

11-12 Grenville Street London

Residential Development Energy Strategy

Issue 1



Client Name	Calabar Properties Ltd	
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CONTENTS

		Page
EXECUT	IVE SUMMARY	3
1.00	Introduction	4
2.00	Policy Review	5
3.00	Outline Methodology	11
4.00	Energy Demand Assessment	12
5.00	Decentralised Heating, Cooling and Power Assessment	15
6.00	Renewable Energy Assessment	18
7.00	Overheating	24
8.00	Overall Building Analysis	25
9.00	Conclusions	26
	Appendix	
	SAP worksheets for the six apartments	



EXECUTIVE SUMMARY

The energy strategy adopts a hierarchical approach using passive and low energy design technologies to reduce the existing development's energy demand and CO_2 emissions followed by the application of low and zero carbon technologies. This strategy is in line with the relevant GLA Policies from the Further Alterations to the London Plan 2015 and the related supplementary guidance. In accordance with the April 2014 issue of the GLA SPG 'Sustainable Design and Construction'. This strategy is also in line with Camden's planning guide (CPG3).

The focus of this energy strategy is on CO_2 reduction by using a highly efficient building envelope with high efficiency mechanical and electrical services, serving the space heating and domestic hot water. The result is a proposed development with a predicted performance of:

• This building comprises of a refurbishment and doesn't fall under the London Plan requirement of 35% carbon reduction and has no carbon requirement under Building Regulations. With the passive improvements proposed a 70.5% reduction is the result in carbon when compared to the existing development.

The carbon dioxide emission and savings values, for the development are as follows:

	CO ₂ Emissions (Tonnes per annum)	
	Regulated	Unregulated
Existing Development	140.38	159.39
Proposed Development after passive/low energy (energy demand) reduction	41.46	60.47

	Regulated CO ₂ Savings	
	Tonnes per annum	%
Savings from passive/low energy (energy demand) reduction	39.73	70.5



1.00 INTRODUCTION

1.01 Purpose

This report has been prepared on behalf of Calabar Properties Ltd for the proposed 11-12 Grenville Street development energy strategy.

The report contains the predicted energy and carbon emission assessment results and identifies savings from the proposed passive and building services technologies to be incorporated into the scheme.

The energy and carbon dioxide emission assessment also known as the SAP assessment (Standard Assessment Procedure) has been undertaken using NHER Plan Assessor 6.2 software. Based on the building design submitted with the planning application the modelling identifies the energy and carbon dioxide performance savings related to the building envelope design and efficient mechanical and electrical services systems for the scheme.

1.02 Existing Building

The existing building is to be retained. This consists of lower ground level, ground floor level and three upper floors. Grenville Street is situated within the London Borough of Camden. Although not listed, Grenville Street falls within the 'Bloomsbury Conservation Area'. This development is currently used as an office development on the upper floors with retail accommodation at ground level located in central London. 11-12 Grenville Street forms part of a Georgian terrace of town houses which dates back to the 1900s.

1.03 Proposed Development

The proposed development consists of the existing building with an extension into the existing roof creating a fourth floor. With the constraints of the conservation area a soft approach was proposed to the front and rear of the building keeping to the Georgian terrace style.

The building comprises of six residential apartments with a retail unit at ground level. As there are no restrictions internally the building fabric has been significantly improved beyond Building Regulation requirements.

High efficiency services have been proposed to provide heating, hot water and energy efficient lighting to create the most energy efficient dwellings within the restrains of the development.

1.04 Reservation

This report has been prepared solely for the use of the applicant and Watkins Payne Partnership accept no responsibility for its use by any third parties.



2.00 POLICY REVIEW

2.01 National Policy

The National Planning Policy Framework sets out the planning policies for England that are to be taken into account within local planning policies. The framework itself does not have specific policies but identifies the purpose of achieving sustainable development.

2.02 Further Alterations to the London Plan 2015

The Further Alterations to the London Plan 2015 identifies key policies associated with building design and energy strategy as noted below:

Policy 5.2 Minimising Carbon Dioxide Emissions

Planning Decisions

- A Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:
 - 1 Be lean: use less energy
 - 2 Be clean: supply energy efficiently
 - *3* Be green: use renewable energy
- B The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outline in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential Buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent (code for sustainable homes level 4)
2013 – 2016	40 per cent
2016 – 2031	Zero carbon

- *C* Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.
- D As a minimum, energy assessments should include the following details:
 - a) Calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy
 - b) Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services



- c) Proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as decentralised heating and cooling and combined heat and power (CHP)
- d) Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies
- *E* The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

Policy 5.4 Retrofitting

A The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

Policy 5.5 Decentralised Energy Networks

Strategic

A The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

Policy 5.6 Decentralised Energy in Development Proposals

Planning Decisions

- A Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.
- *B* Major development proposals should select energy systems in accordance with the following hierarchy:
 - 1. Connection to existing heating or cooling networks.
 - 2. Site wide CHP network.
 - 3. Communal heating and cooling.
- *C* Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.



Policy 5.7 Renewable Energy

Strategic

A The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Policy 5.9 Overheating and Cooling

Strategic

A The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

Planning Decisions

- *B* Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:
 - 1. Minimise internal heat generation through energy efficient design
 - 2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
 - 3. Manage the heat within the building through exposed internal thermal mass and high ceilings
 - 4. Passive ventilation
 - 5. Mechanical ventilation
 - 6. Active cooling systems (ensuring they are the lowest carbon options)
- *C* Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible.

2.03 GLA Supplementary Planning Guidance

The Further Alterations to the London Plan 2015 (FALP 2015) is supported by various supplementary planning guidance (SPG) that includes "Sustainable Design and Construction" dated April 2014 that relates specifically to sustainability issues.

The Sustainable Design and Construction SPG sets out the Mayor's priorities and the Mayor's best practice for new developments encompassing a wide range of sustainability topics.

The major change to the carbon emission savings targets for the April 2014 edition of the SPG is that the overall saving target is benchmarked against a Building Regulations Part L1A:2013 Baseline and not Part L1A:2010. This change gives a revised carbon emission reduction target of 35% less than Part L1A:2013.



The relevant sections from the Sustainable Design and Construction SPG are as follows:

Energy and Carbon Dioxide Emissions			
Mayor's Priority	FALP Policy		
The overall carbon dioxide emissions from a development should be minimized through the implementation of the energy hierarchy set out in the FALP 2015 Policy 5.2.	5.2, 5.3		
Developments should be designed to meet the following Regulated carbon dioxide standards, in line with FALP 2015 Policy 5.2.	5.2		
Residential Buildings			
 Year - Improvements beyond 2010 Building Regulations. 1st October 2013 - 2016 - 40 per cent 2016 - 2031 - Zero carbon 			
Mayor's Best Practice	FALP Policy		
Developments should contribute to ensuring resilient energy infrastructure and a reliable energy supply, including from local low and zero carbon sources.	5.1, 5.5, 5.6, 5.7, 5.8, 5.17		
Developers are encouraged to include innovative low and zero carbon technologies to minimize carbon dioxide emissions within developments and keep up to date with rapidly improving technologies.	5.2, 5.17		
Energy Demand Assessment			
Mayor's Priority	FALP Policy		
Development applications are to be accompanied by an energy demand assessment.	5.2		
Use Less Energy			
Mayor's Priority	FALP Policy		
The design of developments should prioritise passive measures.	5.2, 5.3, 5.9		
Mayor's Best Practice	FALP Policy		
Developers should aim to achieve Part L 2013 Building Regulations requirements through design and energy efficiency alone, as far as is practical.	5.2, 5.3		
Efficient Energy Supply			
Mayor's Priority	FALP Policy		
Where borough heat maps have identified district heating opportunities, boroughs should prepare more detailed Energy Master Plans (EMPs) to establish the extent of market competitive district heating networks.	5.5, 5.6		
Mayor's Priority	FALP Policy		
Developers should assess the potential for their development to:	5.5, 5.6		
• connect to an existing district heating or cooling network;			
• expand an existing district heating or cooling network, and connect to it; or			
• establish a site wide network, and enable the connection of existing buildings in the vicinity of the development.			



Mayor's Priority	FALP Policy
Where opportunities arise, developers generating energy or waste heat should maximize long term carbon dioxide savings by feeding the decentralized energy network with low or zero carbon hot, and where required, cold water.	5.5, 5.6
Renewable Energy	
Mayor's Priority	FALP Policy
Boroughs and neighbourhoods should identify opportunities for the installation of renewable energy technologies in their boroughs and neighbourhoods.	5.4, 5.7
Major development should incorporate renewable energy technologies to minimize overall carbon dioxide emissions, where feasible.	5.7
Carbon Dioxide Off-setting	
Mayor's Priority	FALP Policy
Boroughs should establish a carbon off-set fund and identify suitable projects to be funded.	5.2, 5.4
Where developments do not achieve the Mayor's carbon dioxide reduction targets set out in FALP 2015 Policy 5.2, the developer should make a contribution to the local borough's carbon dioxide off-setting fund.	5.2, 5.4
Retrofitting	
Mayor's Priority	FALP Policy
Boroughs should set out policies to encourage the retrofitting of carbon dioxide and water saving measures in their borough.	5.4, 5.15
Where works to existing developments are proposed developers should retrofit carbon dioxide and water saving measures.	5.4, 5.15
Monitoring Energy Use	
Mayor's Best Practice	FALP Policy
Developers are encouraged to incorporate monitoring equipment and systems where appropriate to enable occupiers to monitor and reduce their energy use.	5.2, 5.3
Supporting a Resilient Energy Supply	
Mayor's Best Practice	FALP Policy
Developers are encouraged to incorporate equipment that would enable their schemes to participate in demand side response opportunities.	5.2, 5.3
Climate Change Adaptation	
Tackling Increased Temperature and Drought	
Overheating	
Mayor's Priority	FALP Policy
Developers should include measures, in the design of their schemes, in line with the cooling hierarchy set out in FALP 2015 Policy 5.9 to prevent overheating over the schemes life-time.	5.3, 5.9



2.04 Camden Council Planning Guidance

Camden Planning Guidance (CPG3) in regards to existing buildings states the following:

Energy efficiency: existing buildings

Key Messages

As a guide, at least 10% of the project cost should be spent on environmental improvements.

Potential measures are bespoke to each property.

Sensitive improvements can be made to historic buildings to reduce carbon dioxide emissions.

- Many of the sections in this guidance focus on reducing the environmental impact of new buildings, however Camden's existing buildings account for almost 80% of the borough's carbon emissions. Therefore it is essential that these buildings make a contribution towards the borough's reduction in carbon dioxide emissions.
- This section provides more information on how existing buildings can be more energy efficient. It builds on the previous section, which covered Stage 1 of the energy hierarchy and improving energy efficiency in new buildings.
- Camden Core Strategy Policy CS13, paragraph 13.9 expects development or alterations to existing buildings to include proportionate measures to be taken to improve their environmental sustainability, where possible.

What Does The Council Expect?

- All buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements to the existing building. Work involving a change of use or an extension to an existing property is included. As a guide, at least 10% of the project cost should be spent on the improvements.
- Where retro-fitting measures are not identified at application stage we will most likely secure the implementation of environmental improvements by way of condition. Appendix 1 sets out a checklist of retro fit improvements for applicants.
- Development involving a change of use or a conversion of 5 or more dwellings or 500sq m of any floorspace, will be expected to achieve

60% of the un-weighted credits in the Energy category in their EcoHomes or BREEAM assessment, whichever is applicable. (See the section on Sustainability assessment tools for more details).

• Special consideration will be given to buildings that are protected e.g. listed buildings to ensure that their historic and architectural features are preserved.



3.00 OUTLINE METHODOLOGY

3.01 Energy Strategy

The fundamental approach for the energy strategy is as follows:

- Establish the existing development energy demand in line with statutory requirements in terms of Building Regulations Part L1A:2013 compliance using SAP assessment methodology.
- Adopt passive and low energy design techniques in order to reduce the energy demand for the development beyond the existing developments energy demand requirements.
- Assess the potential decentralised heating, cooling and power measures available to suit this development and establish potential energy/carbon dioxide reduction for viable solutions (clean scheme).
- Assess the potential low and zero carbon (renewable) technologies to suit the development and establish potential energy/carbon dioxide reduction for viable solutions.
- Establish the anticipated energy and carbon dioxide emission reductions for the residential areas.

This approach is in line with the principles detailed within the relevant policy statements and regulatory guidelines listed in section 2.00. The development consists of only refurbished residential apartments. Unlike the Building Regulations L1A which applies to new builds there is no carbon emission or a fabric efficiency target for the refurbished apartments falling under Building Regulations L1B. The above mentioned methodologies shall be applied to the whole residential development.

3.02 Energy Strategy Targets

There is no set carbon emission target for this development. Above mentioned stages will demonstrate a meaningful reduction by applying passive measures and then looking at efficient technologies that could be applied to the development. The potential for low to zero carbon (renewable) technologies to suit the development shall also be reviewed within this report.



4.00 ENERGY DEMAND ASSESSMENT

4.01 General

4.01.01 Principles

The energy demand assessment work has been undertaken using the Standard Assessment Procedure (SAP) 2012 version 9.9.2 in line with Building Regulations Part L1A: 2013 requirements using NHER Plan Assessor software version 6.2.

Within the energy demand assessment the following fuel carbon dioxide emission intensity factors have been used in line with Part L1A:2013.

Fuel	kg CO ₂ / kWhr
Natural gas	0.216
Grid supplied electricity	0.519
Grid displaced electricity	0.519

4.01.02 Regulated and Un-regulated Energy

The planning application energy strategy will be provided in a format that reflects the recommendations of the GLA document "Energy Planning – GLA Guidance on preparing energy assessments: April 2015" including also Camden's Planning Guide (CPG3).

Therefore this framework energy strategy shows how policy compliance for the "regulated" energy can be achieved at the development and makes reference to the estimated "unregulated" energy usage by means of energy benchmarks.

For clarity "regulated" and "un-regulated" energy are summarised as follows:

electricity, etc.

•	Regulated Energy	This is the energy covered by Approved Document L1A of the Building Regulations i.e. the energy used in heating, cooling, fans and pumps plus domestic hot water	
•	Un - regulated Energy	This is energy used within a building that is not covered by the Building Regulations i.e. the energy used for general small power loads, lifts, external lighting, catering	

The planning policy CO_2 reduction targets are based in "regulated" energy only. Hence the % CO_2 emission savings target is not adversely affected by the estimated "un-regulated" energy in a building.

The assessed un-regulated energy uses for the proposed development are as follows:

- Appliances
- Cooking

For this project the area weighted un-regulated energy equates to 19.01 kgCO₂/m² (7.64 Tonnes CO₂/Year).



4.02 Existing Scheme

The carbon emission is derived from using the Standard Assessment Procedure (SAP) 2012 version 9.92. The review has been carried out utilising the NHER Plan Assessor software version 6.2.

As described in section 3.0 this building is a refurbished development and as such falls under the Building Regulation Part L1B: 2013. Under this regulation there is no carbon emission target but for consistency the carbon emissions are listed.

As there is no fabric data information for the existing development Reduced Data Standard Assessment Procedure (RDSAP) fabric data was utilised based on the age of the building. Same principals were used for the services within these dwellings again utilising RDSAP data.

The existing development CO_2 emissions for this residential development are modelled as follows:-

Apartments	Existing Scheme (kg CO ₂ / m ²)
1	163.43
2	138.29
3	139.96
4	130.15
5	113.06
6	163.39
Area weighted carbon emission	140.38

The annual CO₂ emission resulting from the existing development demand equates to the following:

	CO ₂ Emission (tonnes CO ₂ /year)
Without unregulated uses	56.38
With unregulated uses	64.02

4.03 Energy Efficiency Measures

4.03.01 General

The energy strategy prioritises the reduction in energy consumption and hence CO_2 emissions through the building envelope design together with the use of efficient mechanical and electrical services.

The passive and low energy design principles that have been adopted in the current design include:

- High performance glazing
- Enhanced thermal performance to the existing walls and roof by the introduction of thermal insulations. High degree of thermal insulations within the new walls and roof associated with the building



- Low building air leakage rate (5 m³/hr/m² at 50 Pa)
- Low energy lighting (LED lamp sources)
- High efficiency gas fired boilers

4.03.02 Proposed Dwelling (Lean Scheme)

The Building Regulations SAP analysis identifies the following CO₂ emissions:

Apartments	Existing Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)
1	163.43	34.29
2	138.29	55.65
3	139.96	49.89
4	130.15	44.95
5	113.06	33.38
6	163.39	27.31
Area weighted carbon emission	140.38	41.46
Unregulated Power	19.01	19.01
Total	159.39	60.47

The annual CO_2 emissions resulting from the passive/low energy scheme equates to the following:

	CO ₂ Emission (tonnes CO ₂ /year)
Without unregulated uses	16.65
With unregulated uses	24.29

Apartments	Existing Scheme (kWh/m ² /year)	Lean Scheme (kWh/m ² /year)
1	300.7	115.1
2	250.6	214.8
3	215.9	176.5
4	194.8	154.7
5	186.6	113.4
6	267.7	76.7
Area weighted carbon emission	238.93	145.84



5.00 DECENTRALISED HEATING, COOLING AND POWER ASSESSMENT

5.01 General

The potential use of decentralised heating, cooling and power for the building has been assessed in relation to the following:

- Decentralised heating
- Decentralised cooling
- Combined heat and power (CHP)
- Combined cooling heat and power (CCHP/trigeneration)
- Community heating and cooling

5.02 Decentralised Heating and Cooling

Decentralised heating and cooling relates to a central system that provides the necessary heating and cooling water to more than one use or part of a building or to more than one building. For example a decentralised heating system can comprise central boiler plant that provides heat to separate dwellings and similarly a decentralised cooling system can comprise central refrigeration plant that provides cooling to individual retail units in a shopping centre.

