	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	106.25	x	0.55	x	0.8	=	312.32	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	119.01	x	0.55	x	0.8	=	307	(7
outheast 0.9x	0.77	X	9.6	64	x	119.01	x	0.55	X	0.8	=	349.82	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	118.15	Х	0.55	X	0.8	=	304.78	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	118.15	x	0.55	x	0.8		347.29	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	113.91	×	0.55	x	0.8	=	293.84	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	113.91	x [	0.55	x	0.8	=	334.83	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	104.39	X C	0.55	x	0.8	=	269.29	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	104.39	Х	0.55	х	0.8	=	306.85	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	92.85	x	0.55	x	0.8	=	239.52	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	X	92.85	x	0.55	X	0.8	=	272.93	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	X	69.27	x	0.55	X	0.8	=	178.68	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	69.27	x	0.55	x	0.8	=	203.61	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	44.07	x	0.55	x	0.8		113.69	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	44.07	x	0.55	x	8.0	=	129.54	(7
outheast <sub>0.9x</sub>	0.77	X	8.4	16	x	31.49	x	0.55	x	0.8	=	81.23	(7
outheast <sub>0.9x</sub>	0.77	X	9.6	64	x	31.49	x	0.55	x	8.0	=	92.56	(7
outhwest <sub>0.9x</sub>	0.77	X	4.5	58	x	36.79		0.55	x	0.8	=	51.38	(7
outhwest <sub>0.9x</sub>	0.77	X	4.9	94	x	36.79		0.55	х	0.8	=	55.42	(7
outhwest <sub>0.9x</sub>	0.77	X	4.5	58	x	62.67		0.55	x	0.8		87.53	(7
outhwest <sub>0.9x</sub>	0.77	X	4.9	94	x	62.67		0.55	x	0.8	=	94.41	(7
outhwest <sub>0.9x</sub>	0.77	X	4.5	58	x	85.75		0.55	x	0.8	=	119.76	(7
outhwest <sub>0.9x</sub>	0.77	X	4.9	94	x	85.75		0.55	x	0.8	=	129.17	(7
outhwest <sub>0.9x</sub>	0.77	X	4.5	58	x	106.25		0.55	×	0.8	=	148.38	(7
outhwest <sub>0.9x</sub>	0.77	X	4.9	94	x	106.25		0.55	×	0.8	=	160.05	(7
outhwest <sub>0.9x</sub>	0.77	X	4.5	58	x	119.01		0.55	×	0.8	=	166.2	(7
outhwest <sub>0.9x</sub>	0.77	X	4.9	94	x	119.01		0.55	X	0.8		179.27	<del></del>

0. (1 )			1		1		ı		1		_
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	118.15	<u> </u>	0.55	X	0.8	=	165	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	118.15	ļ	0.55	X	0.8	=	177.97	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	113.91	<u> </u>	0.55	X	0.8	=	159.08	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	113.91	ļ	0.55	X	0.8	=	171.58	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	104.39	[	0.55	X	0.8	=	145.78	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	104.39	]	0.55	X	0.8	=	157.24	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	92.85	]	0.55	X	0.8	=	129.67	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	92.85		0.55	X	0.8	=	139.86	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	69.27		0.55	X	0.8	=	96.73	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	69.27		0.55	X	0.8	=	104.34	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	44.07	]	0.55	X	0.8	=	61.55	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	44.07	]	0.55	X	0.8	=	66.38	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.58	X	31.49	]	0.55	X	0.8	=	43.97	(79)
Southwest <sub>0.9x</sub> 0.77	X	4.94	X	31.49		0.55	X	0.8	=	47.43	(79)
Northwest 0.9x 0.77	X	0.71	X	11.28	X	0.55	X	0.8	=	2.44	(81)
Northwest 0.9x 0.77	X	5.29	X	11.28	X	0.55	X	0.8	=	18.2	(81)
Northwest 0.9x 0.77	X	0.71	X	22.97	X	0.55	X	0.8	=	4.97	(81)
Northwest 0.9x 0.77	x	5.29	X	22.97	Х	0.55	X	0.8	=	37.05	(81)
Northwest 0.9x 0.77	x	0.71	х	41.38	] x	0.55	x	0.8	=	8.96	(81)
Northwest 0.9x 0.77	x	5.29	х	41.38	x	0.55	x	0.8	=	66.75	(81)
Northwest 0.9x 0.77	x	0.71	X	67.96	] <b>x</b>	0.55	x	0.8	=	14.71	(81)
Northwest 0.9x 0.77	x	5.29	х	67.96	Х	0.55	X	0.8	=	109.61	(81)
Northwest 0.9x 0.77	X	0.71	Х	91.35	Х	0.55	X	0.8	=	19.78	(81)
Northwest 0.9x 0.77	X	5.29	X	91.35	x	0.55	X	0.8	<b>=</b>	147.34	(81)
Northwest 0.9x 0.77	X	0.71	X	97.38	x	0.55	X	0.8	=	21.08	(81)
Northwest 0.9x 0.77	X	5.29	X	97.38	X	0.55	X	0.8	=	157.08	(81)
Northwest 0.9x 0.77	X	0.71	X	91.1	x	0.55	X	0.8	<b>=</b>	19.72	(81)
Northwest 0.9x 0.77	X	5.29	X	91.1	x	0.55	X	0.8	=	146.95	(81)
Northwest 0.9x 0.77	X	0.71	X	72.63	X	0.55	X	0.8	=	15.72	(81)
Northwest 0.9x 0.77	X	5.29	X	72.63	x	0.55	x	0.8	=	117.15	(81)
Northwest 0.9x 0.77	X	0.71	X	50.42	x	0.55	x	0.8	=	10.92	(81)
Northwest 0.9x 0.77	X	5.29	X	50.42	x	0.55	x	0.8	=	81.33	(81)
Northwest 0.9x 0.77	X	0.71	X	28.07	X	0.55	X	0.8	=	6.08	(81)
Northwest 0.9x 0.77	X	5.29	X	28.07	x	0.55	X	0.8	<b>=</b>	45.27	(81)
Northwest 0.9x 0.77	X	0.71	X	14.2	x	0.55	X	0.8	<b>=</b>	3.07	(81)
Northwest 0.9x 0.77	X	5.29	x	14.2	x	0.55	x	0.8	] =	22.9	(81)
Northwest 0.9x 0.77	X	0.71	X	9.21	x	0.55	X	0.8	] =	1.99	(81)
Northwest 0.9x 0.77	X	5.29	X	9.21	X	0.55	X	0.8	] =	14.86	(81)
Rooflights <sub>0.9x</sub> 1	X	2.5	×	26	x	0.55	x	0.8	] =	25.74	(82)
Rooflights 0.9x 1	X	2.5	X	26	x	0.55	X	0.8	] =	25.74	(82)
Rooflights 0.9x 1	X	3.61	x	26	X	0.55	X	0.8	=	74.34	(82)