Two types of decentralised heating and cooling schemes have been considered for the development.

- 1. Connection to a district energy network (DEN)
- 2. The provision of a development decentralised energy centre

District Energy Network

Investigations into existing or proposed district energy networks to provide decentralised heating to the development has established that there is an existing and potential district heating network near Farringdon and a potential district heating network near Euston. The Farringdon installation is approximately 1.8km away and the Euston installation is approximately over 1km away.





The heating and hot water demand for these apartments will be considerably low for a DEN system to be viable. The infrastructure required to connect in to the district heating network will be significant making the DEN system not viable.

5.03 Combined Heat and Power

Combined Heat and Power (CHP) generates electricity on site and recovers a proportion of the waste heat for use in heating and/or hot water generation for the building. This allows the overall efficiency to be significantly greater than the electricity generated via power stations feeding the National Grid. The CHP plant typically uses gas as the primary energy source and often incorporates a thermal store. Biomass fuelled CHP is possible however this is typically only for very large schemes due to operational difficulties with smaller capacity units.



CHP systems are typically considered only to be viable where they are able to run for at least 5000 hours per annum and have an appropriate year round heating demand.

The residential apartment will only have a very low base electricity and heating demand, CHP is not considered viable.

5.04 Combined Cooling, Heat and Power





The reason given in section 5.03 applies to CCHP and as no cooling is proposed for the apartments the benefit achieved using the waste heat within the absorption chiller is not utilised.

5.05 Community Heating and Cooling

Community heating and cooling relates to a central system that provides the necessary heating and cooling water to more than one use or part of a building. For example a community heating system can comprise central boiler plant that provides heat to separate dwellings and similarly a community cooling system can comprise central refrigeration plant that provides cooling to individual retail units in a shopping centre.

As there is not plant space associated with the residential demise a community system cannot be provided. The high efficiency gas boilers proposed as detailed in section 4.03.01 which forms part of the passive and low energy design measure shall provide the heating and hot water demands for the apartments.



6.00 RENEWABLE ENERGY ASSESSMENT

6.01 General

The potential use of renewable energy technology has been undertaken for the following:

- Solar water heating
- Wind turbines
- Photovoltaic cells
- Biomass
- Ground source heating and cooling
- Air source heating and cooling
- Fuel cell

6.02 Solar Water Heating

Solar thermal panels utilise the suns energy to generate hot water for use within the building. The panels are commonly provided in either flat plate or evacuated tube arrangements. The panels are ideally located facing south at an approximate 30° inclination angle in areas where they are not subjected to shade.



The development has a mansard roof which forms the top floor apartment. Mounted Based on the buildings orientation the best location would be along the front façade which is easterly facing. At this location the panels can be easily seen and the building opposite is taller which will shade the panels majority of the day. Rear façade is westerly facing which will not provide the radiance for the solar thermal system to be beneficial. There is also the shading due to the taller building on either side to the proposed building. The benefits of having solar thermal panels are limited and such not viable for the development.





6.03 Wind Turbines

Wind turbines generate electrical energy derived from kinetic energy provided by the local wind resource. The performance of wind turbines depends greatly on the wind speed and turbulence that in turn is influenced by the terrain and installation height.







In urban areas non-laminar wind flow occurs as a result of turbulence due primarily to adjacent buildings. There is growing evidence of urban wind turbines failing to perform in line with manufacturer's estimated outputs and as a result wind turbines are likely to produce only modest power outputs with corresponding low carbon dioxide emission reduction within urban sites. The use of wind turbines on the development would also have a significant visual impact.

For the reasons detailed above wind turbines are not considered viable for the development.

6.04 Photovoltaic Cells

Photovoltaic (PV) panels utilise the sun's energy to generate electricity. The optimum location for PV panels is south facing at an approximate 30° inclination angle in areas where they are not subjected to shade.







The installation of PV panels falls under the same criteria as the solar thermal panels. Please refer to section 6.02 for the viability of PV panels.

6.05 Biomass

Biomass is considered to be a renewable fuel source as the CO_2 absorbed during the growth period is assessed as being approximately equal to the CO_2 emitted during combustion and hence deemed "carbon neutral". Biomass for boilers is typically wood either in chip or pellet form.

Biomass boilers require fuel storage together with associated transportation and delivery to the store location. Biomass boilers also increase the NOx emissions when compared to gas fired boilers.







For this development there is no realistic space within the overall development for fuel storage together with the site constraints related to the associated delivery requirements. In addition there are on-going concerns with regard to the potential impact on local air quality.

For the reasons defined above the use of biomass is not considered viable for the development.

6.06 Ground Source Heating and Cooling

Ground source heating and cooling systems utilises the principle during heating mode of upgrading heat from the ground to a usable temperature and during cooling mode of rejecting heat from the building into the ground. There are two primary methods utilising either open or closed loop systems.



The open loop system extracts water, typically from the chalk aquifer, and uses this water in either the heating or cooling process before rejecting this heat back to the aquifer in a separate borehole. The open loop system requires licence approval from the Environment Agency that typically has a 10 year duration.

The closed loop system dissipates heat to or extracts heat from the ground via pipework circuits that are typically inserted into vertical boreholes. These generally do not require Environment Agency licences as no extraction of water from the aquifer takes place.



Generally for both the open and closed loop options heat pumps are used in order to generate the heating and cooling water temperatures needed within a building.

Incorporating ground source heating and cooling technology into the development poses a significant construction programme and operational risk. The building footprint is small and is located between existing buildings. The policy design will restrict the thermal energy generation capacity due to the minimal number of boreholes location available. As a result this option is not considered to be viable for this development.

6.07 Air Source Heating and Cooling

Air sourced heat pump (ASHP) works on the same principles as a ground source heat pump (GSHP) however the medium in which heat is extracted is the external air rather than the ground. The ASHP can be reversed to provide cooling when required. ASHP will generally have a lower seasonal coefficient of performance when compared to GSHP.



The development has no plant space available and the apartment will not be comfort cooled. The progressed high efficient gas fired boiler will offer a more efficient heating system than using an ASHP system.

6.08 Fuel Cell

The fuel cell technology essentially converts chemical energy into both electrical and heat energy. The cell needs to be continually supplied with hydrogen (derived from either a piped or storage source) and oxygen (derived from air) which are combined and the chemical reaction produces electrical energy, heat energy and water vapour.

The fuel cell requires a hydrogen fuel source that can either be from a piped source (not currently available) or from stored gas. However the more usual approach currently in the UK is to use natural gas in order to generate the hydrogen required to operate the fuel cell.

Fuel cells have various commercial and technical limitations. There is a high initial capital cost together with there being few established suppliers and a very limited specialist design, installation and maintenance capabilities. Certain fuel cell elements require regular replacement imposing a significant on-going cost implication. The fuel cells themselves are generally large, heavy and require fresh air ventilation.

Due to the initial capital cost, space requirements and on-going maintenance costs fuel cells are not considered viable for this development.



7.00 OVERHEATING

The building design has adopted the following principles in order to reduce potential overheating:

- Balance between solid and glazed elements within the façade whilst taking into account the building design aesthetic requirements
- Energy efficient design measures such as low energy LED lighting
- High performance glazing to reduce heat losses and solar heat gain



8.00 OVERALL BUILDING ANALYSIS

8.01 Carbon Reduction of the Development

The building analysis can then be summarised as follows:

		Area Weighted	I kg CO ₂ /m ²	
	Existing Scheme	Lean Scheme	Clean Scheme	LZC Scheme
Carbon Emission	140.38	41.46	n/a	n/a
Allowing for Un-regulated Uses	159.39	60.47	n/a	n/a

Utilising high performance fabric and building services the refurbished residential development shows a predicted improvement of 70.5 % over the existing development. With unregulated load this is a 62.1% improvement over the existing development. The relevant SAP work sheets are included within the appendix for each dwelling.



9.00 CONCLUSIONS

In line with the relevant planning policies and guidelines the energy strategy for the proposed development has adopted a hierarchical approach of using passive and low energy design technologies to reduce the existing developments energy demand and hence CO_2 emissions followed by the consideration of passive design measures as appropriate.

The focus of the energy strategy is on CO_2 reduction from the building by adopting a efficient building envelope solution together with high efficiency mechanical and electrical services. The renewable energy technologies assessment is based on using solutions that are technically proven with low maintenance implications taking into account the energy efficiency strategies being proposed in the current design.

The analysis has shown that by incorporating passive and low energy design measures there is a predicted reduction annual CO_2 emissions, as indicated in the table below, from the existing scheme.

Regulated (Regulated CO ₂ Savings										
Tonnes CO ₂ /Year	%										
39.73	70.5										

This is achieved by the following elements:

- High performance glazing
- Improved building fabric thermal insulation
- High efficiency heating plant
- Low energy lighting (LED lighting)

The decentralised heating, cooling and power assessment has indicated that the application of a clean system is not beneficial for the development.

The potential renewable energy technologies have been assessed taking into account the particular development constraints and have been concluded to be unviable for the reason stated within section 6.00.

As it can be seen from the analysis we are significantly improving the existing development by incorporating passive and low energy measures without the need for renewables. Development is located within the conservation area of Bloomsbury and the added site constraint doesn't permit the provision of onsite renewables.



APPENDIX

SAP Worksheet Design - Draft



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

Assessor name	Mr Spyridon	n Karnezi	s					Assessor num	ber	8658		
Client								Last modified		12/08	/2016	
Address	1 11-12 Gre	nville. Ca	amden. WC	21								
		-,	,									
1. Overall dwelling dimen	sions											
				ŀ	Area (m²)		۵	verage storey height (m)		Vo	lume (m³)	
Lowest occupied					28.60](1a) x	Ē	2.50	(2a) =		71.50	(3a)
+1					25.48	(1b) x		3.50	(2b) =		89.18	(3b)
+2					28.60	(1c) x		3.10	(2c) =		88.66	(3c)
Total floor area	(1a) + (1b) + (1c	c) + (1d)(2	Ln) =	82.68	(4)						
Dwelling volume								(3a) + (3b) + (3d	c) + (3d)(3	3n) =	249.34] (5)
2. Ventilation rate												
										m	' per hour	
Number of chimneys								0	x 40 =		0	(6a)
Number of open flues								0	x 20 =	:	0	(6b)
Number of intermittent fan	S						E	3) x 10 =	:	30	(7a)
Number of passive vents								0) x 10 =	:	0	(7b)
Number of flueless gas fires	;							0) x 40 =	:	0	(7c)
										Air c	hanges per hour	r
Infiltration due to chimneys	, flues, fans, P	SVs		(6a) + (6b) + (7	a) + (7b) + ((7c) =	30	÷ (5) =	. [0.12	(8)
If a pressurisation test has l	peen carried ou	ut or is ir	ntended, pr	oceed to	(17), otherw	vise continu	e from (′9) to (16)				-
Air permeability value, q50,	expressed in (cubic me	etres per ho	our per sq	uare metre	of envelop	e area				5.00	(17)
If based on air permeability	value, then (1	.8) = [(17	') ÷ 20] + (8	s), otherw	ise (18) = (1	6)					0.37	(18)
Number of sides on which t	he dwelling is	sheltere	d								4	(19)
Shelter factor								1 -	[0.075 x (1	9)] =	0.70	(20)
Infiltration rate incorporation	ng shelter facto	or							(18) x (2	20) =	0.26	(21)
Infiltration rate modified fo	r monthly win	d speed:										
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	g Sep	Oct	Nov	Dec	
Monthly average wind spee	d from Table U	U2										
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70) 4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4												
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	3 1.00	1.08	1.13	1.18] (22a)
Adjusted infiltration rate (a	llowing for she	elter and	wind facto	or) (21) x (22a)m							
0.33	0.32	0.32	0.29	0.28	0.25	0.25	0.24	0.26	0.28	0.29	0.30	(22b)
Calculate effective air changed	ge rate for the	applicat	ole case:									
If mechanical ventilation	1: air change ra	ate throu	ıgh system								N/A] (23a)
If balanced with heat re	covery: efficier	ncy in %	allowing fo	or in-use fa	actor from T	able 4h					N/A	(23c)
d) natural ventilation or	whole house p	oositive i	input venti	lation from	n loft							_
0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.55	(24d)



Effective air ch	ange rate - e	enter (24a) o	or (24b) oi	r (24c) or (24	1d) in (25)								
	0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.55	(25)
3. Heat losses	and heat lo	ss paramet	er										
Flement				Gross	Openings	Net	area	U-value	A x U M	//К к-\	value.	Ахк.	
Liement				area, m²	m²	Α,	m²	W/m ² K		kJ,	/m².K	kJ/K	
Door						1.	70 x	1.80	= 3.06				(26)
Window						9.	80 x	1.50	= 14.74				(27)
Exposed floor						1.	92 x	0.22	= 0.42				(28b
Ground floor						28	.60 x	0.22	= 6.29				(28a)
External wall						131	09 x	0.28	= 36.71				(29a)
External wall						30	.90 x	1.38	= 42.64				(29a)
Party wall						17	.05 x	0.50	= 8.53				(32)
Roof						30	.52 x	0.18	= 5.49				(30)
Total area of ex	kternal elem	ents ∑A, m²				234	.53						(31)
Fabric heat loss	s, W/K = ∑(A	× U)							(2	6)(30) + (3	32) =	117.88	(33)
Heat capacity C	Cm = ∑(А x к))						(28)	.(30) + (32)	+ (32a)(3	2e) =	N/A	(34)
Thermal mass	parameter (1	TMP) in kJ/m	۱²K									250.00	(35)
Thermal bridge	es: Σ(L x Ψ) c	alculated us	ing Apper	ndix K								35.18	(36)
Total fabric hea	at loss									(33) + (3	36) =	153.06	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation hea	at loss calcul	ated monthl	ly 0.33 x ((25)m x (5)									
	45.64	45.46	45.29	44.49	44.34	43.64	43.64	43.51	43.91	44.34	44.64	44.96	(38)
Heat transfer c	oefficient, V	V/K (37)m +	(38)m										
	198.69	198.52	198.35	197.54	197.39	196.69	196.69	196.56	196.96	197.39	197.70	198.01	
									Average =	Σ(39)112/	/12 =	197.54	(39)
Heat loss parar	meter (HLP),	W/m²K (39)m ÷ (4)										
	2.40	2.40	2.40	2.39	2.39	2.38	2.38	2.38	2.38	2.39	2.39	2.39	
									Average = 2	<u>(40)112</u>	/12 =	2.39	(40)
Number of day	s in month (Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
4. Water neat	ing energy i	requirement	C										
Assumed occup	bancy, N				(a							2.51	(42)
Annual average	e hot water i	usage in litre	es per day	Vd,average	= (25 x N) +	36		_		•		93.85	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usag	ge in litres pe	er day for ea	ch month	n Vd,m = fact	tor from Tab	le 1c x (43)		1			1	-
	103.24	99.49	95.73	91.98	88.22	84.47	84.47	88.22	91.98	95.73	99.49	103.24	
			0.14	- 12			- 11 41	4 4 1)		∑(44)1	.12 =	1126.25	_ (44)
Energy content	t of hot wate	er used = 4.1	.8 x Vd,m	x nm x 1m/3	3600 kWh/m	onth (see	Tables 1b), 1c 1d)	1		1	1	-
	153.10	133.90	138.18	120.47	115.59	99.74	92.43	106.06	107.33	125.08	136.54	148.27	
										∑(45)1	.12 =	1476.69	(45)
Distribution los	s 0.15 x (45	5)m			,								-
	22.97	20.09	20.73	18.07	17.34	14.96	13.86	15.91	16.10	18.76	20.48	22.24	(46)
Water storage	loss calculat	ed for each	month (5	55) x (41)m	· · ·						1		
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel co	ntains dedic	ated solar st	torage or	dedicated W	VWHRS (56)r	n x [(47) -	Vs] ÷ (47)), else (56)	1	1	1		-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit	loss for each	n month froi	m Table 3										

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 (59)	
Combi loss for e	ach month	from Table	3a. 3b or 3	с							I	```	
	50.96	15 79	/8 78	15.36	11 96	<i>4</i> 1 66	13.04	11.96	15 36	18 78	19.06	50.96 (61)	
Total boat roqui	rod for wat	or booting c	valculated f	45.50	++.50	$(45)m \pm (4)$	-3.04	(50) m +	(61)m	40.70	45.00	30.30 (01)	
Total field requi						(43)11 + (40				470.07	405.00		
	204.06	179.69	186.96	165.82	160.55	141.40	135.47	151.02	152.69	1/3.8/	185.60	199.23 (62)	
Solar DHW inpu	t calculated	using Appe	endix G or A	Appendix H							1		
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 (63)	
Output from wa	ter heater f	or each mo	nth (kWh/ı	month) (62	2)m + (63)m	ı							
	204.06	179.69	186.96	165.82	160.55	141.40	135.47	151.02	152.69	173.87	185.60	199.23	
										∑(64)1	12 = 2	.036.36 (64)	
Heat gains from	water heat	ing (kWh/m	nonth) 0.25	5 × [0.85 × ((45)m + (61	.)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]				
	63.65	55.97	58.14	51.39	49.67	43.58	41.49	46.51	47.03	53.79	57.66	62.04 (65)	
											•	·	
5. Internal gair	าร												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)												
	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70	150.70 (66)	
Lighting gains (c	alculated in	Appendix L	, equation	L9 or L9a),	also see Ta	ble 5						·	
	59.98	53.27	43.32	32.80	24.52	20.70	22.37	29.07	39.02	49.54	57.82	61.64 (67)	
Appliance gains	(calculated	in Annendi		on 113 or 11	3a) also se	e Table 5							
, ippliance Same	225 75	220.22	220 45	211 76	200 17	265.00	251 10	247.60	256 47	275 16	209.76	220.02 (68)	
Cooking going (a		Appondix I	330.45	511.70	200.17	203.99	231.10	247.05	230.47	275.10	298.70	320.33 (08)	
COOKINg gains (C					a), also see								
	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58	52.58 (69)	
Pump and fan g	ains (Table 5	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00 (70)	
Losses e.g. evap	oration (Tal	ole 5)											
	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47	-100.47 (71)	
Water heating g	ains (Table	5)											
	85.55	83.29	78.14	71.38	66.76	60.53	55.77	62.51	65.31	72.29	80.09	83.39 (72)	
Total internal ga	ins (66)m +	+ (67)m + (6	8)m + (69)ı	m + (70)m -	+ (71)m + (7	72)m							
	587.09	581.61	557.74	521.76	485.27	453.03	435.13	445.09	466.62	502.82	542.49	571.78 (73)	
		11									1		
6. Solar gains													
			Access f	actor	Area	Sola	ar flux		g	FF		Gains	
			Table	6d	m²	W	//m²	speci or T	ific data able 6b	specific d	lata 60	W	
						- —							
South			0.30		7.20	X 4	6.75 x	0.9 x).73 x	0.70	=	46.44 (78)	
West			0.7	7X	2.60	x 1	9.64 x	0.9 x 0).73 x	0.70	=	18.08 (80)	
Solar gains in wa	atts ∑(74)m	(82)m											
	64.53	111.44	155.15	194.47	218.24	216.41	208.78	191.37	168.97	124.01	77.60	55.00 (83)	
Total gains - inte	ernal and so	lar (73)m +	(83)m										
	651.61	693.04	712.88	716.23	703.50	669.44	643.91	636.46	635.59	626.83	620.09	626.78 (84)	
7. Mean intern	al tempera	ture (heatir	ng season)										
Temperature du	iring heating	g periods in	the living a	area from T	able 9, Th1	.(°C)						21.00 (85)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains f	or living are	a n1,m (se	e Table 9a)									
	0.99	0.99	0.99	0.98	0.96	0.92	0.84	0.86	0.94	0.98	0.99	0.99 (86)	
Mean internal to	emp of livin	g area T1 (s	teps 3 to 7	in Table 9c	.)								

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)19.0819.0819.0919.0919.0919.09	70 20.67 20.29 19.67 19.02 18.50 (87)
19.08 19.08 19.09 19.09 19.09 19.09 19.0	
	09 19.09 19.09 19.09 19.09 19.08 (88)
Utilisation factor for gains for rest of dwelling n2,m	
0.99 0.99 0.98 0.97 0.94 0.84 0.64	i4 0.67 0.88 0.96 0.99 0.99 (89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	
16.96 17.11 17.42 17.86 18.35 18.79 19.0	02 19.00 18.70 18.09 17.46 16.93 (90)
Living area fraction	Living area ÷ (4) = 0.28 (91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	
17.40 17.55 17.86 18.31 18.79 19.25 19.4	49 19.47 19.15 18.54 17.90 17.37 (92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	
17.40 17.55 17.86 18.31 18.79 19.25 19.4	49 19.47 19.15 18.54 17.90 17.37 (93)
8. Space heating requirement	
Jan Feb Mar Apr May Jun Jul	l Aug Sep Oct Nov Dec
Utilisation factor for gains, ηm	
0.99 0.98 0.98 0.96 0.93 0.85 0.70	0 0.73 0.88 0.96 0.98 0.99 (94)
Useful gains, ηmGm, W (94)m x (84)m	
643.09 681.40 695.97 688.83 653.85 568.21 449.7	.76 462.25 561.40 600.65 608.32 619.48 (95)
Monthly average external temperature from Table U1	
4.30 4.90 6.50 8.90 11.70 14.60 16.6	60 16.40 14.10 10.60 7.10 4.20 (96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	
2602.88 2511.06 2253.19 1857.92 1399.37 913.76 568.6	.63 603.18 993.83 1566.44 2134.31 2607.73 (97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	
1458.09 1229.53 1158.57 841.75 554.67 0.00 0.00	0 0.00 0.00 718.55 1098.71 1479.25
	$\Sigma(98)15, 1012 = 8539.12 $ (98)
Space heating requirement kWh/m ² /year	(98) ÷ (4) 103.28 (99)
9a. Energy requirements - individual heating systems including micro-CHP	
Space heating	
Fraction of space heat from secondary/supplementary system (table 11)	0.00 (201)
Fraction of space heat from main system(s)	1 - (201) = 1.00 (202)
Fraction of space heat from main system 2	0.00
Fraction of space heat from main system 2 Fraction of total space heat from main system 1	(202) x [1- (203)] = 1.00 (204)
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2	$(202) \times [1- (203)] = 1.00 $ (204) (202) × (203) = 0.00 (205)
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%)	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ Il Aug Sep Oct Nov Dec
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month	(202) x [1- (203)] = 1.00 (204) (202) x (203) = 0.00 (205) 95.80 (206) I Aug Sep Oct Nov Dec
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $I Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater 94.55 94.50 94.39 94.13 93.54 86.50 86.5	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $10 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$ $50 86.50 86.50 93.83 94.33 94.59 (217)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater 94.55 94.50 94.39 94.13 93.54 86.50 86.5 Water heating fuel, kWh/month	$(202) \times [1-(203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$ $50 86.50 86.50 93.83 94.33 94.59 (217)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater 94.55 94.50 94.39 94.13 93.54 86.50 86.5 Water heating fuel, kWh/month 198.07 176.16 171.63 163.47 156.6	$(202) \times [1- (203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$ $50 86.50 86.50 93.83 94.33 94.59 (217)$ $62 174.59 176.52 185.29 196.75 210.62$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating 94.55 94.50 94.39 94.13 93.54 86.50 86.5 Water heating fuel, kWh/month 152.0 190.14 198.07 176.16 171.63 163.47 156.6	$(202) \times [1-(203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$ $50 86.50 86.50 93.83 94.33 94.59 (217)$ $62 174.59 176.52 185.29 196.75 210.62$ $\Sigma(219a)112 = 2215.66 (219)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater Efficiency of water heater 94.55 94.50 94.39 94.13 93.54 86.50 86.5 Water heating fuel, kWh/month 215.82 190.14 198.07 176.16 171.63 163.47 156.6 Annual totals	$(202) \times [1-(203)] = 1.00 (204)$ $(202) \times (203) = 0.00 (205)$ $95.80 (206)$ $1 Aug Sep Oct Nov Dec$ $00 0.00 0.00 750.05 1146.88 1544.11$ $\Sigma(211)15, 1012 = 8913.49 (211)$ $50 86.50 86.50 93.83 94.33 94.59 (217)$ $62 174.59 176.52 185.29 196.75 210.62$ $\Sigma(219a)112 = 2215.66 (219)$
Fraction of space heat from main system 2 Fraction of total space heat from main system 1 Fraction of total space heat from main system 2 Efficiency of main system 1 (%) Jan Feb Mar Apr May Jun Jul Space heating fuel (main system 1), kWh/month 1522.01 1283.44 1209.37 878.65 578.98 0.00 0.00 Water heating Efficiency of water heater 94.55 94.50 94.39 94.13 93.54 86.50 86.5 Water heating fuel, kWh/month 215.82 190.14 198.07 176.16 171.63 163.47 156.6 Annual totals Space heating fuel - main system 1	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

					2215.66	
Electricity for pumps, fans and electric keep-hot (Table 4f)						
central heating pump or water pump within warm air heatin	ng unit		30.00			(230c)
boiler flue fan			45.00			(230e)
Total electricity for the above, kWh/year					75.00	(231)
Electricity for lighting (Appendix L)					423.68	(232)
Total delivered energy for all uses		(21 ⁻	1) (221) + (231) + (2	(237h) =	11627.83	(238)
		((200)
10a. Fuel costs - individual heating systems including micro-0	СНР					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	8913.49	x	3.48	x 0.01 =	310.19	(240)
Water heating	2215.66	x	3.48	x 0.01 =	77.11	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	423.68	x	13.19	x 0.01 =	55.88	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	573.07	(255)
11a. SAP rating - individual heating systems including micro-	СНР					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.89	(257)
SAP value					73.70	
SAP rating (section 13)					74	(258)
SAP band					С	
12a. CO ₂ emissions - individual heating systems including mid	cro-CHP					
	Energy		Emission factor		Emissions	
	kwn/year		kg CO₂/kWh		kg CO₂/year	
Space heating - main system 1	8913.49	x	kg CO₂/kWh	=	kg CO ₂ /year 1925.31	(261)
Space heating - main system 1 Water heating	8913.49 2215.66	x x	kg CO ₂ /kWh 0.216 0.216	= =	kg CO ₂ /year 1925.31 478.58	(261) (264)
Space heating - main system 1 Water heating Space and water heating	8913.49 2215.66	x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (= = 263) + (264) =	kg CO ₂ /year 1925.31 478.58 2403.90	(261) (264) (265)
Space heating - main system 1 Water heating Space and water heating Pumps and fans	8913.49 2215.66 75.00	x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (0.519	= = 263) + (264) = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93	(261) (264) (265) (267)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89	(261) (264) (265) (267) (268)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year	8913.49 2215.66 75.00 423.68	x x x x	kg CO ₂ /kWh 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71	(261) (264) (265) (267) (268) (272)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21	 (261) (264) (265) (267) (268) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05	(261) (264) (265) (267) (268) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72	 (261) (264) (265) (267) (268) (272) (273)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C	(261) (264) (265) (267) (268) (272) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C	(261) (264) (265) (267) (268) (272) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m	kwn/year 8913.49 2215.66 75.00 423.68	x x x x	kg CO₂/kWh 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C	(261) (264) (265) (267) (268) (272) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m	kwn/year 8913.49 2215.66 75.00 423.68	x x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year	(261) (264) (265) (267) (278) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m	kwn/year 8913.49 2215.66 75.00 423.68	x x x x	kg CO ₂ /kWh 0.216 (261) + (262) + (0.519 0.519 0.519	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46	(261) (264) (265) (267) (278) (273) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating	kwn/year 8913.49 2215.66 75.00 423.68	x x x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (0.519 0.519 0.519 Primary factor 1.22 1.22	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) = = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11	(261) (264) (267) (268) (272) (273) (274) (274)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating Space and water heating	kwn/year 8913.49 2215.66 75.00 423.68	x x x x x	kg CO ₂ /kWh 0.216 (261) + (262) + (0.519 0.519 0.519 Primary factor 1.22 1.22 (261) + (262) + (= = 263) + (264) = = = (265)(271) = (272) ÷ (4) = = = = 263) + (264) =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11 13577.57	(261) (264) (267) (268) (272) (273) (274) (274) (261) (264) (265)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating Space and water heating Pumps and fans	8913.49 2215.66 75.00 423.68	x x x x x x	kg CO ₂ /kWh 0.216 0.216 (261) + (262) + (0.519 0.519 0.519 Primary factor 1.22 (261) + (262) + (3.07	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) = = = 263) + (264) = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11 13577.57 230.25	(261) (264) (267) (268) (272) (273) (274) (274) (261) (264) (265) (267)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	kwn/year 8913.49 2215.66 75.00 423.68	x x x x x x x x	kg CO ₂ /kWh 0.216 (261) + (262) + (0.519 0.519 0.519 Primary factor 1.22 (261) + (262) + (3.07 3.07	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) = = = 263) + (264) = = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11 13577.57 230.25 1300.70	(261) (264) (267) (272) (273) (274) (274) (261) (264) (265) (267) (268)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Primary energy kWh/year	kwn/year 8913.49 2215.66 75.00 423.68	x x x x x x x x x	kg CO ₂ /kWh 0.216 0.216 $(261) + (262) + ($ 0.519 0.519 0.519 0.519 1.22 $(261) + (262) + ($ 1.22 $(261) + (262) + ($ 3.07 3.07	$=$ $=$ $(263) + (264) =$ $=$ $(265)(271) =$ $(272) \div (4) =$ $=$ $=$ $=$ $=$ $=$ $=$ $=$ $=$ $=$	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11 13577.57 230.25 1300.70 15108.52	(261) (264) (267) (268) (272) (273) (274) (274) (261) (264) (265) (267) (268) (272)
Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including m Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Primary energy kWh/year Dwelling primary energy rate kWh/m2/year	8913.49 2215.66 75.00 423.68	x x x x x x x x x	kg CO ₂ /kWh 0.216 (261) + (262) + (0.519 0.519 0.519 Primary factor 1.22 (261) + (262) + (3.07 3.07	= = 263) + (264) = = = (265)(271) = (272) ÷ (4) = = = 263) + (264) = = =	kg CO ₂ /year 1925.31 478.58 2403.90 38.93 219.89 2662.71 32.21 72.05 72 C Primary Energy kWh/year 10874.46 2703.11 13577.57 230.25 1300.70 15108.52 182.73	(261) (264) (267) (268) (272) (273) (274) (261) (264) (265) (267) (268) (272) (273)

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SAP Worksheet Design - Draft



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

Assessor name	Mr Spyrid	don Karnez	is					Assessor num	iber	8658		
Client								Last modified		12/08,	/2016	
Address	2 11-12 0	Grenville, C	amden, WC	21								
			, .	-								
1. Overall dwelling dimen	nsions											
				ļ	Area (m²)		Av	verage storey height (m)		Vo	lume (m³)	
Lowest occupied					17.71] (1a) x		3.50] (2a) =		61.99	(3a)
+1					38.45	(1b) x		3.10	(2b) =		119.20	(3b)
+2					38.45	(1c) x		2.90	(2c) =		111.51	(3c)
Total floor area	(1a)	+ (1b) + (1	c) + (1d)(1n) =	94.61	(4)						
Dwelling volume							(3	3a) + (3b) + (3	c) + (3d)(3	3n) =	292.69] (5)
2. Ventilation rate												
										mª	³ per hour	
Number of chimneys								0] x 40 =	-	0	(6a)
Number of open flues								0] x 20 =	-	0	(6b)
Number of intermittent fa	าร							3	x 10 =	-	30	(7a)
Number of passive vents								0	x 10 =	-	0	(7b)
Number of flueless gas fire	S							0	x 40 =	-	0	(7c)
										Air c	hanges pe hour	r
Infiltration due to chimney	s, flues, fans	s, PSVs		(6a) + (6b) + (7	a) + (7b) + ((7c) =	30	÷ (5) =	-	0.10	(8)
If a pressurisation test has	been carried	d out or is i	ntended, pi	roceed to	(17), otherw	vise continu	e from (9) to (16)	-			-
Air permeability value, q50), expressed	in cubic m	etres per h	our per sq	uare metre	of envelop	e area				5.00	(17)
If based on air permeabilit	y value, ther	n (18) = [(1	7) ÷ 20] + (8	3), otherw	ise (18) = (1	6)					0.35	(18)
Number of sides on which	the dwelling	s is sheltere	ed								4	(19)
Shelter factor								1 -	[0.075 x (1	9)] =	0.70	(20)
Infiltration rate incorporat	ing shelter fa	actor							(18) x (2	20) =	0.25	(21)
Infiltration rate modified for	or monthly v	vind speed	:									_
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spe	ed from Tab	le U2										
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4												
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (a	allowing for	shelter and	I wind facto	or) (21) x (22a)m							
0.31	0.31	0.30	0.27	0.27	0.23	0.23	0.23	0.25	0.27	0.28	0.29	(22b)
Calculate effective air char	ige rate for t	he applica	ble case:									
If mechanical ventilatio	If mechanical ventilation: air change rate through system N/A (23a)											
If balanced with heat re	covery: effic	ciency in %	allowing fo	or in-use fa	actor from T	able 4h					N/A] (23c)
d) natural ventilation of	r whole hou	se positive	input venti	lation fror	n loft							
0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(24d)