Rooflights 0.9x 1	1		1		1		¬ г		_		<b>—</b> (00)
D (C. Ivi	X	2.5	X	54	X	0.55	_	0.8	=	53.46	(82)
Rooflights 0.9x 1	X	2.5	X	54	X	0.55	X	0.8	_ =	53.46	(82)
Rooflights 0.9x 1	X	3.61	X	54	X	0.55	x [	0.8	=	154.39	(82)
Rooflights 0.9x 1	X	2.5	X	96	X	0.55	_ X [	0.8	=	95.04	(82)
Rooflights 0.9x 1	X	2.5	X	96	X	0.55	_ x [	0.8	=	95.04	(82)
Rooflights 0.9x 1	X	3.61	X	96	X	0.55	X	0.8	=	274.48	(82)
Rooflights 0.9x 1	X	2.5	X	150	X	0.55	X	8.0	=	148.5	(82)
Rooflights 0.9x 1	X	2.5	X	150	X	0.55	x	8.0	=	148.5	(82)
Rooflights 0.9x 1	X	3.61	X	150	X	0.55	x	0.8	=	428.87	(82)
Rooflights 0.9x 1	X	2.5	x	192	X	0.55	x	0.8	=	190.08	(82)
Rooflights 0.9x 1	x	2.5	x	192	x	0.55	x	0.8	=	190.08	(82)
Rooflights 0.9x 1	X	3.61	x	192	x	0.55	x	0.8	=	548.95	(82)
Rooflights 0.9x 1	x	2.5	x	200	x	0.55	<b>=</b> x [	0.8	<del>-</del>	198	(82)
Rooflights 0.9x 1	x	2.5	x	200	x	0.55	ĪxĪ	0.8	<del>=</del>	198	(82)
Rooflights 0.9x 1	X	3.61	х	200	x	0.55	×	0.8	=	571.82	(82)
Rooflights 0.9x 1	x	2.5	x	189	x	0.55	i x	0.8	=	187.11	(82)
Rooflights 0.9x 1	x	2.5	x	189	x	0.55	i x	0.8	=	187.11	(82)
Rooflights 0.9x	X	3.61	X	189	Х	0.55	Х	0.8		540.37	(82)
Rooflights 0.9x	x	2.5	х	157	х	0.55	T x	0.8	= -	155.43	(82)
Rooflights 0.9x	X	2.5	x	157	x	0.55	×	0.8	_ =	155.43	(82)
Rooflights 0.9x	X	3.61	X	157	X	0.55	T x	0.8	=	448.88	(82)
Rooflights 0.9x	ı I x	2.5	X	115	x	0.55	T x	0.8	= =	113.85	(82)
Rooflights 0.9x 1	l x	2.5	X	115	X	0.55	_ x [	0.8	= =	113.85	(82)
Rooflights 0.9x	l l x	3.61	X	115	] ]	0.55	_ x [	0.8	= =	328.8	(82)
Rooflights 0.9x 1	] x	2.5	×	66	ı I x	0.55	_  x [	0.8	= =	65.34	(82)
Rooflights 0.9x 1	X	2.5	X	66	] ]	0.55		0.8	= =	65.34	(82)
Rooflights 0.9x 1	X	3.61	l X	66	] ]	0.55		0.8	= =	188.7	(82)
Rooflights 0.9x 1	) x	2.5	×	33	] x	0.55	] x [	0.8	= =	32.67	(82)
Rooflights 0.9x 1	X	2.5	x	33	] ^ ] x	0.55	」^↓ ] x [	0.8	╡ ₌	32.67	(82)
Rooflights 0.9x 1	] ^ ] x	3.61	l ^	33	] ^ ] x	0.55	」^↓ ] x 「	0.8	╡ ₌	94.35	(82)
Rooflights 0.9x 1	] ^ ] <sub>x</sub>	2.5	^   x	21	] ^ ] x	0.55	」^↓ ] <sub>x</sub> [	0.8	╡ ₌	20.79	(82)
D. C. C.	] 1		! ]		] ]		╡ ;		╡ -		(82)
D 61.11	X	2.5	l X	21	X	0.55		0.8	=	20.79	=
Rooflights 0.9x 1	X	3.61	X	21	X	0.55	X	0.8	=	60.04	(82)
Color going in watto, coloul	oto d	for each man	łh.		(02)m	ı = Sum(74)m	(92)m				
Solar gains in watts, calculated (83)m= 456.33 831.16 1262		1745.03 2098.5	_		ì –	1.78 1430.73	(82)m 954.1	556.82	383.67	]	(83)
Total gains – internal and s		<u> </u>			L	11.70		000.02	000.07		(,
<del></del>		2211.87 2533.7	<u> </u>	45.98 2426.72	2165	5.24 1840.29	1393.8	7 1031.39	885.13		(84)
		!			<u> </u>						
7. Mean internal temperat				aroa from Tak	olo O	Th1 (°C)					(05)
Temperature during heating	•		_		JIE 9,	1111 ( C)				21	(85)
Utilisation factor for gains	_	<del></del>	Ť	<u> </u>		ua   ean	Oot	Nov	Doo	1	
Jan Feb M	lar	Apr Ma	<u>у                                    </u>	Jun Jul	LA	ug Sep	Oct	Nov	Dec	l	

(86)m=	1	0.99	0.96	0.85	0.67	0.48	0.35	0.41	0.68	0.94	0.99	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	in Tabl	e 9c)					
(87)m=	19.6	19.88	20.29	20.7	20.92	20.99	21	21	20.94	20.56	19.98	19.55		(87)
Temp	erature	during h	neating p	eriods ir	n rest of	dwelling	from Ta	able 9, T	h2 (°C)					
(88)m=	19.84	19.85	19.85	19.86	19.86	19.87	19.87	19.88	19.87	19.86	19.86	19.85		(88)
Utilisa	ation fac	tor for a	ains for	rest of d	welling.	h2.m (se	ee Table	9a)						
(89)m=	1	0.99	0.94	0.81	0.6	0.4	0.26	0.31	0.59	0.91	0.99	1		(89)
Mean	interna	l temper	ature in	the rest	of dwelli	ina T2 (f	ollow etc	ne 3 to	7 in Tabl		<u> </u>	<u> </u>		
(90)m=	17.99	18.41	18.98	19.55	19.8	19.87	19.87	19.88	19.83	19.39	18.56	17.92		(90)
(00)			10.00		10.0	1	10.01	10.00			g area ÷ (4		0.26	(91)
											`	′	0.20	(c.,
			ature (fo			· · · ·	i	· `	·	40.00			İ	(00)
(92)m=	18.41	18.8	19.32	19.85	20.09	20.16	20.17	20.17	20.12	19.69	18.93	18.35		(92)
	18.26	18.65	ne mean 19.17	19.7	19.94	20.01	20.02	20.02	re appro	19.54	18.78	18.2		(93)
(93)m=					19.94	20.01	20.02	20.02	19.97	19.54	18.78	18.2		(93)
•		· ·	uirement		ro obtoir	and at at	on 11 of	Table 0	h oo tho	+ Ti m=/	76)m on	dro oolo	vulata	
			ernai ter or gains			ied at st	ерттог	Table 9	b, so tha	t 11,m=(	76)m an	d re-calc	culate	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisa		$\overline{}$	ains, hm		111.63	00.11	J Gui	7.09	ООР		1101			
(94)m=	0.99	0.98	0.93	0.81	0.61	0.41	0.27	0.32	0.59	0.9	0.99	1		(94)
	ıl gains,	hmGm	, W = (94	1)m x (8	4)m									
(95)m=	968.6	1319.53		1782.31		1040.49	662.5	698.47	1094.23	1258.9	1017.4	882.01		(95)
Montl	nly avera	age exte	rnal tem	perature	e from Ta	able 8						ı		
(96)m=	_	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat	loss rate	for mea	an intern	al tempe	erature,	Lm , W :	=[(39)m :	x [(93)m	– (96)m	]		ı		
(97)m=	2793.08	2743.92	2524.16	2126.08	1618.73	1050.32	663.61	700.86	1144.92	1756.88	2304.65	2775.31		(97)
Space	e heatin	g require	ement fo	r each n	nonth, k	Wh/mon	th = 0.02	24 x [(97	)m – (95	)m] x (4	1)m		l	
(98)m=	1357.41	957.19	656.3	247.52	59.1	0	0	0	0	370.5	926.82	1408.62		
						•		Tota	l per year	(kWh/year	·) = Sum(9	8) <sub>15,912</sub> =	5983.46	(98)
Snac	e heatin	a require	ement in	kWh/m²	²/vear								38.74	(99)
•		•			7 y 0 0 1								00.14	
		Ĭ	quiremen		O T-1	- 1- 10b								
Caicu	Jan	Feb	July and Mar		See Tai	Jun	Jul	Διια	Sep	Oct	Nov	Dec		
Heat			L	Apr		<u> </u>	L	Aug and ext	ernal ten		<u> </u>	L		
(100)m=		0	0	0	0		1436.44		0	0	0	0		(100)
		tor for lo				102 1.07	1100.11	1171110						( = = 7
(101)m=		0	0	0	0	0.96	0.98	0.96	0	0	0	0		(101)
			Vatts) = (				1 0.00	1 0.00						, ,
(102)m=		0	0	0	0	1744.35	1404.91	1420.25	0	0	0	0		(102)
			lculated	l	<u> </u>	l .	l	l	10)					, ,
(103)m=	<u> </u>	0	0	0	0	2930.3	<del></del>			0	0	0		(103)
		a reavire	∟ ement f∩	r month	whole a	Į			/h) = 0.0	24 x [(1(	<u> </u>		ı x (41)m	
			(104)m <				20	( ///	, 5.0	[[ 10	, (	/ ] /	- ( /	
(104)m=	0	0	0	0	0	853.89	1035.87	817.98	0	0	0	0		
									Total	= Sum(	104)	=	2707.74	(104)

Cooled fraction Intermittency		ahla 10h	.\					f C =	cooled	area ÷ (4	4) =	0.66	(105)
(106)m= 0	0	0	0	0	0.25	0.25	0.25	0	0	0	0		
		<u> </u>	<u> </u>	<u> </u>	<u> </u>	ļ		Tota	l = Sum(	(104)	=	0	(106)
Space cooling	g require	ment for	month =	(104)m	× (105)	× (106)r	m				,		
(107)m= 0	0	0	0	0	141.84	172.08	135.88	0	0	0	0		_
								Total	I = Sum(	(107)	=	449.8	(107)
Space cooling	g require	ment in k	رWh/m²/y	year				(107)	) ÷ (4) =			2.91	(108)
9a. Energy re		nts – Indi	ividual h	eating sy	ystems i	ncluding	micro-C	CHP)					
Space heat	•	at from s	ocondar	v/cupplo	montary	cyctom						0	(201)
Fraction of s	•				memary	•	(202) = 1 -	(201) =				0	= '
Fraction of s	•		•	` ,				` '	(202)] -			1	(202)
Fraction of to		Ū	•				(204) = (2	02) * [1 –	(203)] =			1	(204)
Efficiency of	•		•									93.3	(206)
Efficiency of				•	g systen	າ, %						0	(208)
Cooling Sys	tem Ener	gy Efficie	ency Ra	tio								4.32	(209)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ear
Space heati		· `											
1357.4	_	656.3	247.52	59.1	0	0	0	0	370.5	926.82	1408.62		
$(211)m = {[(9)$	<u> </u>										l		(211)
1454.8	1025.93	703.43	265.29	63.35	0	0	0 T-10	0	397.1	993.38			¬
							Tota	ıl (kWh/yea	ar) =Sum(2	211) <sub>15,10. 12</sub>	2	6413.14	(211)
Space heati $= \{[(98)m \times (2$				month									
$= \chi (30) m \times (215) m = 0$	0	00 1 (20	0	0	0	0	0	0	0	0	0		
` '		<u> </u>					Tota	l (kWh/yea	ar) =Sum(2	215) <sub>15,10. 12</sub>	=	0	(215)
Water heatin	а												
Output from v		ter (calc	ulated a	bove)			_		_	_		1	
220.69	194.47	204.14	182.86	177.98	156.76	150.19	167.42	168.3	189.63	200.68	215.33		_
Efficiency of v	water hea	ater	T			ı			T	T	1	81	(216)
(217)m= 88.87	88.58	87.91	86.1	83.13	81	81	81	81	86.92	88.49	88.95		(217)
Fuel for wate (219)m = (64													
(219)m = 248.32		232.23	212.39	214.09	193.53	185.41	206.69	207.78	218.16	226.78	242.09		
		!	!	!	!		Tota	I = Sum(2	19a) <sub>112</sub> =	!	!	2607	(219)
Space coolir			nth.										
(221)m = (10)	<del> </del>	r	ı	ı	Ι.	Ι.	T .	1	ı	ı	<u> </u>	1	
(221)m= 0	0	0	0	0	32.83	39.83	31.45	0	0	0	0		<b></b>
							I ota	ıl = Sum(22				104.12	(221)
Annual total		ad!:	عامري	4					k'	Wh/yeaı	r I	kWh/yea	<u>r</u>
Space heatin	y tuel use	eu, main	system	I								6413.14	
	_												_
Water heating	g fuel use	ed										2607	

Electricity for pumps, fans and electric keep-hot mechanical ventilation - balanced, extract or positive input from outside 346.16 (230a) central heating pump: (230c)30 sum of (230a) (230g) = Total electricity for the above, kWh/year (231) 376.16 Electricity for lighting 512.18 (232)12a. CO2 emissions – Individual heating systems including micro-CHP **Emission factor Emissions Energy** kWh/year kg CO2/kWh kg CO2/year Space heating (main system 1) (211) x (261) 1385.24 0.216 Space heating (secondary) (215) x (263)0.519 0 (219) x Water heating (264)0.216 563.11 (261) + (262) + (263) + (264) =Space and water heating (265)1948.35 (221) x Space cooling 0.519 54.04 (266)(231) x Electricity for pumps, fans and electric keep-hot (267)0.519 195.23 (232) x Electricity for lighting (268)0.519 265.82 sum of (265) (271) = Total CO2, kg/year (272)2463.44  $(272) \div (4) =$ **Dwelling CO2 Emission Rate** (273)15.95 El rating (section 14) (274)83



# Appendix Energy Assessment Ellerdale Road

### **GREEN Scenario**

			User [	Details:						
Assessor Name: Software Name:	Stroma FS	AP 2012		Softwa	a Num are Vei	rsion:		1.0.1.2	25	
Address :	1 Ellerdale F	Road	Property	Address	: House	1-GREE	.N			
1. Overall dwelling dime		toau								
			Are	a(m²)		Av. Hei	ight(m)		Volume(m <sup>3</sup>	3)
Basement				67	(1a) x		2.6	(2a) =	174.2	(3a)
Ground floor				87.44	(1b) x		3	(2b) =	262.32	(3b)
Total floor area TFA = (1	a)+(1b)+(1c)+(	(1d)+(1e)+(	1n) 1	54.44	(4)					
Dwelling volume					(3a)+(3b	)+(3c)+(3d	)+(3e)+	.(3n) =	436.52	(5)
2. Ventilation rate:								ı		
	main heating	second heating		other		total			m³ per hou	ır
Number of chimneys	0	+ 0	+ [	0	] = [	0	X 4	10 =	0	(6a)
Number of open flues	0	+ 0	<b>=</b>   +	0	j <u>-</u> L	0	x2	20 =	0	(6b)
Number of intermittent fa	ans					0	x -	10 =	0	(7a)
Number of passive vents	5				Ī	0	x -	10 =	0	(7b)
Number of flueless gas f	ires				\	0	X 4	10 =	0	(7c)
					_					
								Air ch	anges per ho	our —
Infiltration due to chimne	7				continue fr	0		÷ (5) =	0	(8)
Number of storeys in t			, ca to (17),	Ollici Wisc (	Sontinue II	om (5) to (	10)	[	0	(9)
Additional infiltration							[(9)-	-1]x0.1 =	0	(10)
Structural infiltration: 0	0.25 for steel or	timber frame	or 0.35 fc	r masoni	ry constr	ruction			0	(11)
if both types of wall are p deducting areas of openi			to the grea	ter wall are	a (after					
If suspended wooden			0.1 (seal	ed), else	enter 0				0	(12)
If no draught lobby, en	nter 0.05, else e	enter 0							0	(13)
Percentage of window	s and doors dr	aught stripped							0	(14)
Window infiltration				0.25 - [0.2	2 x (14) ÷ 1	00] =			0	(15)
Infiltration rate				(8) + (10)	+ (11) + (1	12) + (13) +	+ (15) =		0	(16)
Air permeability value,	•		•	•	•	etre of e	nvelope	area	3	(17)
If based on air permeabi	•								0.15	(18)
Air permeability value applie		on test has been d	one or a de	gree air pe	rmeability	is being us	sed	Ī		7(10)
Number of sides sheltered Shelter factor	<del>z</del> u			(20) = 1 -	[0.075 x (1	19)] =			0.85	(19)
Infiltration rate incorpora	ting shelter fac	tor		(21) = (18	`	·-		 	0.03	(21)
Infiltration rate modified	<del>-</del>			•	•			l	0.10	
Jan Feb	Mar Apr	May Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp	<u> </u>					•				
(22)m= 5.1 5	4.9 4.4	4.3 3.8	3.8	3.7	4	4.3	4.5	4.7		