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

Effective air cha	inge rate - e	nter (24a)	or (24b) or	(24c) or (24	ld) in (25)	-			-		1	_	_
	0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)
3. Heat losses	and heat lo	ss parame	ter										
Element				Gross	Opening	zs Net	area	U-value	A x U W	//К к-ч	value,	Ахк,	
			a	area, m²	m²	Α,	m²	W/m²K		kJ,	/m².K	kJ/K	
Door						1.	70 x [3.00	= 5.10				(26)
Window						16	.77 x	1.50	= 25.22	2			(27)
Exposed floor						20	.74 x	1.20	= 24.89)			(28b
Ground floor						17	.71 x	1.28	= 22.67	,			(28a)
External wall						16	.15 x	0.28	= 4.52				(29a)
External wall						80	.05 x	1.38	= 110.4	7			(29a)
Party wall						36	.00 x	0.50	= 18.00)			(32)
External wall						73	.03 x	2.10	= 153.3	6			(29a)
Total area of ex	ternal eleme	ents ∑A, m	2			226	5.15						(31)
Fabric heat loss	, W/K = ∑(A	× U)							(20	5)(30) + (3	32) =	364.23	(33)
Heat capacity C	m = ∑(А x к)							(28)	.(30) + (32) -	+ (32a)(32	2e) =	N/A	(34)
Thermal mass p	arameter (T	MP) in kJ/	m²K									250.00	(35)
Thermal bridges	s: ∑(L x Ψ) ca	alculated u	ising Appen	dix K								33.92	(36)
Total fabric hea	t loss									(33) + (3	36) =	398.15	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation hea	t loss calcula	ated montl	hly 0.33 x (25)m x (5)									
	53.07	52.89	52.71	51.85	51.69	50.95	50.95	50.81	51.23	51.69	52.01	52.35	(38)
Heat transfer co	pefficient, W	//K (37)m	+ (38)m								1		
	451.22	451.04	450.86	450.00	449.84	449.10	449.10	448.96	449.38	449.84	450.17	450.50	7
				•	•				Average = 2	(39)112/	/12 =	450.00	(39)
Heat loss param	neter (HLP),	W/m²K (3	9)m ÷ (4)										
	4.77	4.77	4.77	4.76	4.75	4.75	4.75	4.75	4.75	4.75	4.76	4.76	7
						-		•	Average = 2	5(40)112/	/12 =	4.76	(40)
Number of days	s in month (1	Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
		ł	•					4	•	1	1	•	
4. Water heati	ing energy r	equireme	nt	_									7
Assumed occup	ancy, N											2.68	(42)
Annual average	hot water u	isage in liti	res per day	Vd,average	= (25 x N)	+ 36						97.94	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	e in litres pe	r day for e	ach month	Vd,m = fact	or from Ta	able 1c x (43	3)					.	_
	107.73	103.81	99.90	95.98	92.06	88.14	88.14	92.06	95.98	99.90	103.81	107.73	
										∑(44)1	.12 =	1175.26	(44)
Energy content	of hot wate	r used = 4.	18 x Vd,m >	k nm x Tm/3	3600 kWh/	month (see	Tables 1b,	1c 1d)					
	159.76	139.73	144.19	125.71	120.62	104.09	96.45	110.68	112.00	130.53	142.48	154.72	
										∑(45)1	.12 =	1540.95	(45)
Distribution los	s 0.15 x (45))m											
	23.96	20.96	21.63	18.86	18.09	15.61	14.47	16.60	16.80	19.58	21.37	23.21	(46)
Water storage I	oss calculate	ed for each	n month (5	5) x (41)m									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel cor	ntains dedica	ated solar	storage or o	dedicated W	/WHRS (56	6)m x [(47) -	Vs] ÷ (47),	else (56)					
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit l	loss for each	n month fro	om Table 3										

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 (59))
Combi loss for ea	ach month f	from Table 3	3a, 3b or 3	с									
	50.96	46.03	50.91	47.33	46.91	43.47	44.92	46.91	47.33	50.91	49.32	50.96 (61))
Total heat requi	red for wate	er heating ca	alculated f	or each mo	nth 0.85 x	(45)m + (4	6)m + (57)ı	m + (59)m +	- (61)m				
	210.72	185.76	195.10	173.04	167.53	147.55	141.37	157.59	159.33	181.43	191.79	205.68 (62))
Solar DHW input	t calculated	using Appe	ndix G or A	Appendix H									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 (63))
Output from wat	ter heater f	or each moi	nth (kWh/i	month) (62	2)m + (63)m	I							
	210.72	185.76	195.10	173.04	167.53	147.55	141.37	157.59	159.33	181.43	191.79	205.68	
										∑(64)1	12 = 2	2116.90 (64))
Heat gains from	water heati	ing (kWh/m	onth) 0.25	5 × [0.85 × ((45)m + (61)m] + 0.8 ×	[(46)m + (57)m + (59)	m]				
	65.86	57.97	60.67	53.63	51.83	45.48	43.30	48.53	49.07	56.13	59.70	64.18 <mark>(65</mark>))
5. Internal gain	IS .			_						.			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)				101.00					101.00			
	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02	161.02 (66))
Lighting gains (ca	alculated in	Appendix L	, equation	L9 or L9a),	also see Ta	ble 5							
• ·· ·	59.46	52.81	42.95	32.52	24.31	20.52	22.17	28.82	38.68	49.12	57.33	<u>61.11</u> (67))
Appliance gains	(calculated	In Appendix	L, equation	on L13 or L1	.3a), also se	e Table 5				000 - 1			
	369.12	372.95	363.29	342.75	316.81	292.43	276.14	272.31	281.96	302.51	328.45	352.83 (68))
Cooking gains (C			, equation	L15 OF L15	a), also see		50.70	52.70	50.70	50.70	50 70		
	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	53.79	<u>53.79</u> (69))
Pump and ran ga			2.00	2.00	2.00	2.00		2.00	2.00	2.00	2.00		
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00 (70))
Losses e.g. evap			407.25	107.05	407.25	407.25	107.25	407.25	407.05	107.05	107.25	407.05 (74)	,
Water besting a	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35	-107.35 (71))
water neating g			01 5 4	74.40	C0 C7	62.16	58.20	65.22	69.16	75.44	82.02	06.27 (72)	A
Total internal ga	88.52	(67)m + (6)	81.54	74.49	69.67	03.10	58.20	65.23	68.16	75.44	82.92	86.27 (72))
TOLAI IIILEITIAI ga			5)11 + (69)	n + (70)m -	F (71)III + (7	400 57	466.07	476.00	400.27	F27 F2	570.10	(10.00 (72)	4
	627.56	622.48	598.25	560.21	521.24	486.57	466.97	476.82	499.27	537.53	579.16	610.68 (73))
6. Solar gains													
			Access f	actor	Area	Sola	ar flux		g	FF		Gains	
			Table	6d	m²	W	//m²	spec or T	ific data	specific d	ata 6c	W	
North			0.30		2.90		0.63 X	0.9 x ()./3 x	0.70		4.25 (74))
East			0.30		6.80		9.64 X		J.73 X	0.70		18.43 (76))
West			0.7		6.35		9.64 X	0.9 x 0	J.73 X	0.70		44.16 (80))
North	5(74)	(02)	0.7	/×	0.72	X 1	0.63 x	0.9 x()./3 x	0.70	=	2./1 (/4))
Solar gains in wa		(82)m	224.26	220.42	400.20	424.24	400.47	240 52	264 72	161.12	06.64	57.20 (02)	
Tatal saina inte	69.56	135.75	224.26	330.42	409.36	421.34	400.17	340.53	261.72	161.13	86.64	57.28 (83))
Total gains - Inte		lar (73)m +	(83)m	000.63	020.00	007.04	06745	047.05	70.00	600.66	665.00	CC7.05 (0.4)	,
	697.12	/58.23	822.51	890.63	930.60	907.91	867.15	817.35	760.98	698.66	665.80	667.95 (84))
7. Mean intern	al temperat	ture <u>(heatin</u>	g season)										
Temperature du	ring heating	g periods in	the living a	area from T	able 9, Th1	(°C)						21.00 (85))
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor	r for gains fo	or living are	a n1,m (se	e Table 9a)									

	0.99	0.99	0.99	0.98	0.96	0.93	0.88	0.90	0.95	0.98	0.99	0.99 <mark>(86)</mark>
Mean internal te	emp of livin	g area T1 (s	teps 3 to 7	in Table 9c)							
	16.91	17.11	17.58	18.26	19.03	19.78	20.27	20.20	19.58	18.61	17.65	16.87 <mark>(87)</mark>
Temperature du	uring heating	g periods in	the rest of	dwelling fr	om Table 9	9, Th2(°C)						
	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13	18.13 (88)
Utilisation facto	r for gains f	or rest of d	welling n2.	n				1				
	0.99	0.99	0.98	0.96	0.93	0.82	0.58	0.65	0.89	0.96	0.98	0.99 (89)
Mean internal to	emperature	in the rest	of dwelling	T2 (follow	stens 3 to	7 in Table 0		0.05	0.05	0.50	0.50	
		15.01	1E 47	16.16	16.01	17.62	19.02	17.09	17.45	16 51	16.66	14.77 (00)
1 : . :	14.81	15.01	15.47	10.10	10.91	17.03	18.02	17.98	17.45	10.51	15.55	<u>14.77</u> (90)
Living area fract	lon	6	- 1 111	- (1	(4 (1 A) 7				Lr	ving area ÷	(4) =	0.31 (91)
wean internal te	emperature	for the wh	ole dwellin	g TLA X 11 +	(1 - TLA) X I	2		r		1		
	15.47	15.67	16.14	16.82	17.58	18.31	18.73	18.68	18.12	17.17	16.21	15.43 <mark>(92)</mark>
Apply adjustme	nt to the me	an internal	temperatu	ire from Ta	ble 4e whe	re appropr	iate					
	15.47	15.67	16.14	16.82	17.58	18.31	18.73	18.68	18.12	17.17	16.21	15.43 <mark>(93)</mark>
9 Space heatin	ag roquirom	ont										
8. Space fleatin	ng requirem	ent .		A		1	1.1	A	6	0.4		Dec
	Jan ,	Feb	war	Apr	iviay	Jun	Jui	Aug	Sep	Uct	NOV	Dec
Utilisation facto	r for gains, i	յm I								1	·	
	0.98	0.98	0.97	0.95	0.91	0.84	0.70	0.74	0.89	0.96	0.98	0.98 <mark>(94)</mark>
Useful gains, ηm	nGm, W (94)m x (84)m								-		
	684.91	741.71	797.27	846.61	850.24	758.69	603.47	601.02	674.45	667.24	650.29	657.24 <mark>(95)</mark>
Monthly average	e external to	emperature	from Tabl	e U1								
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20 (96)
Heat loss rate fo	or mean inte	ernal tempe	rature, Lm	, W [(39)m	x [(93)m -	(96)m]						
	5040.40	4856.84	4344.10	3563.29	2644.63	1664.47	956.62	1023.64	1805.85	2954.08	4101.18	5059.47 (97)
Space heating re	equirement,	kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)r	n						
	3240.49	2765.36	2638.84	1956.01	1335.02	0.00	0.00	0.00	0.00	1701.41	2484.64	3275.26
								•	Σ(98	8)15, 10	12 = 19	9397.02 (98)
Space heating re	equirement	kWh/m²/ve	ear						2.	(98)	÷ (4)	205.02 (99)
		, ,,								(<i>i</i>	(/	
9a. Energy req	uirements -	individual	heating sys	stems inclu	ding micro	-CHP						
Space heating												
Fraction of space	e heat from	secondary,	/supplemei	ntary system	m (table 11)						0.00 (201)
Fraction of space	e heat from	main syste	m(s)							1 - (20)1) =	1.00 (202)
Fraction of space	e heat from	main syste	m 2									0.00 (202)
Fraction of total	space heat	from main	system 1						(20)2) x [1- (20	3)] =	1.00 (204)
Eraction of total	l snace heat	from main	system 2						(=0	(202) x (20)3) =	0.00 (205)
Efficiency of ma	in system 1	(0/)	System 2							(202) × (20	,5,7 - <u> </u>	
Efficiency of fila	III System 1	(%)								_		<u>95.80</u> (200)
			N A a st	A				A	C	^ -+		
Space heating fu		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	uel (main sy	Feb stem 1), kW	Mar /h/month	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	
	uel (main sy: 3382.55	Feb stem 1), kW 2886.60	Mar /h/month 2754.53	Apr 2041.76	May 1393.55	Jun 0.00	Jul 0.00	Aug 0.00	Sep 0.00	Oct 1776.00	Nov 2593.57	3418.85
	uel (main sys 3382.55	Feb stem 1), kW 2886.60	Mar /h/month 2754.53	Apr 2041.76	May 1393.55	Jun 0.00	Jul 0.00	Aug	Sep 0.00 Σ(21:	Oct 1776.00 1)15, 10	Nov 2593.57 12 = 20	3418.85 0247.42 (211)
Water heating	Jan Jel (main sy 3382.55	Feb stem 1), kW 2886.60	Mar /h/month 2754.53	Apr	May 1393.55	Jun 0.00	Jul 0.00	Aug	Sep 0.00 Σ(212	Oct 1776.00 1)15, 10	Nov 2593.57 12 = 20	3418.85)247.42 (211)
Water heating Efficiency of wat	uel (main sy 3382.55 ter heater	Feb stem 1), kW 2886.60	Mar /h/month 2754.53	Apr 2041.76	May 1393.55	Jun 0.00	Jul 0.00	Aug	Sep 0.00 Σ(212	Oct 1776.00 1)15, 10	Nov 2593.57 12 = 20	3418.85 0247.42 (211)
Water heating Efficiency of wat	uel (main sy: 3382.55 ter heater 95.18	Feb stem 1), kW 2886.60 95.16	Mar /h/month 2754.53 95.10	Apr 2041.76 94.97	May 1393.55 94.67	Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	Sep 0.00 Σ(21: 86.50	Oct 1776.00 1)15, 10 94.82	Nov 2593.57 12 = 20 95.07	3418.85 0247.42 (211) 95.20 (217)
Water heating Efficiency of wat Water heating fr	uel (main sy: 3382.55 ter heater 95.18 uel, kWh/m	Feb stem 1), kW 2886.60 95.16 onth	Mar /h/month 2754.53 95.10	Apr 2041.76 94.97	May 1393.55 94.67	Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	Sep 0.00 Σ(21: 86.50	Oct 1776.00 1)15, 10 94.82	Nov 2593.57 12 = 20 95.07	3418.85 0247.42 (211) 95.20 (217)
Water heating Efficiency of wat Water heating fo	3382.55 ter heater 95.18 uel, kWh/m 221.40	Feb stem 1), kW 2886.60 95.16 onth 195.21	Mar /h/month 2754.53 95.10 205.16	Apr 2041.76 94.97 182.20	May 1393.55 94.67 176.97	Jun 0.00 86.50 170.58	Jul 0.00 86.50 163.43	Aug 0.00 86.50 182.19	Sep 0.00 Σ(21: 86.50 184.20	Oct 1776.00 1)15, 10 94.82 191.35	Nov 2593.57 12 = 20 95.07 201.74	3418.85 0247.42 (211) 95.20 (217) 216.06
Water heating Efficiency of wat Water heating fo	uel (main sy: 3382.55 ter heater 95.18 uel, kWh/m 221.40	Feb stem 1), kW 2886.60 95.16 onth 195.21	Mar /h/month 2754.53 95.10 205.16	Apr 2041.76 94.97 182.20	May 1393.55 94.67 176.97	Jun 0.00 86.50 170.58	Jul 0.00 86.50 163.43	Aug 0.00 86.50 182.19	Sep 0.00 Σ(21: 86.50 184.20	Oct 1776.00 1)15, 10 94.82 191.35 Σ(219a)1	Nov 2593.57 12 = 20 95.07 201.74 12 = 2	3418.85 0247.42 (211) 95.20 (217) 216.06 (219)

Annual totals

Space heating fuel - main system 1

Water heating fuel Electricity for pumps, fans and electric keep-hot (Table 4f) central heating pump or water pump within warm air heating unit 30.00 (230c) Total electricity for the above, kWh/year 30.00 (231)420.05 Electricity for lighting (Appendix L) (232)Total delivered energy for all uses 22987.97 (238)(211)...(221) + (231) + (232)...(237b) = 10a. Fuel costs - individual heating systems including micro-CHP **Fuel price** Fuel Fuel

	kWh/year				cost £/year	
Space heating - main system 1	20247.42	x	3.48	x 0.01 =	704.61	(240)
Water heating	2290.51	x	3.48	x 0.01 =	79.71	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	420.05	x	13.19	x 0.01 =	55.40	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	963.68	(255)
11a. SAP rating - individual heating systems including micro-CH	Р					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					2.90	(257)
SAP value					59.56	
SAP rating (section 13)					60	(258)
SAP band					D	

Emission factor Emissions Energy kg CO₂/kWh kWh/year kg CO₂/year 20247.42 0.216 4373.44 (261) Space heating - main system 1 х = 2290.51 0.216 494.75 Water heating (264)х = Space and water heating (261) + (262) + (263) + (264) =4868.19 (265) Pumps and fans 30.00 0.519 (267)х = 15.57 0.519 Electricity for lighting 420.05 х 218.00 (268) = Total CO₂, kg/year (265)...(271) = 5101.77 (272)(272) ÷ (4) = Dwelling CO₂ emission rate 53.92 (273) EI value 51.53 El rating (section 14) 52 (274) Е EI band

Primary factor Primary Energy Energy kWh/year kWh/year Space heating - main system 1 20247.42 х 1.22 24701.85 (261) 2794.42 2290.51 1.22 Water heating (264)х = Space and water heating (261) + (262) + (263) + (264) = 27496.27 (265)Pumps and fans 30.00 3.07 92.10 (267) х Electricity for lighting 420.05 3.07 1289.54 (268)х = Primary energy kWh/year 28877.91 (272)Dwelling primary energy rate kWh/m2/year 305.23 (273)

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

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

20247.42 2290.51

SAP Worksheet Design - Draft



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

Assessor name	Mr Spyrida	on Karnezi	is					Assessor nun	nber	8658		
Client								ast modifier	1	12/08	/2016	
	244 42 6			~4						12,00	2010	
Address	3 11-12 Gr	enville, Ca	amden, wo	-1								
1. Overall dwelling dimen	isions											
				ļ	Area (m²)		Av	erage storey height (m)	,	Vo	lume (m³)	
Lowest occupied					47.75	(1a) x	Г	2.80	(2a) =		133.70	(3a)
Total floor area	(1a) +	(1b) + (1d	c) + (1d)(1n) =	47.75	(4)						
Dwelling volume							(3	a) + (3b) + (3	c) + (3d)(3	n) =	133.70	(5)
2 Ventilation rate									_			
										mª	³ ner hour	
Number of chimesus								0] 40			
Number of chimneys								0] x 40 =] (6a)
Number of open flues								0] x 20 =			_ (60) _ (7a)
Number of massive vents	15							3	X10=] (7d)] (7b)
Number of flueloss gas fire	c							0	$\begin{bmatrix} x & 10 \end{bmatrix} = \begin{bmatrix} x$] (70)
Number of fideless gas file	5							0	X 40 -		banges ne	_ (/C) r
											hour	•
Infiltration due to chimney	s, flues, fans,	PSVs		(6a) + (6b) + (7	'a) + (7b) + (7c) =	30	÷ (5) =		0.22	(8)
If a pressurisation test has	been carried	out or is ir	ntended, p	roceed to	(17), otherv	vise continu	e from (9) to (16)	_			_
Air permeability value, q50	, expressed ir	n cubic me	etres per h	our per sq	uare metre	of envelope	e area				5.00	(17)
If based on air permeability	value, then	(18) = [(17	7) ÷ 20] + (8	3), otherwi	ise (18) = (1	.6)					0.47	(18)
Number of sides on which	the dwelling i	s sheltere	d								4	(19)
Shelter factor								1 -	· [0.075 x (19	9)] =	0.70	(20)
Infiltration rate incorporati	ng shelter fac	ctor							(18) x (2	0) =	0.33	(21)
Infiltration rate modified for	or monthly wi	nd speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spec	ed from Table	e U2										
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4					_							_
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (a	Illowing for st	nelter and	wind fact	or) (21) x (22a)m	-						_
0.42	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.33	0.36	0.37	0.39	(22b)
Calculate effective air chan	ge rate for th	e applical	ole case:									-
If mechanical ventilation	n: air change	rate throu	ugh system	I							N/A	(23a)
If balanced with heat re	covery: effici	ency in %	allowing fo	or in-use fa	actor from T	Fable 4h					N/A	(23c)
d) natural ventilation or	whole house	e positive	input vent	ilation fror	n loft	1	1		· · · ·			٦.
0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(24d)
Effective air change rate - e	enter (24a) or	(24b) or (24c) or (24	1d) in (25)	-	-	-	-	1		<u> </u>	
0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58	(25)



3. Heat losses a	and heat lo	ss paramet	er										
Element			а	Gross irea, m²	Openings m ²	Net A,	area m²	U-value W/m²K	A x U W	//К к- [,] kJ	value, /m².K	Ахк, kJ/K	
Door						1.	.70 x	1.00	= 1.70				(26)
Window						7.	.26 x	1.50	= 10.92	2			(27)
Exposed floor						7.	.56 x	0.79	= 5.97				(28b
Exposed floor						40).19 x	0.60	= 24.11				(28b
External wall						20).18 x	2.10	= 42.38	3			(29a)
External wall						20).16 x	1.38	= 27.82	2			(29a)
Party wall						33	3.04 x	0.50	= 16.52	2			(32)
External wall						26	5.02 x	0.25	= 6.51				(29a)
Total area of ext	ernal elem	ents ∑A, m²	2			123	3.07						(31)
Fabric heat loss,	W/K = ∑(A	× U)							(20	6)(30) + (32) =	135.93	(33)
Heat capacity Cr	n = ∑(А x к)							(28)	(30) + (32)	+ (32a)(3	2e) =	N/A	(34)
Thermal mass pa	arameter (T	MP) in kJ/r	n²K									250.00	(35)
Thermal bridges	: Σ(L x Ψ) ca	alculated us	sing Appen	dix K								18.46	(36)
Total fabric heat	loss									(33) + (36) =	154.39	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat	loss calcula	ated month	ly 0.33 x (2	25)m x (5)					Í			1	-
	26.01	25.86	25.71	25.00	24.87	24.26	24.26	24.14	24.49	24.87	25.14	25.42	(38)
Heat transfer co	efficient, W	//K (37)m ⊣ □	⊦ (38)m							1	1	1	-
	180.40	180.25	180.10	179.39	179.26	178.64	178.64	178.53	178.88	179.26	179.53	179.81	
									Average = 2	∑(39)112 _.	/12 =	179.39	(39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)		1						1		-
	3.78	3.77	3.77	3.76	3.75	3.74	3.74	3.74	3.75	3.75	3.76	3.77	
Number of dour	in manth (Fable 1a)							Average = 2	2(40)112	/12 =	3.76	_ (40)
Number of days		able 1a)	24.00	1 22 22	24.00	20.00	24.00	24.00	20.00	24.00	20.00	24.00	
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	_ (40)
4. Water heating	ng energy r	equiremen	t										
Assumed occupa	ancy, N											1.62	(42)
Annual average	hot water u	isage in litre	es per day	Vd,average	= (25 x N) +	36						72.77	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	in litres pe	r day for ea	ach month	Vd,m = fact	tor from Tab	ole 1c x (43	3)						
	80.05	77.14	74.23	71.32	68.41	65.50	65.50	68.41	71.32	74.23	77.14	80.05]
										∑(44)1	.12 =	873.27	(44)
Energy content of	of hot wate	r used = 4.2	18 x Vd,m x	(nm x Tm/3	3600 kWh/m	nonth (see	Tables 1b	, 1c 1d)				- -	_
	118.71	103.83	107.14	93.41	89.63	77.34	71.67	82.24	83.22	96.99	105.87	114.97	
										∑(45)1	.12 =	1145.00	(45)
Distribution loss	0.15 x (45)m									1	-	_
	17.81	15.57	16.07	14.01	13.44	11.60	10.75	12.34	12.48	14.55	15.88	17.24	(46)
Water storage lo	oss calculate	ed for each	month (5	5) x (41)m			1	_	1	1	1	-	-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel cont	tains dedica	ated solar s	torage or c	ledicated W	/WHRS (56)r	m x [(47) -	Vs] ÷ (47)	, else (56)	Т		1	1	-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit lo	oss for each	month fro	m Table 3	1	,		1		1		1	1	٦.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for ea	ach month	trom Table	3a, 3b or 3	3C									