	(22a)m =	<del>`</del>	4						,			1	
(22a)m= 1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18		
Adjusted infilt	tration 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		
<i>Calculate effe</i> If mechanic		•	rate for t	ne appli	cable ca	se						0.	5 (23a
If exhaust air I			endix N, (2	3b) = (23a	a) × Fmv (e	equation (N	N5)) , othe	rwise (23b	) = (23a)			0.	<del></del>
If balanced wi	ith heat reco	overy: effic	iency in %	allowing f	or in-use f	actor (fron	n Table 4h	) =				76	
a) If balanc	ed mech	anical ve	entilation	with he	at recove	ery (MVI	HR) (24a	a)m = (2:	2b)m + (	23b) × [	1 – (23c)		,
24a)m= 0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27	]	(24
b) If balanc	ed mech	anical ve	ntilation	without	heat rec	overy (N	ИV) (24b	o)m = (22	2b)m + (2	23b)	•	•	
24b)m= 0	0	0	0	0	0	0	0	0	0	0	0		(24
c) If whole	house ex	tract ver	ntilation o	or positiv	e input v	ventilatio	on from o	outside	_	-	_	-	
if (22b)	)m < 0.5 ×	(23b), t	· ` `	c) = (23b		· ·	c) = (22h	ŕ	.5 × (23b	)		1	
(24c)m= 0	0	0	0	0	0	0	0	0	0	0	0		(24)
d) If natura	l ventilation) )m = 1, the								0.51				
24d)m= 0	0	0	0	0	0 0	0	0.5 1 [(2	0	0.0]	0	0		(24
Effective ai	ir change	rate - er	ıter (24a	) or (24h	o) or (24)	c) or (24	d) in box	(25)				,	
25)m= 0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27	]	(25
2 Hoot less		ot loss :	o a romo o t	2.81								1	
3. Heat loss	es and ne	eat loss	oarameu										
	Gros	20			Net Δr	<b>e</b> a	I I-valı	III A	ΔΧΙΙ		k-value	۵ .	ΔXk
	Gros area		Openin m	gs	Net Ar A ,r		U-vali W/m2		A X U (W/l	<b>K</b> )	k-value kJ/m²·l	-	A X k kJ/K
	7		Openin	gs			W/m2			<b>(</b> )		-	kJ/K
Doors	area		Openin	gs	A ,r	m² x	W/m2	2K =	(W/I	<) 		-	kJ/K (26
Doo <mark>rs</mark> Windows Typ	area		Openin	gs	A ,r	x x1.	W/m2	0.04] =	(W/F 2.112	<) 		-	
Doo <mark>rs</mark> Vindows Typ Vindows Typ	area oe 1 oe 2		Openin	gs	A ,r	x x1.	W/m2 1.2 /[1/( 1.2 )+	= 0.04] = 0.04] =	2.112 0.81	<) 		-	kJ/K (26 (27
Doo <mark>rs</mark> Vindows Typ Vindows Typ Vindows Typ	area  oe 1  oe 2  oe 3		Openin	gs	A ,r 1.76 0.71 5.29	x1. x1. x1.	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] =	0.81 6.06	K)		-	kJ/K (26 (27
Doo <mark>rs</mark> Windows Typ Windows Typ Windows Typ Windows Typ	area  oe 1  oe 2  oe 3  oe 4		Openin	gs	A ,r 1.76 0.71 5.29 8.46	x1. x1. x1.	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] = 0.04] =	0.81 6.06 9.69	<) 		-	kJ/K (26 (27 (27
Doors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ	area  oe 1  oe 2  oe 3  oe 4  oe 5		Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64	x1. x1. x1. x1.	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04] = 0.04] = 0.04] = 0.04] = 0.04] =	0.81 6.06 9.69	<) 		-	kJ/K (26 (27 (27 (27 (27
Coors  Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ	area  oe 1  oe 2  oe 3  oe 4  oe 5  oe 6		Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58	x x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24	<)		-	kJ/K (26 (27 (27 (27 (27 (27 (27
Doors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ	area  pe 1 pe 2 pe 3 pe 4 pe 5 pe 6 ppe 1		Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94	x1. x1. x1. x1. x1. x1. x1.	W/m2 1.2 /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+ /[1/( 1.2 )+	0.04] = 0.04]	0.81 6.06 9.69 11.04 5.24	<) 		-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Rooflights Typ	area  ne 1 ne 2 ne 3 ne 4 ne 5 ne 6 ne 6 npe 1 npe 2		Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5	x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66	<) 		-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Poors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Rooflights Ty Rooflights Ty	area  ne 1 ne 2 ne 3 ne 4 ne 5 ne 6 ne 6 npe 1 npe 2		Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5	x1. x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3			-	kJ/K (26 (27 (27 (27 (27 (27 (27
Doors  Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Rooflights Typ Rooflights Typ Rooflights Typ	area  ne 1 ne 2 ne 3 ne 4 ne 5 ne 6 ne 6 npe 1 npe 2	(m²)	Openin	gs	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5 3.61	x1. x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332			-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Rooflights Type1	area  pe 1 pe 2 pe 3 pe 4 pe 5 pe 6 ppe 1 ppe 2 ppe 3	(m²)	Openin m	gs 1 <sup>2</sup>	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5 3.61 87.44	x x1. x1. x1. x1. x1. x1. x1. x1. x1. x1	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/(1.2) +  /[1/(1.2) +  /[1/(1.2) +	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840			-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ	area  pe 1 pe 2 pe 3 pe 4 pe 5 pe 6 pp 1 pp 2 pp 3	(m²)	Openin m	gs <sup>2</sup>	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5 3.61 87.44 81.4	x1. x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/(1.2) +  /[1/(1.2) +  0.11  0.18	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65			-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Doors  Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Windows Typ Rooflights Ty Rooflights Ty Floor Walls Type1 Walls Type2	area  De 1  De 2  De 3  De 4  De 5  De 6  Ope 1  Ope 2  Ope 3  De 4  De 5  De 6  Ope 1  Ope 2  Ope 3	(m²) 4 79	Openin m	gs <sup>2</sup>	A ,r  1.76  0.71  5.29  8.46  9.64  4.58  4.94  2.5  2.5  3.61  87.44  81.4	x1. x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/(1.2 )+  /[1/(1.2 )+  0.11  0.18  0.18	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65 15.73			-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27
Vindows Typ Vindows Typ Vindows Typ Vindows Typ Vindows Typ Vindows Typ Vindows Typ Rooflights Typ Rooflights Typ Rooflights Typ Vindows Typ Rooflights Typ Rooflights Typ Rooflights Typ Rooflights Typ Rooflights Typ Rooflights Type Rooflights Type Rooflights Type Rooflights Type Rooflights Type Rooflights Type Roof	area  De 1  De 2  De 3  De 4  De 5  De 6  Ope 1  Ope 2  Ope 3  De 4  De 5  De 6  Ope 1  Ope 2  Ope 3	(m²) 4 79	Openin m	gs <sup>2</sup>	A ,r 1.76 0.71 5.29 8.46 9.64 4.58 4.94 2.5 2.5 3.61 87.44 87.41 75.22	x1. x1. x1. x1. x1. x1. x1. x1. x1. x1.	W/m2  1.2  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/( 1.2 )+  /[1/(1.2 )+  /[1/(1.2 )+  0.11  0.18  0.18	0.04] = 0.04]	2.112 0.81 6.06 9.69 11.04 5.24 5.66 3 4.332 9.61840 14.65 15.73			-	kJ/K (26 (27 (27 (27 (27 (27 (27 (27 (27 (27 (27

(26) (30) + (32) =

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

Fabric heat loss, W/K = S (A x U)

102.88

(33)