	10 70	25.54	27.02	25.47	24.00	22.20	22.20	24.00	25.47	27.02	20.04	10 70	
	40.79	35.51	37.83	35.17	34.86	32.30	33.38	34.86	35.17	37.83	38.04	40.79	(61)
Total heat requi	ired for wate	er heating o	calculated f	or each mo	nth 0.85 x	(45)m + (4	6)m + (57)n	n + (59)m +	· (61)m				_
	159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	(62)
Solar DHW inpu	t calculated	using Appe	endix G or A	Appendix H									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from wa	nter heater f	or each mo	onth (kWh/r	month) (62	!)m + (63)m	1						•	-
·	159 50	139 33	1// 97	128 58	12/ /8	109.64	105.04	117 10	118 39	13/ 81	1/13 01	155 76	1
	135.50	135.55	144.57	120.50	124.40	105.04	105.04	117.10	110.55	5(64)1	12 - 12	F01 F1	
							[(46) (1			2(04)1	12 = 1	.581.51	(64)
Heat gains from	water heat	ing (kWh/m	nonth) 0.25	5 × [0.85 × (45)m + (61)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]			1	-
	49.67	43.40	45.08	39.85	38.52	33.79	32.17	36.06	36.46	41.70	44.71	48.42	(65)
5 Internal gain	ns												
5. Internal gain	lan	Fab	Mar	Apr	May	lun	Int	Aug	Son	Oct	Nov	Doc	
		TED	Ividi	Арі	Iviay	Juli	501	Aug	зер	000	NOV	Dec	
wietabolic gains								r				1	-
	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	(66)
Lighting gains (c	alculated in	Appendix I	L, equation	L9 or L9a),	also see Ta	ble 5							
	33.22	29.50	23.99	18.17	13.58	11.46	12.39	16.10	21.61	27.44	32.03	34.14	(67)
Appliance gains	(calculated	in Appendi	x L, equatio	on L13 or L1	3a), also se	e Table 5							
	211.03	213.22	207.71	195.96	181.13	167,19	157.88	155.69	161.21	172.96	187.79	201.72	(68)
Cooking gains (calculated in	Annendix		115 or 115		Table 5	107.00	100.00	101.11	1, 1, 0, 0	10/110] (00)
COOKING gains (C							46.07	46.97	46.07	46.27	46.27	46.07	
	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	(69)
Pump and fan g	ains (Table 5	5a)											_
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evap	oration (Tal	alo 5)											
0 1		JIE J											
	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	(71)
Water heating g	-64.96 gains (Table	-64.96 5)	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96] (71)
Water heating g	-64.96 gains (Table	-64.96 5)	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96] (71)
Water heating g	-64.96 gains (Table 66.76	-64.96 5) 64.58	-64.96 60.59	-64.96 55.35	-64.96 51.77	-64.96 46.93	-64.96 43.24	-64.96 48.47	-64.96 50.64	-64.96 56.05	-64.96 62.10	-64.96 65.09] (71)] (72)
Water heating g	-64.96 gains (Table 66.76 ains (66)m +	-64.96 5) 64.58 - (67)m + (6	-64.96 60.59 58)m + (69)r	-64.96 55.35 m + (70)m -	-64.96 51.77 + (71)m + (7	-64.96 46.93 72)m	-64.96 43.24	-64.96 48.47	-64.96 50.64	-64.96 56.05	-64.96 62.10	-64.96 65.09] (71)] (72)
Water heating g	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)r 374.14	-64.96 55.35 m + (70)m - 351.32	-64.96 51.77 + (71)m + (7 328.33	-64.96 46.93 72)m 307.44	-64.96 43.24 295.36	-64.96 48.47 302.11	-64.96 50.64 315.31	-64.96 56.05 338.30	-64.96 62.10 363.76	-64.96 65.09 382.80] (71)] (72)] (73)
Water heating g Total internal ga	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 68)m + (69)n 374.14	-64.96 55.35 m + (70)m - 351.32	-64.96 51.77 + (71)m + (7 328.33	-64.96 46.93 72)m 307.44	-64.96 43.24 295.36	-64.96 48.47 302.11	-64.96 50.64 315.31	-64.96 56.05 338.30	-64.96 62.10 363.76	-64.96 65.09 382.80] (71)] (72)] (73)
Water heating g Total internal ga 6. Solar gains	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)r 374.14	-64.96 55.35 m + (70)m - 351.32	-64.96 51.77 + (71)m + (7 328.33	-64.96 46.93 72)m 307.44	-64.96 43.24 295.36	-64.96 48.47 302.11	-64.96 50.64 315.31	-64.96 56.05 338.30	-64.96 62.10 363.76	-64.96 65.09 382.80] (71)] (72)] (73)
Water heating g Total internal ga 6. Solar gains	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)r 374.14 Access f Table	-64.96 55.35 m + (70)m - 351.32 actor 6d	-64.96 51.77 + (71)m + (7 328.33 Area m ²	-64.96 46.93 72)m 307.44 Sol. W	-64.96 43.24 295.36 ar flux	-64.96 48.47 302.11	-64.96 50.64 315.31 g ific data	-64.96 56.05 338.30 FF specific d	-64.96 62.10 363.76	-64.96 65.09 382.80 Gains W] (71)] (72)] (73)
Water heating g Total internal ga 6. Solar gains	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 68)m + (69)t 374.14 Access f Table	-64.96 55.35 m + (70)m - 351.32 actor 6d	-64.96 51.77 + (71)m + (7 328.33 Area m ²	-64.96 46.93 72)m 307.44 Sol	-64.96 43.24 295.36 ar flux	-64.96 48.47 302.11 speci or T	-64.96 50.64 315.31 g ific data able 6b	-64.96 56.05 338.30 FF specific d or Table	-64.96 62.10 363.76 ata 6c	-64.96 65.09 382.80 Gains W] (71)] (72)] (73)
Water heating g Total internal ga 6. Solar gains	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)r 374.14 Access f Table	-64.96 55.35 m + (70)m - 351.32 factor 6d	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70	-64.96 46.93 72)m 307.44 Sol. W	-64.96 43.24 295.36 ar flux //m ² 9.64 x	-64.96 48.47 302.11 speci or T	-64.96 50.64 315.31 g ific data able 6b	-64.96 56.05 338.30 FF specific d or Table	-64.96 62.10 363.76 lata 6c	-64.96 65.09 382.80 Gains W 39.64] (71)] (72)] (73)
Water heating g Total internal ga 6. Solar gains East	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)n 374.14 Access f Table	-64.96 55.35 m + (70)m - 351.32 actor 6d	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70	-64.96 46.93 72)m 307.44 Sol. W	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x	-64.96 48.47 302.11 speci or T	-64.96 50.64 315.31 g ific data able 6b 0.73 x	-64.96 56.05 338.30 FF specific d or Table	-64.96 62.10 363.76 Jata 6c =	-64.96 65.09 382.80 Gains W 39.64] (71)] (72)] (73)] (76)] (78)
Water heating g Total internal ga 6. Solar gains East South	-64.96 gains (Table 66.76 ains (66)m + 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)t 374.14 Access f Table 0.77 0.77	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56	-64.96 46.93 72)m 307.44 Sol. W 307.44	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0	-64.96 50.64 315.31 sfic data able 6b 0.73 x 0.73 x	-64.96 56.05 338.30 FF specific d or Table	-64.96 62.10 363.76 lata 6c =	-64.96 65.09 382.80 Gains W 39.64 25.83] (71)] (72)] (73)] (76)] (76)] (78)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa	-64.96 gains (Table 66.76 ains (66)m 4 392.86	-64.96 5) 64.58 - (67)m + (6 389.16	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77	-64.96 55.35 m + (70)m - 351.32 actor 6d 7	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56	-64.96 46.93 72)m 307.44 Sol. W 3 x 1 x 4	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x	-64.96 48.47 302.11 speci or Tr 0.9 x (0 0.9 x (0	-64.96 50.64 315.31 g ific data able 6b 0.73 x 0.73 x	-64.96 56.05 338.30 FF specific d or Table 0.70 0.70	-64.96 62.10 363.76 ata 6c =	-64.96 65.09 382.80 Gains W 39.64 25.83] (71)] (72)] (73)] (76)] (76)] (78)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa	(-64.96) gains (Table 66.76 ains (66)m + 392.86 392.86 (5.47)	-64.96 5) 64.58 - (67)m + (6 389.16 (82)m 119.85	-64.96 60.59 68)m + (69)t 374.14 Access f Table 0.77 0.77 0.77	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [7 x [7 x]	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74	-64.96 46.93 72)m 307.44 Sol W 307.44 294.75	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14	-64.96 48.47 302.11 speci or T 0.9 x (0.9 x (-64.96 50.64 315.31 sific data able 6b 0.73 x 0.73 x 0.73 x	-64.96 56.05 338.30 FF specific d or Table 0.70 0.70	-64.96 62.10 363.76 ata 6c = = 80.05	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92] (71)] (72)] (73)] (73)] (76)] (78)] (83)
Water heating g Total internal ga 6. Solar gains East Solar gains in wa Total gains - inte	-64.96 gains (Table 66.76 ains (66)m + 392.86 392.86 65.47 ernal and so	-64.96 5) 64.58 - (67)m + (6 389.16 (82)m 119.85 lar (73)m +	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.7 0.7 181.60 (83)m	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [7 x [-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74	-64.96 46.93 72)m 307.44 Sol. X 1 x 1 x 4 294.75	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0 249.05	-64.96 50.64 315.31 g fic data able 6b 0.73 x 0.73 x 204.82	-64.96 56.05 338.30 FF specific d or Table 0.70 0.70 137.64	-64.96 62.10 363.76 ata 6c = = 80.05	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92] (71)] (72)] (73)] (73)] (76)] (78)] (83)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inte	-64.96 gains (Table 66.76 ains (66)m + 392.86 392.86 52.86 52.86 392.8	64.96 5) 64.58 - (67)m + (6 389.16 389.16 (82)m 119.85 lar (73)m + 509.01	-64.96 60.59 68)m + (69)t 374.14 Access f Table 0.77 0.77 0.77 181.60 (83)m 555.74	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [7 x [7 x [7 x]	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06	-64.96 46.93 72)m 307.44 Sol X 1 x 1 x 4 294.75 602.19	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51	-64.96 48.47 302.11 speci or T 0.9 x (0.9 x (249.05 551.16	-64.96 50.64 315.31 sific data able 6b 0.73 x 0.73 x 204.82 520.14	-64.96 56.05 338.30 FF specific d or Table 0.70 0.70 137.64	-64.96 62.10 363.76 lata 6c = = 80.05	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 54.92] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (84)
Water heating g Total internal ga 6. Solar gains East Solar gains in wa Total gains - inter	[-64.96] gains (Table 66.76] ains (66)m + 392.86] 392.86] 52.86] (74)m 65.47] ernal and so 458.34	64.96 5) -64.58 -(67)m + (6 389.16 (82)m 119.85 lar (73)m + 509.01	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77 181.60 (83)m 555.74	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [7 x] 247.16	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06	-64.96 46.93 72)m 307.44 Sol. W 294.75 602.19	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51	-64.96 48.47 302.11 302.11 0.9 x (0 0.9 x (0 249.05 551.16	-64.96 50.64 315.31 g fic data able 6b 0.73 x 0.73 x 204.82 520.14	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64	-64.96 62.10 363.76 lata 6c = [] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 54.92] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (84)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inter 7. Mean intern	atts $\Sigma(74)$ m 65.47 ernal and so 458.34 -64.96 66.76 66.76 392.86 392.86	(82)m 119.85 lar (73)m + 509.01 ture (heating	-64.96 60.59 58)m + (69)n 374.14 Access f Table 0.77 0.77 181.60 (83)m 555.74 ng season)	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [7 x] 247.16	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06	-64.96 46.93 72)m 307.44 Sol X 1 x 1 x 4 294.75 602.19	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0 249.05 551.16	-64.96 50.64 315.31 sific data able 6b 0.73 x 0.73 x 204.82 520.14	-64.96 56.05 338.30 FF specific d or Table 0.70 0.70 137.64	-64.96 62.10 363.76 lata 6c = [] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 437.72] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (84)
Water heating g Total internal ga 6. Solar gains East Solar gains in wa Total gains - international 7. Mean internation Temperature du	atts $\Sigma(74)$ m 65.47 55.4	64.96 5) 64.58 - (67)m + (6 389.16 (82)m 119.85 lar (73)m + 509.01 ture (heating periods in	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77 0.77 181.60 (83)m 555.74 ng season) the living a	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [247.16 598.49 area from T	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 able 9, Th1	-64.96 46.93 72)m 307.44 Sol W 307.44 294.75 602.19	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51	-64.96 48.47 302.11 302.11 0.9 x (0 0.9 x (0 249.05 551.16	-64.96 50.64 315.31 g fic data able 6b 0.73 x 0.73 x 204.82 520.14	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95	-64.96 62.10 363.76 lata 6c] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 437.72 21.00] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (83)] (84)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inter 7. Mean intern Temperature du	atts $\Sigma(74)$ m 66.76 ains (66)m + 392.86 392.86 5.47 ernal and so 458.34 hal tempera uring heating Jan		-64.96 60.59 58)m + (69)n 374.14 Access f Table 0.77 0.77 181.60 (83)m 555.74 ng season) n the living a Mar	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x] 247.16 598.49 area from T Apr	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 able 9, Th1 May	-64.96 46.93 72)m 307.44 Sol W 294.75 602.19 (°C) Jun	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0 249.05 551.16 551.16	-64.96 50.64 315.31 sific data able 6b 0.73 x 0.73 x 204.82 520.14 Sep	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95	-64.96 62.10 363.76 data 6c = [] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 437.72 21.00 Dec] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (84)] (85)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inter 7. Mean interr Temperature du Utilisation facto	atts $\Sigma(74)$ m 65.47 ernal and so 458.34 and tempera uring heating Jan or for gains for	64.96 5) 64.58 - (67)m + (6 389.16 389.16 119.85 lar (73)m + 509.01 ture (heating periods in Feb or living are	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77 0.77 181.60 (83)m 555.74 ng season) the living a Mar ea n1,m (se	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x [247.16 598.49 area from T Apr e Table 9a)	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 able 9, Th1 May	-64.96 46.93 72)m 307.44 Sol. W 204.75 602.19 (°C) Jun	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0 249.05 551.16 Aug	-64.96 50.64 315.31 315.31 8 ific data able 6b 0.73 x 0.73 x 204.82 520.14 520.14	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95	-64.96 62.10 363.76 lata 6c = [] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 437.72 21.00 Dec] (71)] (72)] (73)] (73)] (76)] (78)] (83)] (83)] (84)
Water heating g Total internal ga 6. Solar gains East Solar gains in wa Total gains - intern Temperature du Utilisation facto	atts $\Sigma(74)$ m 66.76 ains (66)m = 392.86 392.86 5.47 ernal and so 458.34 hal temperating uring heating Jan or for gains for 0.99	64.96 5) 64.58 - (67)m + (6 389.16 (82)m 119.85 lar (73)m + 509.01 ture (heating g periods in Feb or living are 0.98	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77 181.60 (83)m 555.74 181.60 (83)m 555.74 ng season) n the living a Mar ea n1,m (see 0.97	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [247.16 598.49 area from T Apr e Table 9a) 0.96	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 able 9, Th1 May 0.93	-64.96 46.93 72)m 307.44 Sol. W 294.75 602.19 (°C) Jun 0.87	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul 0.79	-64.96 48.47 302.11 302.11 0.9 x (0) 0.9 x (0) 249.05 551.16 Aug 0.81	-64.96 50.64 315.31 315.31 g fic data able 6b 0.73 x 0.73 x 204.82 520.14 520.14 Sep 0.91	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95	-64.96 62.10 363.76 ata 6c = [] = [80.05 443.81	-64.96 65.09 382.80 382.80 39.64 25.83 54.92 437.72 21.00 Dec 21.00] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (83)] (83)] (84)] (85)] (85)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inter 7. Mean intern Temperature du Utilisation facto Mean internal t	atts $\Sigma(74)$ m 65.47 ains (66)m + 392.86 ains (66)m + 392.86 ains (66)m + (65,47) ernal and so 458.34 mal tempera uring heating Jan or for gains for 0.99 emp of living		-64.96 60.59 58)m + (69)n 374.14 Access f Table 0.77 0.77 0.77 181.60 (83)m 555.74 (83)m 555.74 (83)m 555.74 ng season) the living a Mar ea n1,m (see 0.97 steps 3 to 7	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x 247.16 598.49 area from T Apr e Table 9a) 0.96 in Table 9c	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 620.06 able 9, Th1 May 0.93)	-64.96 46.93 72)m 307.44 Sol W 294.75 602.19 (°C) Jun 0.87	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul 0.79	-64.96 48.47 302.11 specior T 0.9 x (0) 0.9 x (0) 249.05 551.16 Aug 0.81	-64.96 50.64 315.31 315.31 8 ific data able 6b 0.73 x 0.73 x 204.82 520.14 520.14 Sep 0.91	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95	-64.96 62.10 363.76 ata 6c = [] = [80.05 443.81	-64.96 65.09 382.80 Gains W 39.64 25.83 54.92 437.72 21.00 Dec 0.99] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (83)] (83)] (84)] (85)] (86)
Water heating g Total internal ga 6. Solar gains East South Solar gains in wa Total gains - inter 7. Mean intern Temperature du Utilisation facto Mean internal t	-64.96 gains (Table 66.76 ains (66)m + 392.86 392.86 55.47 ernal and so 458.34 hal temperation uring heating Jan or for gains for 0.99 emp of living 17.59	64.96 5) 64.58 - (67)m + (6 389.16 389.16 (82)m 119.85 lar (73)m + 509.01 ture (heating g periods in Feb or living are 0.98 g area T1 (s 17.80	-64.96 60.59 58)m + (69)r 374.14 Access f Table 0.77 0.77 0.77 0.77 181.60 (83)m 555.74 ng season) a the living a Mar ea n1,m (see 0.97 steps 3 to 7 18.24	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x (7 x (7 x (7 x (247.16 598.49 area from T Apr e Table 9a) 0.96 in Table 9c 18.87	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06 291.74 620.06 able 9, Th1 May 0.93) 19.54	-64.96 46.93 72)m 307.44 Sol M Sol M 294.75 602.19 (°C) Jun 0.87 20.17	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul 0.79 20.56	-64.96 48.47 302.11 speci or T 0.9 x (0 0.9 x (0 249.05 551.16 Aug 0.81 20.50	-64.96 50.64 315.31 315.31 8 6 7 7 7 7 7 7 7 7 7 7	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95 137.64	-64.96 62.10 363.76 ata 6c = [] = [80.05 443.81 443.81 Nov 0.98	-64.96 65.09 382.80 382.80 39.64 25.83 54.92 437.72 21.00 Dec 0.99] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (83)] (83)] (84)] (85)] (85)] (86)] (87)
Water heating g Total internal ga 6. Solar gains East Solar gains in wa Total gains - intern Temperature du Utilisation facto Mean internal to	-64.96 gains (Table 66.76 ains (66)m 4 392.86 392.86 392.86 65.47 ernal and so 458.34 hal temperation uring heating Jan or for gains for 0.99 emp of living 17.59 uring heating	64.96 5) 64.58 - (67)m + (6 389.16 (82)m 119.85 lar (73)m + 509.01 ture (heating g periods in Feb or living area 0.98 g area T1 (s 17.80 g periods in	-64.96 60.59 68)m + (69)n 374.14 Access f Table 0.77 0.77 181.60 (83)m 555.74 ng season) ng season) n	-64.96 55.35 m + (70)m - 351.32 actor 6d 7 x [7 x [7 x] 247.16 598.49 area from T Apr e Table 9a) 0.96 in Table 9c 18.87 c dwelling fr	-64.96 51.77 + (71)m + (7 328.33 Area m ² 5.70 1.56 291.74 620.06	-64.96 46.93 72)m 307.44 Sol. W 294.75 602.19 (°C) Jun 0.87 0.87 20.17 0, Th2(°C)	-64.96 43.24 295.36 ar flux //m ² 9.64 x 6.75 x 282.14 577.51 Jul 0.79 20.56	-64.96 48.47 302.11 302.11 0.9 x 0 0.9 x 0 249.05 551.16 Aug 0.81 20.50	-64.96 50.64 315.31 g fic data able 6b 0.73 x 204.82 520.14 520.14 Sep 0.91 19.98	-64.96 56.05 338.30 338.30 FF specific d or Table 0.70 0.70 137.64 475.95 137.64	-64.96 62.10 363.76 ata 6c = [] = [80.05 443.81 443.81	-64.96 65.09 382.80 382.80 39.64 25.83 39.64 25.83 39.64 21.00 21.00 Dec 21.00 Dec] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (83)] (83)] (84)] (85)] (85)] (86)] (87)

	-		-										1
	18.41	18.41	18.41	18.42	18.42	18.43	18.43	18.43	18.42	18.42	18.42	18.42	(88)
Utilisation facto	or for gains f	or rest of d	welling n2,	m									1
	0.98	0.98	0.96	0.94	0.88	0.73	0.48	0.54	0.81	0.94	0.97	0.98	(89)
Mean internal t	emperature	in the rest	of dwelling	g T2 (follow	steps 3 to	7 in Table 9	Əc)						_
	15.62	15.83	16.27	16.89	17.54	18.10	18.36	18.34	17.96	17.15	16.29	15.58	(90)
Living area fract	tion								Li	ving area ÷	(4) =	0.56	(91)
Mean internal t	emperature	for the wh	ole dwellin	g fLA x T1 +	(1 - fLA) x 1	2							
	16.72	16.93	17.37	17.99	18.65	19.25	19.58	19.54	19.08	18.25	17.38	16.68	(92)
Apply adjustme	nt to the me	ean interna	l temperatu	ure from Ta	ble 4e whe	re appropr	iate						
	16.72	16.93	17.37	17.99	18.65	19.25	19.58	19.54	19.08	18.25	17.38	16.68	(93)
0. Constanting to a st													
8. Space heati	ng requirem	ient		_		- -						_	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	or for gains,	ηm											1
	0.98	0.97	0.96	0.93	0.88	0.79	0.66	0.70	0.85	0.94	0.97	0.98	(94)
Useful gains, ηn	nGm, W (94	l)m x (84)m											
	447.60	493.40	531.23	556.41	546.87	477.69	382.88	384.28	441.41	445.69	429.65	428.46	(95)
Monthly averag	e external t	emperature	e from Tabl	e U1									
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for	or mean inte	ernal tempe	erature, Lm	, W [(39)m	x [(93)m -	(96)m]							
	2240.53	2168.17	1957.32	1630.74	1246.37	831.37	533.01	560.91	891.48	1370.73	1845.59	2243.73	(97)
Space heating r	equirement	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)ı	n							
	1333.94	1125.44	1061.01	773.51	520.42	0.00	0.00	0.00	0.00	688.23	1019.48	1350.57]
									Σ(98	3)15, 10	12 =	7872.60	(98)
Space heating r	equirement	kWh/m²/ye	ear							(98)	÷ (4)	164.87	(99)
													-
9a. Energy req	uirements -	individual	heating sys	stems inclu	ding micro	-СНР							
Space heating													_
Fraction of space	e heat from	secondary	/supplemei	ntary system	m (table 11)						0.00	(201)
Fraction of space	e heat from	main syste	em(s)							1 - (20	01) =	1.00	(202)
Fraction of space	e heat from	main syste	em 2									0.00	(202)
Fraction of tota	l space heat	from main	system 1						(20	02) x [1- (20	3)] =	1.00	(204)
Fraction of tota	l space heat	from main	system 2							(202) x (20)3) =	0.00	(205)
Efficiency of ma	in system 1	(%)										95.80	(206)
													-
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	-
Space heating for	Jan uel (main sy	Feb stem 1), kV	Mar Vh/month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	-
Space heating f	Jan uel (main sy 1392.42	Feb stem 1), kW	Mar Vh/month 1107.53	Apr 807.43	May 543.24	Jun 0.00	Jul 0.00	Aug	Sep	Oct 718.40	Nov 1064.17	Dec 1409.78]
Space heating for	Jan uel (main sy 1392.42	Feb stem 1), kW 1174.78	Mar Vh/month 1107.53	Apr 807.43	May 543.24	Jun 0.00	Jul	Aug	Sep 0.00 Σ(21)	Oct 718.40	Nov 1064.17 12 = 8	Dec 1409.78 3217.75]] (211)
Space heating for Water heating	Jan uel (main sy 1392.42	Feb stem 1), kW 1174.78	Mar Vh/month 1107.53	Apr 807.43	May 543.24	Jun 0.00	Jul 0.00	Aug 0.00	Sep 0.00 Σ(21:	Oct 718.40 l)15, 10	Nov 1064.17 12 = [8	Dec 1409.78 3217.75]] (211)
Space heating for Water heating Efficiency of wa	Jan uel (main sy 1392.42 ter heater	Feb stem 1), kW	Mar Vh/month 1107.53	Apr 807.43	May 543.24	Jun 0.00	Jul 0.00	Aug 0.00	Sep 0.00 Σ(21:	Oct 718.40 I)15, 10	Nov 1064.17 12 =	Dec 1409.78]] (211)
Space heating for Water heating Efficiency of wa	Jan uel (main sy 1392.42 ter heater 94.71	Feb stem 1), kW 1174.78 94.68	Mar Vh/month 1107.53 94.58	Apr 807.43 94.35	May 543.24 93.85	Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	Sep 0.00 Σ(21) 86.50	Oct 718.40 1)15, 10	Nov 1064.17 12 = 8 94.54	Dec 1409.78 3217.75 94.75]] (211)] (217)
Space heating for Water heating Efficiency of wa Water heating f	Jan uel (main sy 1392.42 ter heater 94.71 uel, kWh/m	Feb stem 1), kW 1174.78 94.68 onth	Mar Vh/month 1107.53 94.58	Apr 807.43 94.35	May 543.24 93.85	Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	Sep 0.00 Σ(21: 86.50	Oct 718.40 1)15, 10 94.14	Nov 1064.17 12 = 94.54	Dec 1409.78 3217.75 94.75]] (211)] (217)
Space heating for Water heating Efficiency of wa Water heating f	Jan uel (main sy 1392.42 ter heater 94.71 fuel, kWh/m 168.41	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 1)15, 10 94.14 143.20	Nov 1064.17 12 = 8 94.54 152.22	Dec 1409.78 3217.75 94.75 164.39]] (211)] (217)]
Space heating for Water heating Efficiency of wa Water heating f	Jan uel (main sy 1392.42 ter heater 94.71 uel, kWh/m 168.41	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58 153.28	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 1)15, 10 94.14 143.20 Σ(219a)1	Nov 1064.17 12 = 94.54 152.22 12 =	Dec 1409.78 3217.75 94.75 164.39 1718.00]] (211)] (217)]] (219)
Space heating for Water heating Efficiency of wa Water heating for Annual totals	Jan uel (main sy 1392.42 ter heater 94.71 uel, kWh/m 168.41	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58 153.28	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 L)15, 10 94.14 143.20 Σ(219a)1	Nov 1064.17 12 = 94.54 152.22 12 = 2	Dec 1409.78 3217.75 94.75 164.39 1718.00] (211)] (217)] (219)
Space heating for Water heating Efficiency of wa Water heating for Annual totals Space heating for	Jan uel (main sy 1392.42 ter heater 94.71 uel, kWh/m 168.41	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58 153.28	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 1)15, 10 94.14 143.20 Σ(219a)1	Nov 1064.17 12 = 94.54 152.22 12 = 12 = 5	Dec 1409.78 3217.75 94.75 164.39 1718.00 3217.75]] (211)] (217)] (219)
Space heating for Water heating Efficiency of wa Water heating for Annual totals Space heating for Water heating for	Jan uel (main sy 1392.42 ter heater 94.71 fuel, kWh/m 168.41	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58 153.28	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 1)15, 10 94.14 143.20 Σ(219a)1	Nov 1064.17 12 = 94.54 152.22 12 = 8 5 5 5 5 5 5 5 5 5 5 5 5 5	Dec 1409.78 3217.75 94.75 94.75 164.39 1718.00 3217.75 1718.00] (211)] (217)] (219)]
Space heating for Water heating Efficiency of wa Water heating for Annual totals Space heating for Water heating for Electricity for market	Jan uel (main sy 1392.42 ter heater 94.71 fuel, kWh/m 168.41 uel - main sy fuel	Feb stem 1), kW 1174.78 94.68 onth 147.16	Mar Vh/month 1107.53 94.58 153.28	Apr 807.43 94.35 136.27	May 543.24 93.85 132.64	Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	Sep 0.00 Σ(21: 86.50 136.87	Oct 718.40 1)15, 10 94.14 143.20 Σ(219a)1	Nov 1064.17 12 = 94.54 152.22 12 =	Dec 1409.78 3217.75 94.75 164.39 1718.00 3217.75 1718.00] (211)] (217)] (219)]