Heat capacity Cm = S(A	xk)						((28)	(30) + (32	2) + (32a)	(32e) =	44603.08	(34)
Thermal mass paramete	er (TMP =	= Cm ÷	TFA) in	ı kJ/m²K			Indica	tive Value:	Medium		250	(35)
For design assessments where can be used instead of a detail			constructi	ion are not	t known pr	ecisely the	indicative	values of	TMP in Ta	able 1f		
Thermal bridges : S (L x	Y) calcu	ılated ι	ısing Ap	pendix l	<						56.86	(36)
if details of thermal bridging ar	re not know	vn (36) =	: 0.15 x (3	1)								
Total fabric heat loss							(33) +	(36) =			159.74	(37)
Ventilation heat loss cald	culated m	nonthly	′				(38)m	= 0.33 × (	25)m x (5)		_	
Jan Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m= 40.34 39.88	39.43	37.13	36.67	34.37	34.37	33.92	35.29	36.67	37.59	38.51		(38)
Heat transfer coefficient,	, W/K	·					(39)m	= (37) + (3	38)m		_	
(39)m= 200.08 199.62	199.16 1	196.87	196.41	194.11	194.11	193.65	195.03	196.41	197.33	198.25		_
Heat loss parameter (HL	₋P), W/m²	¹K						Average = = (39)m ÷	· /	12 /12=	196.75	(39)
(40)m= 1.3 1.29	1.29	1.27	1.27	1.26	1.26	1.25	1.26	1.27	1.28	1.28		
Number of days in montl	h (Table	1a)					,	Average =	Sum(40) <sub>1</sub>	12 /12=	1.27	(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. Water heating energy	v require	ement:						_		kWh/y	ear:	
Assumed occupancy, N if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1 Annual average hot wate Reduce the annual average ho not more that 125 litres per per	er usage ot water usa	in litre	s per da	ay Vd,av	erage = designed t	(25 x N)	+ 36		9)	94 4.05		(42)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot more that 125 litres per per	er usage ot water usa erson per da	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, f	y Vd,av welling is not and co	erage = designed t	(25 x N) o achieve	+ 36 a water us	se target of	9)	1.05		` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average ho	er usage ot water usa erson per da	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, F	y Vd,av welling is not and co	erage = designed t ld)	(25 x N) to achieve	+ 36		9)			` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage ot water usa erson per da Mar	in litre sage by 5 ay (all wa	s per da 5% if the d ater use, F	y Vd,av welling is not and co	erage = designed t ld)	(25 x N) to achieve	+ 36 a water us	se target of	9)	1.05		` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage ot water usa erson per da Mar	in litre sage by s ay (all wa Apr h month	s per da 5% if the d ater use, t May Vd,m = fac	y Vd,av welling is not and co Jun ctor from	erage = designed t id)  Jul Fable 1c x	(25 x N) to achieve Aug (43)	+ 36 a water us Sep	oe ta <mark>rget of</mark> Oct	9) 10 <sup>4</sup> Nov 110.29	Dec 114.45	1248.56	` ,
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot wate Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de	er usage of water usa	in litre bage by 5 ay (all was Apr h month	s per da 5% if the d ater use, I May Vd,m = fac 97.8	y Vd,av welling is not and co Jun ctor from 1	erage = designed to do	(25 x N) o achieve  Aug (43)  97.8	+ 36 a water us Sep	Oct  106.13  Fotal = Sur	Nov 110.29 m(44) <sub>1 12</sub> =	Dec 114.45	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per per litres per per litres per de litr	er usage of water usage or son per da Mar alay for each 106.13 1	in litre bage by 5 ay (all was Apr h month	s per da 5% if the d ater use, I May Vd,m = fac 97.8	y Vd,av welling is not and co Jun ctor from 1	erage = designed to do	(25 x N) o achieve  Aug (43)  97.8	+ 36 a water us Sep	Oct  106.13  Fotal = Sur	Nov 110.29 m(44) <sub>1 12</sub> =	Dec 114.45	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per Jan Feb  Hot water usage in litres per de (44)m= 114.45 110.29  Energy content of hot water usage (45)m= 169.73 148.45	er usage of water usage erson per da Mar lay for each 106.13 1 seed - calculation 153.18 1	in litre sage by say (all wa Apr h month 101.97	s per da 5% if the dater use, t May Vd,m = fac 97.8 enthly = 4.	Jun 93.64 190 x Vd,r	erage = designed to do	(25 x N) o achieve Aug (43) 97.8 97.8	+ 36 a water us  Sep  101.97 0 kWh/more 118.99	Oct  106.13  Fotal = Sur th (see Ta	Nov  110.29  m(44) <sub>1 12</sub> = 15bles 1b, 1  151.37	1.05  Dec  114.45  c, 1d)  164.37	1248.56	(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per de la litres pe	er usage of water usa	in litre sage by 8 ay (all wa Apr h month 101.97 lated mo 133.55	s per da 5% if the dater use, I May Vd,m = fac 97.8 enthly = 4. 128.14	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58	erage = designed to to to to to to to to to to to to to	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46)	+ 36 a water us Sep 101.97 118.99 1 to (61)	Oct  106.13  Fotal = Sur  138.67  Fotal = Sur	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> =	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water usa	in litre sage by say (all wa Apr h month 101.97	s per da 5% if the dater use, t May Vd,m = fac 97.8 enthly = 4.	Jun 93.64 190 x Vd,r	erage = designed to do	(25 x N) o achieve Aug (43) 97.8 97.8	+ 36 a water us  Sep  101.97 0 kWh/more 118.99	Oct  106.13  Fotal = Sur th (see Ta  138.67	Nov  110.29  m(44) <sub>1 12</sub> = 15bles 1b, 1  151.37	1.05  Dec  114.45  c, 1d)  164.37		(43)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de (44)m= 114.45 110.29  Energy content of hot water us (45)m= 169.73 148.45  If instantaneous water heating (46)m= 25.46 22.27  Water storage loss:	er usage of water and water usage of	in litre sage by 8 ay (all wa Apr h month 101.97 lated mo 133.55 f use (no	s per da 5% if the dater use, I May Vd,m = fac 97.8 enthly = 4. 128.14 hot water 19.22	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58	erage = designed to do	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64	+ 36 a water us  Sep  101.97  118.99  100 (61)  17.85	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per de la litres pe	er usage of water of the sed - calculation of the sed of the	in litre sage by say (all wa Apr h month 101.97 lated mo 133.55 f use (no 20.03 any so	s per da 5% if the da ater use, the May Vd,m = factor of the second o	y Vd,av welling is not and co Jun 93.64 190 x Vd,r 110.58 storage), 16.59	erage = designed to do	(25 x N) o achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa	+ 36 a water us  Sep  101.97  118.99  100 (61)  17.85	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de (44)m= 114.45 110.29  Energy content of hot water us (45)m= 169.73 148.45  If instantaneous water heating (46)m= 25.46 22.27  Water storage loss:	er usage of water usage of water usage Mar Mar 106.13 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	in litre rage by 5 ay (all was Apr 101.97 latted mo 133.55 fuse (no 20.03 any so	s per da 5% if the da ater use, the second of the second	y Vd,av welling is not and co Jun ctor from 7 93.64 190 x Vd,r 110.58 storage), 16.59	erage = designed to did)  Jul  Fable 1c x  93.64  102.47  enter 0 in  15.37  storage  litres in	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = sbles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water and usage of water usage of water usage of water (	in litre sage by say (all was Apr In month 101.97 In month 133.55 In say (all was (no 20.03 In say (this in In say))	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = sbles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de litres p	er usage of water and usage of water usage of water usage of water (	in litre sage by say (all was Apr In month 101.97 In month 133.55 In say (all was (no 20.03 In say (this in In say))	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = bles 1b, 1  151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37		(43) (44) (45) (46)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per defended by the second of the second	er usage of water (as a first of the sed - calculation of the	in litre sage by 8 ay (all we hand) Apr handth 101.97  lated mo 20.03  any so k in dw (this in ess factors)	s per da 5% if the da ater use, I May Vd,m = fact 97.8 enthly = 4. 128.14 hot water 19.22 plar or Water or Wat	y Vd,av welling is not and co Jun g3.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110	erage = designed to do	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97  118.99  10 to (61)  17.85  American	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> = 151.37  m(45) <sub>1 12</sub> = 22.7	1.05  Dec  114.45  c, 1d)  164.37  24.66		(43) (44) (45) (46) (47)
if TFA > 13.9, N = 1 + if TFA £ 13.9, N = 1  Annual average hot water Reduce the annual average hot not more that 125 litres per per litres per per litres per de litres p	er usage of water (all of the points of	in litre sage by 8 ay (all we had month) 101.97  lated mo 20.03  any so k in dw (this in ss factor b) kWh/ye	s per da 5% if the da ater use, I May Vd,m = fac 97.8 enthly = 4. 128.14 hot water 19.22 plar or W elling, e cludes in	y Vd,av welling is not and co Jun 93.64 190 x Vd,r 110.58 storage), 16.59 /WHRS nter 110 nstantar	erage = designed to designed t	(25 x N) to achieve  Aug (43) 97.8  97.8  117.58  boxes (46) 17.64  within sa (47)	+ 36 a water us  Sep  101.97 118.99 10 to (61) 17.85  ame vess ers) enter	Oct  106.13  Total = Sur  138.67  Total = Sur  20.8	Nov  110.29  m(44) <sub>1 12</sub> =  sbles 1b, 1  151.37  m(45) <sub>1 12</sub> =  22.7	1.05  Dec  114.45  c, 1d)  164.37  24.66		(43) (44) (45) (46) (47)

Hot water storage loss factor from Table 2 (kWh/litr	e/day)		0	(51)
If community heating see section 4.3				<b>1</b>
Volume factor from Table 2a Temperature factor from Table 2b			0	(52)
·	(47) (54	) (50) (50)	0	(53)
Energy lost from water storage, kWh/year	(47) x (51	) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)	((FG)m = 1	(EE) v (44)m	0	(55)
Water storage loss calculated for each month	<u> </u>	(55) × (41)m		<b>1</b>
(44)	0 0 0	0 0	0 0	(56)
If cylinder contains dedicated solar storage, (57)m = (56)m x [(56)m x (56)m x	0) – (HTT)] ÷ (50), else (5	7)m = (56)m where (	HII) is from Append	אוג H ר
(57)m= 0 0 0 0 0	0 0	0 0	0 0	(57)
Primary circuit loss (annual) from Table 3			0	(58)
Primary circuit loss calculated for each month (59)n				
(modified by factor from Table H5 if there is solar	<del></del>	<del>, , , , , , , , , , , , , , , , , , , </del>	<del>' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' </del>	<b>1</b>
(59)m= 0 0 0 0 0	0 0 0	0 0	0 0	(59)
Combi loss calculated for each month (61)m = (60)	÷ 365 × (41)m			
(61)m= 50.96 46.03 50.96 49.32 49.84 46.	.18 47.72 49.84	49.32 50.96	49.32 50.96	(61)
Total heat required for water heating calculated for	each month (62)m =	= 0.85 × (45)m +	(46)m + (57)m +	- (59)m + (61)m
(62)m= 220.69 194.47 204.14 182.86 177.98 156	6.76   150.19   167.42	168.3 189.63	200.68 215.33	(62)
Solar DHW input calculated using Appendix G or Appendix H (n	egative quantity) (enter 'C	)' if no solar contribut	ion to water heating	)
(add additional lines if FGHRS and/or WWHRS app	olies, see Appendix (	G)		
(63)m= 0 0 0 0 0	0 0	0 0	0 0	(63)
Output from water heater				1
	6.76 150.19 167.42	168.3 189.63	200.68 215.33	]
	Out	put from water heate	r (annual) <sub>1 12</sub>	2228.45 (64)
Heat gains from water heating, kWh/month 0.25 ′ [0	0.85 × (45)m + (61)n	n] + 0.8 x [(46)m	+ (57)m + (59)n	n l
	.31 46 51.56	51.89 58.85	62.66 67.39	(65)
include (57)m in calculation of (65)m only if cylind	der is in the dwelling	or hot water is fi	rom community l	neating
5. Internal gains (see Table 5 and 5a):				g
Metabolic gains (Table 5), Watts  Jan Feb Mar Apr May J	un Jul Aug	Sep Oct	Nov Dec	1
	7.05 147.05 147.05	147.05 147.05	147.05 147.05	(66)
			111.00	] (55)
Lighting gains (calculated in Appendix L, equation L (67)m= 29 25.76 20.95 15.86 11.86 10.	.01 10.81 14.06	18.87 23.96	27.96 29.81	(67)
` '		<u> </u>	27.90   29.61	] (07)
Appliances gains (calculated in Appendix L, equation		т т	l <del>.</del> l	7 (60)
	7.73 243.37 240	248.5 266.61	289.47 310.96	(68)
Cooking gains (calculated in Appendix L, equation I	<del>- i - i</del>	<del> </del>	, , , , , , , , , , , , , , , , , , , ,	<b>7</b>
(69)m= 37.7 37.7 37.7 37.7 37.7 37.7 37.7	7.7 37.7 37.7	37.7 37.7	37.7 37.7	(69)
Pumps and fans gains (Table 5a)				_
(70)m= 3 3 3 3 3 3	3 3	3 3	3 3	(70)
Losses e.g. evaporation (negative values) (Table 5)	)			_
(71)m= -117.64 -117.64 -117.64 -117.64 -117.64 -117	7.64 -117.64 -117.64	-117.64 -117.64	-117.64 -117.64	(71)
Water heating gains (Table 5)				
(72)m= 92.98 90.57 85.58 78.8 74.02 67	7.1 61.83 69.3	72.07 79.09	87.02 90.58	(72)
	•	•	•	-

Total internal	<del></del>			ı	· `	1 ,		)m + (69)m +	<del>`                                    </del>	·	1	1	
(73)m= 517.4	515.13	496.82	466.84	435.19	404.9	386.13	393.	46 409.56	439.78	3 474.57	501.46		(73)
6. Solar gains				T-1-1- 0-			4: 4			-1-1			
Solar gains are o		•				•	tions t		ne аррис	able orientat FF	ion.	Coino	
Orientation: <i>F</i>	rable 6d	actor	Area m²			lux able 6a		g_ Table 6b		Table 6c		Gains (W)	
Southeast <sub>0.9x</sub> [	0.77	x	8.4	16	х	36.79	] <sub>x</sub> [	0.55	x	0.8		94.91	(77)
Southeast 0.9x	0.77	$=$ $\hat{x}$	9.6		×	36.79	] ^	0.55	$=$ $\begin{bmatrix} \cdot \\ \times \end{bmatrix}$	0.8	= -	108.15	$=$ $\binom{(77)}{(77)}$
Southeast <sub>0.9x</sub>	0.77	^	8.4		x	62.67	] ^	0.55	$=$ $\begin{bmatrix} \cdot \\ \times \end{bmatrix}$	0.8	= -	161.67	<b></b> (77)
Southeast <sub>0.9x</sub>	0.77	$\frac{1}{x}$	9.6		x -	62.67	] ^ [   <sub>x</sub> [	0.55	$=$ $\begin{bmatrix} \cdot \\ \times \end{bmatrix}$	0.8	= =	184.22	(77)
Southeast <sub>0.9x</sub>	0.77	x	8.4		×	85.75	] ^	0.55	$=$ $\begin{bmatrix} \cdot \\ \times \end{bmatrix}$	0.8	= =	221.21	=\(\frac{1}{177}\)
Southeast 0.9x	0.77	x	9.6		x	85.75	]	0.55	×	0.8	= =	252.06	(77)
Southeast <sub>0.9x</sub>	0.77	X	8.4		x	106.25	]	0.55	×	0.8	=	274.09	(77)
L Southeast <sub>0.9x</sub> آ	0.77	x	9.6		x 🗀	106.25	]	0.55	= x	0.8	= =	312.32	(77)
ے Southeast <sub>0.9x</sub> آ	0.77	x	8.4		x	119.01	)	0.55	×	0.8	= =	307	<b>-</b>
L Southeast <sub>0.9x</sub> آ	0.77	X	9.6		x	119.01	]	0.55	×	0.8	= =	349.82	(77)
Southeast <sub>0.9x</sub>	0.77	X	8.4		x	118.15	X	0.55	X	0.8		304.78	(77)
Southeast <sub>0.9x</sub>	0.77	×	9.6	_	x	118.15	Х	0.55	X	0.8		347.29	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	x	8.4		x	113.91	×	0.55	x	0.8	_	293.84	(77
Sout <mark>heast <sub>0.9x</sub> [</mark>	0.77	x	9.6	64	x	113.91	×	0.55	x	0.8	_	334.83	(77
Southeast <sub>0.9x</sub>	0.77	x	8.4	16	x	104.39	x	0.55	x	0.8	_	269.29	(77
Southeast <sub>0.9x</sub>	0.77	x	9.6	64	x	104.39	Х	0.55	x	0.8	=	306.85	(77)
Southeast <sub>0.9x</sub>	0.77	x	8.4	16	x	92.85	x	0.55	x	0.8		239.52	(77
Southeast <sub>0.9x</sub>	0.77	x	9.6	64	X	92.85	x	0.55	X	0.8	=	272.93	(77
Southeast <sub>0.9x</sub>	0.77	x	8.4	16	x	69.27	x	0.55	x	0.8		178.68	(77
Southeast <sub>0.9x</sub>	0.77	x	9.6	64	x	69.27	x	0.55	x	0.8	=	203.61	(77
Southeast <sub>0.9x</sub>	0.77	X	8.4	16	x	44.07	х	0.55	x	0.8	=	113.69	(77
Southeast <sub>0.9x</sub>	0.77	X	9.6	64	x	44.07	х	0.55	x	0.8	=	129.54	(77)
Southeast <sub>0.9x</sub>	0.77	x	8.4	16	x	31.49	х	0.55	x	0.8	=	81.23	(77
Southeast <sub>0.9x</sub>	0.77	х	9.6	64	x	31.49	x	0.55	x	0.8	=	92.56	(77
Southwest <sub>0.9x</sub>	0.77	X	4.5	58	x	36.79		0.55	x	0.8		51.38	(79
Southwest <sub>0.9x</sub>	0.77	X	4.9	94	x	36.79		0.55	x	0.8	=	55.42	(79
Southwest <sub>0.9x</sub>	0.77	X	4.5	58	x	62.67		0.55	x	0.8	_	87.53	(79
Southwest <sub>0.9x</sub>	0.77	X	4.9	94	x	62.67		0.55	x	0.8		94.41	(79
Southwest <sub>0.9x</sub>	0.77	x	4.5	58	x	85.75	] [	0.55	x	0.8	=	119.76	(79
Southwest <sub>0.9x</sub>	0.77	X	4.9	94	x	85.75	] [	0.55	x	0.8	=	129.17	(79
Southwest <sub>0.9x</sub>	0.77	x	4.5	58	x	106.25	] [	0.55	x	0.8	=	148.38	(79
Southwest <sub>0.9x</sub>	0.77	x	4.9	94	x	106.25	<u> </u>	0.55	x	0.8	=	160.05	(79
Southwest <sub>0.9x</sub>	0.77	X	4.5	58	x	119.01	] [	0.55	x	0.8	=	166.2	(79)
Southwest <sub>0.9x</sub>	0.77	×	4.9	94	x $\overline{}$	119.01	ÌΓ	0.55	<b>=</b> x	0.8	=	179.27	(79)