30.00 central heating pump or water pump within warm air heating unit (230c) Total electricity for the above, kWh/year 30.00 (231) Electricity for lighting (Appendix L) 234.66 (232) 10200.41 Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) = (238)10a. Fuel costs - individual heating systems including micro-CHP Fuel **Fuel price** Fuel kWh/year cost £/year Space heating - main system 1 8217.75 3.48 x 0.01 = 285.98 (240) х 1718.00 3.48 x 0.01 = 59.79 Water heating (247)х Pumps and fans 30.00 13.19 x 0.01 = 3.96 (249) х 234.66 13.19 30.95 Electricity for lighting x 0.01 = (250) х Additional standing charges 120.00 (251) Total energy cost (240)...(242) + (245)...(254) = 500.67 (255)11a. SAP rating - individual heating systems including micro-CHP Energy cost deflator (Table 12) 0.42 (256) (257) Energy cost factor (ECF) 2.27 SAP value 68.37

SAP rating (section 13)

SAP band

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

	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO₂/year	
Space heating - main system 1	8217.75	x	0.216	= [1775.03	(261)
Water heating	1718.00	x	0.216	= [371.09	(264)
Space and water heating			(261) + (262) +	(263) + (264) = [2146.12	(265)
Pumps and fans	30.00	х	0.519	= [15.57	(267)
Electricity for lighting	234.66	x	0.519	= [121.79	(268)
Total CO₂, kg/year				(265)(271) = [2283.48	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) = [47.82	(273)
El value				[67.01]
El rating (section 14)				[67	(274)
El band				[D]

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	8217.75	x	1.22	=	10025.65	(261)
Water heating	1718.00	х	1.22	=	2095.96	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	12121.61	(265)
Pumps and fans	30.00	х	3.07	=	92.10	(267)
Electricity for lighting	234.66	x	3.07	=	720.41	(268)
Primary energy kWh/year					12934.13	(272)
Dwelling primary energy rate kWh/m2/year					270.87	(273)

68

D

(258)

SAP Worksheet Design - Draft



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

Assessor name	Mr Spyrid	don Karnez	is					Assessor nur	nber	8658		
Client								Last modifie	d	12/08	/2016	
Address	4 11-12 0	Grenville, C	amden, W	C1								
1. Overall dwelling dimer	isions											
					Area (m²)			Average storey height (m)	¥	Va	lume (m³)	
Lowest occupied					47.75	(1a) x		2.60	(2a) =		124.15	(3a)
Total floor area	(1a)	+ (1b) + (1	c) + (1d)((1n) =	47.75	(4)						
Dwelling volume								(3a) + (3b) + (3	3c) + (3d)(3	8n) =	124.15	(5)
2. Ventilation rate									_			
										m	³ per hour	
Number of chimneys							Г	0	x 40 =			(6a)
Number of open flues							ſ	0	$x^{20} =$] (6b)
Number of intermittent far	is						Ē	3	x 10 =		30] (02)
Number of passive vents							Ĺ	0	x 10 =] (7b)
Number of flueless gas fire	s							0	x 40 =] (7c)
	-									Air	changes per hour	r
Infiltration due to chimney	s, flues, fans	s, PSVs		()	6a) + (6b) +	(7a) + (7b) +	(7c) = [30	÷ (5) =	: [0.24	(8)
If a pressurisation test has	been carried	d out or is i	ntended, p	proceed t	o (17), othe	rwise contin	ue from	(9) to (16)				_
Air permeability value, q50	, expressed	in cubic m	etres per h	our per :	square met	re of envelo	pe area				5.00	(17)
If based on air permeability	value, ther	n (18) = [(1	7) ÷ 20] + (8), other	wise (18) =	(16)					0.49	(18)
Number of sides on which	the dwelling	g is sheltere	ed								4	(19)
Shelter factor								1	- [0.075 x (1	9)] =	0.70	(20)
Infiltration rate incorporati	ng shelter fa	actor							(18) x (2	20) =	0.34	(21)
Infiltration rate modified for	or monthly w	vind speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Au	g Sep	Oct	Nov	Dec	
Monthly average wind spec	ed from Tab	le U2										
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.7	0 4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4												
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.9	3 1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (a	llowing for	shelter and	l wind fact	or) (21) >	k (22a)m							_
0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.3	2 0.34	0.37	0.39	0.40	(22b)
Calculate effective air chan	ge rate for t	the applica	ble case:									_
If mechanical ventilation	n: air chang	e rate thro	ugh systen	า							N/A	(23a)
If balanced with heat re	covery: effic	ciency in %	allowing f	or in-use	factor from	n Table 4h					N/A	(23c)
d) natural ventilation or	whole hou	se positive	input vent	ilation fr	om loft				-1			-
0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.5	5 0.56	0.57	0.57	0.58	(24d)
Effective air change rate - e	enter (24a) o	or (24b) or	(24c) or (2	4d) in (2	5)				- <u>r</u> i			-
0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.5	5 0.56	0.57	0.57	0.58	(25)



3. Heat losses	and heat lo	ss paramet	er										
Element			а	Gross rea, m²	Openings m ²	Net A,	area m²	U-value W/m²K	A x U W	//К к-\ kJ	/alue, /m².K	Ахк, kJ/K	
Door						1.	70 x	1.00	= 1.70				(26)
Window						7.	.61 x	1.50	= 11.44				(27)
External wall						32	.43 x	2.10	= 68.10)			(29a)
External wall						18	.72 x	1.38	= 25.83				(29a)
Party wall						16	.12 x	0.50	= 8.06				(32)
External wall						24	.04 x	0.25	= 6.01				(29a)
Total area of ext	ternal elem	ents ∑A, m²	2			84	.50						(31)
Fabric heat loss,	W/K = ∑(A	× U)							(20	5)(30) + (32) =	121.15	(33)
Heat capacity Cr	m = ∑(А x к)							(28)	.(30) + (32) -	+ (32a)(3	2e) =	N/A	(34)
Thermal mass p	arameter (T	MP) in kJ/r	n²K									250.00	(35)
Thermal bridges	s: Σ(L x Ψ) ca	alculated us	sing Appen	dix K								12.68	(36)
Total fabric heat	t loss									(33) + (36) =	133.83	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_
Ventilation heat	loss calcula	ated month	ly 0.33 x (2	25)m x (5)									
	24.43	24.28	24.13	23.42	23.29	22.67	22.67	22.56	22.91	23.29	23.56	23.83	(38)
Heat transfer co	efficient, W	//K (37)m +	⊦ (38)m		• •					•			
	158.25	158.10	157.95	157.25	157.11	156.50	156.50	156.39	156.74	157.11	157.38	157.66	
									Average = 2	<u>5</u> (39)112,	/12 =	157.25	(39)
Heat loss param	eter (HLP),	W/m²K (39	ə)m ÷ (4)										
	3.31	3.31	3.31	3.29	3.29	3.28	3.28	3.28	3.28	3.29	3.30	3.30	
									Average = 2	<u>5</u> (40)112,	/12 =	3.29	(40)
Number of days	in month (Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
		•				_							
4. Water heati	ng energy r	equiremen	t										7
Assumed occup	ancy, N											1.62	_ (42)
Annual average	hot water u	isage in litro	es per day	Vd,average	e = (25 x N) +	36				• •		72.77	_ (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	e in litres pe	er day for ea	ach month	Vd,m = fac	tor from Tab	le 1c x (43	3)	1	1		1		7
	80.05	77.14	74.23	71.32	68.41	65.50	65.50	68.41	71.32	74.23	77.14	80.05	
				_ "						∑(44)1	.12 =	873.27	(44)
Energy content	of hot wate	r used = 4.1	18 x Vd,m x	nm x Tm/3	3600 kWh/m	onth (see	Tables 1b	, 1c 1d)	1		1		7
	118.71	103.83	107.14	93.41	89.63	77.34	71.67	82.24	83.22	96.99	105.87	114.97	
										∑(45)1	.12 =	1145.00	(45)
Distribution loss	5 0.15 x (45)m					T	1	1				
	17.81	15.57	16.07		13.44	11.60	10.75	12.34	12.48	14.55	15.88	17.24	(46)
Water storage lo	oss calculate	ed for each	month (55	5) x (41)m				1	1		1		-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	_ (56)
If the vessel con	tains dedica	ated solar s	torage or d	ledicated V	VWHRS (56)r	n x [(47) -	Vs] ÷ (47),	, else (56)			1		-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit l	oss for each	n month fro	m Table 3		· · · · ·		1				1		-
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for e	ach month	from Table	3a, 3b or 3	c	,		1	_			1		-
	40.79	35.51	37.83	35.17	34.86	32.30	33.38	34.86	35.17	37.83	38.04	40.79	(61)
Total heat requi	red for wat	er heating o	calculated f	or each mo	onth 0.85 x (45)m + (4	6)m + (57))m + (59)m ·	+ (61)m				

			Access f Table	actor 6d	Area m²	Sol W	ar flux //m²	speci or Ta	g fic data able 6b	FF specific c or Table	lata 6c	Gains W	
6. Solar gains													
	392.55	388.88	373.92	351.15	328.20	307.33	295.24	301.95	315.11	338.04	303.40	382.48] (73)
i otal internal ga	1115 (66)m +	+ (b/)m + (b	os)m + (69)i	m + (70)m	+ (/1)m + (/	2)m	205.24	201 05	215 11	220 04	262.46	202 40	(72)
Total internal	66.76	64.58	60.59	55.35	51.77	46.93	43.24	48.47	50.64	56.05	62.10	65.09] (72)
water neating ga		5)	co =0	FF 25	E4 77	46.00	42.24	40.47	50.64	50.05	62.40	65.00] ()
Water beating a	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96	-64.96] (/1)
Losses e.g. evapo	bration (Tai	ole 5)											۰۲
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00] (70)
Pump and tan ga	ins (Table S		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
Dump and for a	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37	46.37] (69)
COOKING Bains (Ca			L, equation				46.27	46.27	46.27	46.27	46.27	46.27	
Cooking going (or	211.03	213.22	207.71	195.96	181.13	167.19	157.88	155.69	161.21	172.96	187.79	201.72	(68)
Appliance gains (157.00	155.00	101 21	172.00	107 70	201 72	
Appliance gains	calculated	in Annondi		17.99	12a) also se	11.55	12.27	15.95	21.41	27.10	51.72	55.62] (07)
Lighting gains (Co				17.00			12.27	15.05	21.41	27.19	21 72	22.02	
Lighting going (or	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	97.45	(66)
Metabolic gains		07.45	07.45	07.45	07.45	07.45	07.45	07.45	07.45	07.45	07.45	07.45	
Motobolio goine	Jan (Tabla C)	Feb	iviar	Apr	iviay	Jun	Jui	Aug	Sep	Oct	NOV	Dec	
5. Internal gain	5	F . I.		• • • •	84	1	11		6 -11	0.1	NI	Dee	
E laternal acto	_												
	49.67	43.40	45.08	39.85	38.52	33.79	32.17	36.06	36.46	41.70	44.71	48.42	(65)
Heat gains from	water heat	ing (kWh/m	nonth) 0.25	5 × [0.85 ×	(45)m + (61)m] + 0.8 ×	[(46)m + (57)m + (59)	m]				
										∑(64)1	.12 = 1	581.51	(64)
	159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	
Output from wat	er heater f	or each mo	nth (kWh/ı	month) (62	2)m + (63)m	1							
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Solar DHW input	calculated	using Appe	endix G or A	Appendix H									
	159.50	139.33	144.97	128.58	124.48	109.64	105.04	117.10	118.39	134.81	143.91	155.76	(62)

0.77

0.77

0.77

189.44

563.36

Mar

0.97

18.54

18.60

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

East

South

West

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

67.91

Total gains - internal and solar (73)m + (83)m 460.45

7. Mean internal temperature (heating season)

Jan

0.99

17.91

18.60

124.61

513.49

Feb

0.98

18.12

18.60

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

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

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

4.60

1.56

1.45

305.75

633.95

May

0.92

19.76

18.61

х

х

х

258.60

609.75

Apr

0.96

19.13

18.61

19.64

46.75

19.64

295.81

591.05

Jul

0.76

20.66

18.62

x 0.9 x

x 0.9 x

x 0.9 x

260.78

562.74

Aug

0.79

20.61

18.62

0.73

0.73

0.73

213.95

529.05

Sep

0.90

20.14

18.62

х

х

х

0.70

0.70

0.70

143.30

481.34

Oct

0.96

19.34

18.61

х

х

х

309.10

616.43

Jun

0.85

20.33

18.62

31.99

25.83

10.08

56.92

21.00

Dec

0.99

17.87

18.61

439.40 (84)

(76)

(78)

(80)

(83)

(85)

(86)

(87)

(88)