Southwest <sub>0.9x</sub>		1		1	140.45	1	0	۱		1 _	405	7(70)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	118.15	] 1	0.55	X	0.8	= 	165	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	118.15	] 1	0.55	X	0.8	=	177.97	(79)
<u> </u>	0.77	X	4.58	X	113.91	] 1	0.55	X	0.8	= 	159.08	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	113.91	] 1	0.55	X	0.8	= 	171.58	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	104.39	<u> </u>	0.55	X	0.8	=	145.78	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	104.39	<u> </u>	0.55	X	0.8	=	157.24	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	92.85		0.55	X	0.8	=	129.67	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	92.85	<u> </u>	0.55	X	0.8	=	139.86	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	69.27	<u> </u>	0.55	X	0.8	=	96.73	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	69.27	<u> </u>	0.55	X	0.8	=	104.34	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	44.07	[	0.55	X	0.8	=	61.55	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	44.07	[	0.55	X	0.8	=	66.38	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.58	X	31.49	<u> </u>	0.55	X	0.8	=	43.97	(79)
Southwest <sub>0.9x</sub>	0.77	X	4.94	X	31.49	]	0.55	X	0.8	=	47.43	(79)
Northwest <sub>0.9x</sub>	0.77	X	0.71	X	11.28	X	0.55	X	0.8	=	2.44	(81)
Northwest 0.9x	0.77	X	5.29	x	11.28	X	0.55	X	0.8	=	18.2	(81)
Northwest 0.9x	0.77	X	0.71	X	22.97	X	0.55	X	0.8	=	4.97	(81)
Northwest 0.9x	0.77	X	5.29	X	22.97	Х	0.55	X	0.8	=	37.05	(81)
Northwest 0.9x	0.77	X	0.71	х	41.38	_ x	0.55	x	0.8	=	8.96	(81)
Northwest 0.9x	0.77	x	5.29	x	41.38	×	0.55	x	0.8	=	66.75	(81)
Northwest 0.9x	0.77	X	0.71	X	67.96	x	0.55	x	0.8	=	14.71	(81)
Northwest 0.9x	0.77	x	5.29	х	67.96	X	0.55	x	0.8	=	109.61	(81)
Northwest <sub>0.9x</sub>	0.77	x	0.71	х	91.35	×	0.55	x	0.8	=	19.78	(81)
Northwest 0.9x	0.77	X	5.29	х	91.35	x	0.55	x	0.8	=	147.34	(81)
Northwest 0.9x	0.77	X	0.71	x	97.38	x	0.55	x	0.8	=	21.08	(81)
Northwest <sub>0.9x</sub>	0.77	X	5.29	x	97.38	x	0.55	x	0.8	=	157.08	(81)
Northwest <sub>0.9x</sub>	0.77	x	0.71	x	91.1	x	0.55	x	0.8	=	19.72	(81)
Northwest <sub>0.9x</sub>	0.77	X	5.29	x	91.1	x	0.55	x	0.8	=	146.95	(81)
Northwest <sub>0.9x</sub>	0.77	X	0.71	x	72.63	x	0.55	x	0.8	=	15.72	(81)
Northwest 0.9x	0.77	X	5.29	x	72.63	x	0.55	x	0.8	=	117.15	(81)
Northwest <sub>0.9x</sub>	0.77	X	0.71	X	50.42	x	0.55	x	0.8	=	10.92	(81)
Northwest <sub>0.9x</sub>	0.77	X	5.29	x	50.42	x	0.55	X	0.8	=	81.33	(81)
Northwest 0.9x	0.77	X	0.71	x	28.07	x	0.55	X	0.8	=	6.08	(81)
Northwest <sub>0.9x</sub>	0.77	x	5.29	x	28.07	x	0.55	x	0.8	=	45.27	(81)
Northwest <sub>0.9x</sub>	0.77	x	0.71	x	14.2	×	0.55	x	0.8	j =	3.07	(81)
Northwest <sub>0.9x</sub>	0.77	x	5.29	x	14.2	x	0.55	X	0.8	j =	22.9	(81)
Northwest <sub>0.9x</sub>	0.77	x	0.71	x	9.21	x	0.55	x	0.8	j =	1.99	(81)
Northwest <sub>0.9x</sub>	0.77	x	5.29	×	9.21	x	0.55	x	0.8	j =	14.86	(81)
Rooflights <sub>0.9x</sub>	1	x	2.5	×	26	x	0.55	x	0.8	j =	25.74	(82)
Rooflights <sub>0.9x</sub>	1	x	2.5	x	26	x	0.55	x	0.8	j =	25.74	(82)
Rooflights <sub>0.9x</sub>	1	×	3.61	x	26	x	0.55	x	0.8	=	74.34	(82)
								ı		•		_

D. distric		7		,		1		_				_
Rooflights 0.9x	1	X	2.5	X	54	X	0.55	×	0.8	=	53.46	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	54	X	0.55	X	0.8	=	53.46	(82)
Rooflights 0.9x	1	X	3.61	X	54	X	0.55	X	0.8	=	154.39	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	96	X	0.55	X	0.8	=	95.04	(82)
Rooflights 0.9x	1	X	2.5	X	96	X	0.55	X	0.8	=	95.04	(82)
Rooflights <sub>0.9x</sub>	1	X	3.61	X	96	X	0.55	X	0.8	=	274.48	(82)
Rooflights 0.9x	1	X	2.5	X	150	X	0.55	X	0.8	=	148.5	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	150	X	0.55	x	0.8	=	148.5	(82)
Rooflights <sub>0.9x</sub>	1	X	3.61	X	150	X	0.55	x	0.8	=	428.87	(82)
Rooflights 0.9x	1	X	2.5	X	192	X	0.55	x	0.8	=	190.08	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	192	X	0.55	x	0.8	=	190.08	(82)
Rooflights <sub>0.9x</sub>	1	X	3.61	X	192	X	0.55	x	0.8	=	548.95	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	200	X	0.55	x	0.8	=	198	(82)
Rooflights 0.9x	1	X	2.5	X	200	X	0.55	x	0.8	=	198	(82)
Rooflights <sub>0.9x</sub>	1	X	3.61	X	200	X	0.55	x	0.8	=	571.82	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	189	x	0.55	x	0.8	=	187.11	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	X	189	x	0.55	x	0.8	=	187.11	(82)
Rooflights 0.9x	1	X	3.61	X	189	Х	0.55	X	0.8	=	540.37	(82)
Rooflights 0.9x	1	x	2.5	х	157	x	0.55	x	0.8		155.43	(82)
Rooflights <sub>0.9x</sub>	1	x	2.5	x	157	x	0.55	x	0.8	=	155.43	(82)
Rooflights <sub>0.9x</sub>	1	x	3.61	X	157	X	0.55	x	0.8	=	448.88	(82)
Rooflights 0.9x	1	x	2.5	х	115	х	0.55	x	0.8	=	113.85	(82)
Rooflights 0.9x	1	x	2.5	х	115	×	0.55	x	0.8	=	113.85	(82)
Rooflights 0.9x	1	X	3.61	х	115	x	0.55	x	0.8	=	328.8	(82)
Rooflights 0.9x	1	x	2.5	x	66	x	0.55	x	0.8	=	65.34	(82)
Rooflights 0.9x	1	X	2.5	x	66	x	0.55	×	0.8	=	65.34	(82)
Rooflights 0.9x	1	X	3.61	x	66	x	0.55	x	0.8	=	188.7	(82)
Rooflights 0.9x	1	X	2.5	x	33	x	0.55	×	0.8	=	32.67	(82)
Rooflights 0.9x	1	X	2.5	x	33	x	0.55	x	0.8	<u> </u>	32.67	(82)
Rooflights 0.9x	1	X	3.61	x	33	x	0.55	×	0.8	<del>-</del>	94.35	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	x	21	x	0.55	×	0.8	=	20.79	(82)
Rooflights <sub>0.9x</sub>	1	X	2.5	x	21	x	0.55	x	0.8		20.79	(82)
Rooflights 0.9x	1	X	3.61	x	21	x	0.55	×	0.8	<del>-</del>	60.04	(82)
		_		•		•						
Solar gains in watt	s, calcul	ated	for each mon	th		(83)m	ı = Sum(74)m	(82)m				
(83)m= 456.33 831	.16 126	2.46	1745.03 2098.5	3 2	2040.6	177′	1.78 1430.73	954.1	556.82	383.67		(83)
Total gains – interr	nal and s	solar	(84)m = $(73)$ r	n + (	83)m , watts						_	
(84)m= 973.74 134	6.29 175	9.28	2211.87 2533.7	'2 25	2426.72	2165	5.24 1840.29	1393.8	7 1031.39	885.13		(84)
7. Mean internal t	emperat	ture (	heating seaso	on)								
Temperature duri			_		area from Tal	ole 9	Th1 (°C)				21	(85)
Utilisation factor f	or gains	for li	ving area, h1,	m (s	ee Table 9a)							
Jan F	eb M	1ar	Apr Ma	у	Jun Jul	A	ug Sep	Oct	Nov	Dec		
	•				•		•				-	

(86)m=	1	0.99	0.96	0.85	0.67	0.48	0.35	0.41	0.68	0.94	0.99	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	' in Tabl	e 9c)				1	
(87)m=	19.6	19.88	20.29	20.7	20.92	20.99	21	21	20.94	20.56	19.98	19.55		(87)
Temp	erature	during h	neating p	eriods ir	rest of	dwelling	from Ta	ble 9, T	h2 (°C)				ı	
(88)m=	19.84	19.85	19.85	19.86	19.86	19.87	19.87	19.88	19.87	19.86	19.86	19.85		(88)
l Itilie:	ation fac	tor for a	ains for i	rest of di	welling	h2 m (se	e Tahle	0a)					J	
(89)m=	1	0.99	0.94	0.81	0.6	0.4	0.26	0.31	0.59	0.91	0.99	1		(89)
					- <b>6</b> -l 113	I TO (6	- 11 4 -		7 to Tabl	- 0-\			l	, ,
(90)m=	17.99	18.41	ature in	tne rest	of dwelli	ng 12 (f	19.87	19.88	/ IN Tabl	e 9c)	18.56	17.92		(90)
(90)111–	17.99	10.41	10.90	19.55	19.0	19.07	19.07	19.00		LA = Livin			0.26	(91)
									'	LA - LIVIII	g area · (-	•) =	0.26	(91)
			ature (fo			lling) = f	LA × T1	+ (1 – fL					i	
(92)m=	18.41	18.8	19.32	19.85	20.09	20.16	20.17	20.17	20.12	19.69	18.93	18.35		(92)
			he mean	r		r	r						I	
(93)m=	18.26	18.65	19.17	19.7	19.94	20.01	20.02	20.02	19.97	19.54	18.78	18.2		(93)
			uirement											
			ternal ter			ed at st	ep 11 of	Table 9	o, so tha	t Ti,m=(	76)m an	d re-calc	ulate	
the u			or gains							0.1				
1.160	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
			ains, hm		0.01	0/11	0.07	0.00	0.50	0.0	0.00		I	(04)
(94)m=	0.99	0.98	0.93	0.81	0.61	0.41	0.27	0.32	0.59	0.9	0.99	1		(94)
			, W = (94	<u> </u>									ı	(0-1)
(95)m=	968.6		1642.03				662.5	698.47	1094.23	1258.9	1017.4	882.01		(95)
	_	_	rnal tem										ı	
(96)m=		4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
			an intern					x [(93)m	– (96)m	]			1	
(97)m=	2793.08	2743.92	2524.16	2126.08	1618.73	1050.32	663.61	700.86	1144.92	1756.88	2304.65	2775.31		(97)
Spac	e heatin	g require	ement fo	r each n	nonth, k	Wh/mon	th = 0.02	4 x [(97	)m – (95	)m] x (4	1)m		•	
(98)m=	1357.41	957.19	656.3	247.52	59.1	0	0	0	0	370.5	926.82	1408.62		
								Tota	l per year	(kWh/year	) = Sum(9	8) <sub>15,912</sub> =	5983.46	(98)
Spac	e heatin	g require	ement in	kWh/m²	<sup>2</sup> /year								38.74	(99)
8c S	nace co	olina rec	quiremen	nt .										
		Ĭ	July and		See Tal	hle 10h								
Calcu	Jan	Feb	Mar	August	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Heat			lculated	<u> </u>					•					
(100)m=		0	0	0	0		1436.44		0	0	0	0		(100)
, ,	ation fac			, ,		102 1.07	1100.11		ŭ	ŭ	ŭ	ŭ		( )
(101)m=		0	0	0	0	0.96	0.98	0.96	0	0	0	0		(101)
			Vatts) = (				0.00	0.00	Ů	Ü	Ü	ŭ	ĺ	(101)
(102)m=		0	0	0	0	i	1404.91	1420.25	0	0	0	0	1	(102)
			l culated	l		l	l			ŭ	ŭ	ŭ	l	(112)
(103)m=	<u> </u>	0	0		0	2930.3		2519.69	0	0	0	0	1	(103)
													/ v (11)m	(.00)
			<i>ement fo</i> (104)m <			iwellilig,	COMMINU	JUS (KVI	11) = 0.0	∠4 X [( I C	ווונטי – (	102)111])	· (41)III	
(104)m=		0	0	0	0	853.89	1035.87	817.98	0	0	0	0		
, , ,			<u> </u>			L	l ·			= Sum(		=	2707.74	(104)
									. 3.01	(	5 <del></del> 0 • /		2.01.14	

Cooled fraction		-bl- 40b	`					f C =	cooled	area ÷ (4	4) = [	0.66	(105)
Intermittency for (106)m= 0	actor (18	able 10b	0	0	0.25	0.25	0.25	0	0	0	0		
(100)111			Ů		0.20	0.20	0.20		l <u> </u>	<u> </u>		0	(106)
Space cooling	require	ment for	month =	(104)m	× (105)	× (106)r	m			10401/	L		`
(107)m= 0	0	0	0	0	141.84	172.08	135.88	0	0	0	0		
		-			-	-	-	Total	l = Sum(	107)	= [	449.8	(107)
Space cooling	require	ment in k	:Wh/m²/y	/ear				(107)	) ÷ (4) =		Ī	2.91	(108)
9a. Energy red	uiremer	nts – Indi	vidual h	eating sy	ystems i	ncluding	micro-C	CHP)					
Space heating	•										ı		_
Fraction of sp					mentary	•					ļ	0	(201)
Fraction of sp	ace hea	at from m	nain syst	em(s)			(202) = 1	, ,			ļ	1	(202)
Fraction of to	al heati	ng from	main sys	stem 1			(204) = (2	02) × [1 –	(203)] =			1	(204)
Efficiency of r	nain spa	ace heat	ing syste	em 1								93.3	(206)
Efficiency of s	seconda	ry/suppl	ementar	y heating	g systen	າ, %						0	(208)
Cooling Syste	m Ener	gy Efficie	ency Ra	tio								4.32	(209)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ear
Space heating	g require	ement (c	alculate	d above	)								
1357.41	957.19	656.3	247.52	59.1	0	0	0	0	370.5	926.82	1408.62		
$(211)$ m = {[(98]	)m x (20	)4)] } x 1	00 ÷ (20	6)									(211)
14 <mark>54.89</mark>	1025.93	703.43	265. <mark>2</mark> 9	63.35	0	0	0	0	397.1	993.38			_
							Tota	ıl (kWh/yea	ar) =Sum(2	211) <sub>15,10. 12</sub>	<b>=</b>	6413.14	(211)
Space heating	•			month									
$= \{[(98)m \times (200)]$	(1)] } x 1	00 ÷ (20	8)	0		0	0	0	0	0	0		
(215) <mark>m= 0</mark>	U	U	U	U	0	U		l (kWh/yea	-			0	(215)
Water heating	•							(	, Ga(-	- 1 715,10. 12			(210)
Output from wa		ter (calc	ulated al	oove)									
220.69	194.47	204.14	182.86	177.98	156.76	150.19	167.42	168.3	189.63	200.68	215.33		
Efficiency of w	ater hea	ter										81	(216)
(217)m= 88.87	88.58	87.91	86.1	83.13	81	81	81	81	86.92	88.49	88.95		(217)
Fuel for water	•												
(219)m = (64) (219)m = 248.32	<u>m x 100</u> 219.54	) ÷ (217) 232.23	m 212.39	214.09	193.53	185.41	206.69	207.78	218.16	226.78	242.09		
(210)111- 240.02	210.04	202.20	212.00	214.00	100.00	100.41	ļ	I = Sum(2		220.70	242.00	2607	(219)
Space cooling	ı fuel k	Wh/mor	nth					`	/112		l	2007	(210)
(221)m = $(107)$													
(221)m= 0	0	0	0	0	32.83	39.83	31.45	0	0	0	0		
							Tota	ıl = Sum(2:	21) <sub>68</sub> =			104.12	(221)
Annual totals									k'	Wh/yeaı	•	kWh/yea	<u></u>
Space heating	fuel use	ed, main	system	1								6413.14	
Water heating	fuel use	ed										2607	7
Space cooling	fuel use	ed									ĺ	104.12	Ħ
											L		

Electricity for pumps, fans and electric keep-hot mechanical ventilation - balanced, extract or positive input from outside 346.16 (230a) central heating pump: (230c)30 sum of (230a) (230g) = Total electricity for the above, kWh/year (231)376.16 Electricity for lighting 512.18 (232)Electricity generated by PVs (233)-1878.42 12a. CO2 emissions – Individual heating systems including micro-CHP **Energy Emission factor Emissions** kWh/year kg CO2/kWh kg CO2/year (211) x Space heating (main system 1) (261)0.216 1385.24 (215) x Space heating (secondary) (263)0.519 0 (219) x Water heating (264)0.216 563.11 (261) + (262) + (263) + (264) =Space and water heating 1948.35 (265)(221) x Space cooling (266)0.519 54.04 Electricity for pumps, fans and electric keep-hot (231) x (267)0.519 195.23 (232) x **Electricity for lighting** 265.82 (268)0.519 Energy saving/generation technologies Item 1 0.519 -974.9 (269)sum of (265) (271) Total CO2, kg/year (272)1488.54

 $(272) \div (4) =$ 

**Dwelling CO2 Emission Rate** 

El rating (section 14)

9.64

90

(273)

(274)