=

=

=

83.08

446.54

Nov

0.98

18.53

18.61

Utilisation facto	r for gains f	or rest of c	aweiling n2,	m									
	0.98	0.98	0.96	0.93	0.86	0.71	0.47	0.53	0.80	0.94	0.97	0.98	(89)
Mean internal to	emperature	in the rest	t of dwelling	g T2 (follov	v steps 3 to	7 in Table 9	Əc)						
	16.05	16.25	16.67	17.25	17.85	18.35	18.57	18.55	18.21	17.47	16.66	16.01	(90)
Living area fract	ion								Li	ving area ÷	(4) =	0.56	(91)
Mean internal to	emperature	for the wh	nole dwellin	g fLA x T1	+(1 - fLA) x	Т2							
	17.08	17.29	17.71	18.30	18.91	19.45	19.73	19.69	19.29	18.51	17.70	17.04	(92)
Apply adjustme	nt to the me	ean interna	al temperati	ure from T	able 4e wh	ere appropr	iate						_
	17.08	17.29	17.71	18.30	18.91	19.45	19.73	19.69	19.29	18.51	17.70	17.04	(93)
				1							1		
8. Space heatir	ng requirem	nent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains,	ηm											
	0.98	0.97	0.96	0.93	0.87	0.78	0.64	0.68	0.84	0.93	0.97	0.98	(94)
Useful gains, ηπ	nGm, W (94	4)m x (84)n	n										
	450.15	498.06	538.24	564.99	553.84	478.49	377.17	379.90	443.72	450.04	432.64	430.59	(95)
Monthly average	e external t	emperatur	e from Tabl	e U1									
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate fo	or mean inte	ernal temp	erature, Lm	, W [(39)n	n x [(93)m -	· (96)m]			<i>.</i>	-	•	•	_
	2023.18	1958.96	1770.64	1477.82	1132.89	758.77	489.83	514.97	812.83	1242.89	1668.12	2025.01	(97)
Space heating re	equirement	, kWh/mor	nth 0.024 x	[(97)m - (9	- 95)m] x (41))m			4	-	1	-	
	1170.33	981.73	916.91	657.24	430.81	0.00	0.00	0.00	0.00	589.89	889.55	1186.25	7
		1							5(9		.12 =	6822.71	(98)
Snace heating re	auirement	kWh/m²/v	vear						210	(98)	÷ (4)	142.88] (99)
opuce neuting re	quirement	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	cui							(50)	. (./	112.00	
9a. Energy req	uirements -	individual	I heating sys	stems incl	uding micro	o-CHP							
9a. Energy req Space heating	uirements -	individua	I heating sys	stems incl	uding micro	o-CHP							
9a. Energy req Space heating Fraction of spac	uirements - e heat from	individual	l heating sys	stems inclonation	uding micro em (table 1:	о-СНР 1)						0.00] (201)
9a. Energy req Space heating Fraction of spac Fraction of spac	uirements - e heat from e heat from	individual secondary main syste	l heating sys y/supplement em(s)	stems inclunt	uding micro em (table 1:	o-CHP 1)				1 - (2	01) =	0.00] (201)] (202)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac	uirements - e heat from e heat from e heat from	secondary main syste	l heating sys y/supplemene em(s) em 2	stems inclunt	uding micro em (table 1:	р-СНР 1)				1 - (2	01) =	0.00 1.00 0.00) (201)) (202)) (202)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total	uirements - e heat from e heat from e heat from space heat	individual secondary main syste main syste from mair	I heating sys y/suppleme em(s) em 2 n system 1	stems inclu	uding micro em (table 1	р-СНР 1)			(20	1 - (2)2) x [1- (20	01) =	0.00 1.00 0.00 1.00) (201)) (202)) (202)) (204)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total	uirements - e heat from e heat from e heat from space heat space heat	individual secondary main syste main syste from mair from mair	I heating sys y/supplemene em(s) em 2 n system 1 n system 2	stems incl	uding micro	р-СНР 1)			(20	1 - (2)2) x [1- (20 (202) x (2	01) = []] []] = []] =	0.00 1.00 0.00 1.00 0.00) (201)) (202)) (202)) (204)) (205)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma	uirements - e heat from e heat from e heat from space heat space heat in system 1	individual secondary main syste main syste from mair from mair (%)	I heating sys y/supplemene em(s) em 2 n system 1 n system 2	stems incluntary syste	uding micro	р-СНР 1)			(20	1 - (2)2) x [1- (20 (202) x (2	01) = 03)] = 03) =	0.00 1.00 0.00 1.00 0.00 95.80) (201)) (202)) (202)) (204)] (205)] (206)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan	individual secondary main syste main syste from mair from mair (%) Feb	I heating sys y/supplemene em(s) em 2 n system 1 n system 2 Mar	stems incl ntary syste Apr	uding micro em (table 1: May	D-CHP 1) Jun	lut	Aug	(20 Sep	1 - (2)2) x [1- (20 (202) x (2 Oct	01) = 03)] = 03) = Nov	0.00 1.00 0.00 1.00 0.00 95.80 Dec) (201) (202) (202) (204) (205) (206)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy	individual secondary main syste main syste from mair from mair (%) Feb stem 1), kV	I heating sys y/supplement em(s) em 2 n system 1 n system 2 Mar Wh/month	stems incl ntary syste Apr	uding micro em (table 1: May	D-CHP 1) Jun	lut	Aug	(20 Sep	1 - (2)2) x [1- (20 (202) x (2 Oct	01) = 03)] = 03) = Nov	0.00 1.00 0.00 1.00 0.00 95.80 Dec] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan Jel (main sy 1221.64	individual secondary main syste main syste from mair from mair (%) Feb stem 1), kV	//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month	Apr	uding micro em (table 1: May	D-CHP 1) Jun	Jul	Aug	(20 Sep	1 - (2)2) x [1- (20 (202) x (2 Oct	01) = 03)] = 03) = Nov	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu	e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64	individual secondary main syste main syste from mair from mair (%) Feb stem 1), kt 1024.77	y/supplement em(s) em 2 h system 1 h system 2 Mar Wh/month 957.11	Apr 686.06	uding micro em (table 1: May 449.70	D-CHP 1) Jun 0.00	Jul 0.00	Aug	(20 Sep	1 - (2)2) x [1- (20 (202) x (2 Oct <u>615.75</u> 1)1 5 10	01) = 03)] = 03) = Nov 928.55 12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26 7121.83) (201)) (202)) (202)) (204)] (205)] (206)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64	individual secondary main syste main syste from mair from mair (%) Feb stem 1), kt 1024.77	I heating sys //supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11	Apr 686.06	uding micro em (table 1: May 449.70	D-CHP 1) Jun 0.00	Jul	Aug	(20 Sep 0.00 Σ(21	1 - (2)2) x [1- (2((202) x (2 Oct <u>615.75</u> 1)15, 10	01) = 03)] = 03) = Nov 928.55 .12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26 7121.83) (201)) (202)) (202)) (204)] (205)] (206)] (211)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating	uirements - e heat from e heat from e heat from space heat space heat is system 1 Jan uel (main sy 1221.64	individual secondary main syste main syste from mair (%) Feb stem 1), kt 1024.77	//suppleme em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11	Apr 686.06	uding micro em (table 1: May 449.70	D-CHP 1) Jun 0.00	Jul 0.00	Aug	(20 Sep 0.00 Σ(21)	1 - (2)2) × [1- (2((202) × (2 Oct <u>615.75</u> 1)15, 10	01) = 03)] = 03) = Nov 928.55 .12 =	0.00 1.00 0.00 95.80 Dec 1238.26 7121.83) (201) (202) (202) (204) (205) (206)) (211)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64 ter heater	individual secondary main syste main syste from mair from mair (%) Feb stem 1), kt 1024.77	//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11	Apr 686.06	May	D-CHP 1) Jun 0.00	Jul 0.00	Aug	(20 Sep 0.00 Σ(21)	1 - (2)2) x [1- (2((202) x (2 Oct] 615.75 1)15, 10	01) = 03)] = 03) = Nov 928.55 .12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26 7121.83) (201) (202) (202) (204) (205) (206)) (211)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat	uirements - e heat from e heat from e heat from space heat space heat is system 1 Jan uel (main sy 1221.64 ter heater 94.58	individual secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77	//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11	Apr 686.06 94.14	uding micro em (table 1: May 449.70 93.55	D-CHP 1) Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	(20 Sep 0.00 Σ(21) 86.50	1 - (2)2) x [1- (2((202) x (2 Oct <u>615.75</u> 1)15, 10 <u>93.92</u>	01) = 03) = 03) = Nov 928.55 .12 = 94.39	0.00 1.00 0.00 95.80 Dec 1238.26 7121.83) (201) (202) (202) (204) (205) (206)) (211)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Water heating fu	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m	individual secondary main syste main syste from mair (%) Feb stem 1), kt 1024.77 94.54 onth	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41</pre>	Apr 686.06 94.14	uding micro em (table 1: May 449.70 93.55	D-CHP 1) Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	(20 Sep 0.00 Σ(21) 86.50 126.87	1 - (2)2) x [1- (2((202) x (2 Oct] 615.75 1)15, 10] 93.92	01) = 03)] = 03) = Nov 928.55 .12 = 94.39	0.00 1.00 0.00 1.00 95.80 Dec 1238.26 7121.83 94.62) (201) (202) (202) (204) (205) (206) (206) (211)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Water heating fi	uirements - e heat from e heat from e heat from space heat space heat is system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64	individual e secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77 94.54 onth 147.38	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	stems incl ntary syste Apr 686.06 94.14 136.57	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21: 86.50 136.87	1 - (2)2) x [1- (2((202) x (2 Oct)115, 10 93.92 143.54	01) = 03) = 03) = Nov 928.55 .12 = 94.39 152.47	0.00 1.00 0.00 95.80 Dec 1238.26 7121.83 94.62 164.62) (201) (202) (202) (204) (205) (206)) (211)) (211)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Water heating fu	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64	individual secondary main syste main syste from mair (%) Feb stem 1), kt 1024.77 94.54 onth 147.38	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	Apr 686.06 94.14 136.57	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21) 86.50 136.87	$1 - (2)$ $22) \times [1 - (20) \times (2) \times $	01) = 03) = 03) = Nov 928.55 .12 = 94.39 152.47 .12 =	0.00 1.00 0.00 1.00 95.80 Dec 1238.26 7121.83 94.62 164.62 1720.27) (201) (202) (202) (204) (205) (206) (206) (211)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat Water heating fu	uirements - e heat from e heat from e heat from space heat space heat is system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64	individual secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77 94.54 onth 147.38	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	Apr 686.06 94.14 136.57	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21: 86.50 136.87	1 - (2)2) × [1- (2((202) × (2) Oct 615.75 1)15, 10 93.92 143.54 Σ (219a)1	01) = 03) = 03) = Nov 928.55 .12 = 94.39 152.47 .12 =	0.00 1.00 0.00 95.80 Dec 1238.26 7121.83 94.62 164.62 1720.27) (201) (202) (204) (205) (206)) (206)) (211)) (217)) (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating fu Water heating fu Annual totals Space heating fu 	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64 uel - main sy	individual secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77 94.54 onth 147.38	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	Apr 686.06 94.14 136.57	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21) 86.50 136.87	$1 - (2)$ $22) \times [1 - (20) \times (2) \times $	01) = 03) = 03) = Nov 928.55 .12 = 94.39 152.47 .12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26 7121.83 94.62 164.62 1720.27 7121.83) (201) (202) (204) (205) (206) (206) (211) (217) (217)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating fu Water heating fu Annual totals Space heating fu Water heating fu 	uirements - e heat from e heat from e heat from space heat is space heat is system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64 uel - main sy uel	individual secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77 94.54 onth 147.38 ystem 1	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	Apr 686.06 94.14 136.57	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21: 86.50 136.87	1 - (2) (202) x [1- (20) (202) x (2) Oct 615.75 1)15, 10 93.92 143.54 Σ (219a)1	01) = 03)] = 03) = Nov 928.55 .12 = 94.39 152.47 .12 =	0.00 1.00 0.00 95.80 Dec 1238.26 7121.83 94.62 164.62 1720.27 7121.83) (201) (202) (204) (205) (206)) (206)) (211)) (211)) (217)) (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu Water heating fu Water heating fu Space heating fu Water heating fu 	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan uel (main sy 1221.64 ter heater 94.58 uel, kWh/m 168.64 uel - main sy uel umps, fans a	individual secondary main syste main syste from mair (%) Feb stem 1), kv 1024.77 94.54 onth 147.38 ystem 1 and electric	<pre>//supplemen em(s) em 2 n system 1 n system 2 Mar Wh/month 957.11 94.41 153.54</pre>	Apr 686.06 94.14 136.57 Table 4f)	uding micro em (table 1: May 449.70 93.55 133.07	D-CHP 1) Jun 0.00 86.50 126.75	Jul 0.00 86.50 121.44	Aug 0.00 86.50 135.37	(20 Sep 0.00 Σ(21) 86.50 136.87	1 - (2)2) × [1- (2((202) × (2) Oct 615.75 1)15, 10 93.92 143.54 Σ (219a)1	01) = 03) = 03) = Nov 928.55 .12 = 94.39 152.47 .12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 1238.26 7121.83 94.62 164.62 1720.27 7121.83 1720.27) (201) (202) (204) (205) (206) (206) (211) (217) (217)

Total electricity for the above, kWh/year

Electricity for lighting (Appendix L)

Total delivered energy for all uses

	_
(211)(221) + (231) + (232)(237b) =	

30.00(231)232.43(232)9104.53(238)

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	7121.83	x	3.48	x 0.01 =	247.84	(240)
Water heating	1720.27	х	3.48	x 0.01 =	59.87	(247)
Pumps and fans	30.00	х	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	232.43	х	13.19	x 0.01 =	30.66	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	462.32	(255)
11a. SAP rating - individual heating systems include	ding micro-CHP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					2.09	(257)
SAP value					70.80]
SAP rating (section 13)					71	(258)
SAP band					С]
12a. CO ₂ emissions - individual heating systems in	ncluding micro-CHP					
	Energy		Emission factor		Emissions	

	kWh/year		kg CO ₂ /kWh		kg CO₂/year	
Space heating - main system 1	7121.83	x	0.216	= [1538.32	(261)
Water heating	1720.27	x	0.216	= [371.58	(264)
Space and water heating			(261) + (262) +	(263) + (264) = [1909.89	(265)
Pumps and fans	30.00	x	0.519	= [15.57	(267)
Electricity for lighting	232.43	x	0.519	=	120.63	(268)
Total CO ₂ , kg/year				(265)(271) = [2046.09	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) = [42.85	(273)
El value					70.44]
El rating (section 14)					70	(274)
El band				[С]

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	,
Space heating - main system 1	7121.83] x	1.22	=	8688.63	(261)
Water heating	1720.27) x	1.22	=	2098.73	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	10787.36	(265)
Pumps and fans	30.00] x	3.07	=	92.10	(267)
Electricity for lighting	232.43	x	3.07	=	713.56	(268)
Primary energy kWh/year					11593.02	(272)
Dwelling primary energy rate kWh/m2/year					242.79	(273)

SAP Worksheet Design - Draft



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

Assessor name	Mr Spyri	don Karnez	is					Assessor nur	nber	8658		
Client								Last modified	d	12/08	/2016	
Address	5 11-12 (Grenville, C	amden, W	C1								
1. Overall dwelling dime	nsions											
					Area (m²)		ľ	Average storey height (m)	1	Va	lume (m³)	
Lowest occupied					82.76	(1a) x	Ē	2.15	(2a) =		177.93	(3a)
Total floor area	(1a)	+ (1b) + (1	c) + (1d)(1n) =	82.76	(4)						
Dwelling volume								(3a) + (3b) + (3	3c) + (3d)(3	8n) =	177.93	(5)
2. Ventilation rate												
										m	³ per hour	
Number of chimneys							Γ	0	x 40 =		0	(6a)
Number of open flues							Ī	0	 x 20 =		0	(6b)
Number of intermittent fa	ns						Ē	4	x 10 =		40	(7a)
Number of passive vents							Ē	0	x 10 =		0	(7b)
Number of flueless gas fire	2S						Ē	0	x 40 =		0	(7c)
										Air	hanges pe hour	r
Infiltration due to chimney	rs, flues, fan	s, PSVs		(6	a) + (6b) + (7	7a) + (7b) + ((7c) = 🗌	40	÷ (5) =	:	0.22	(8)
If a pressurisation test has	been carrie	d out or is i	ntended, p	roceed to	(17), otherv	wise continu	le from	(9) to (16)				
Air permeability value, q50), expressed	in cubic m	etres per h	our per s	quare metre	e of envelop	e area				5.00	(17)
If based on air permeabilit	y value, the	n (18) = [(1	7) ÷ 20] + (8), otherv	vise (18) = (1	16)					0.47	(18)
Number of sides on which	the dwelling	g is sheltere	ed								4	(19)
Shelter factor								1	- [0.075 x (1	9)] =	0.70	(20)
Infiltration rate incorporat	ing shelter f	actor							(18) x (2	20) =	0.33	(21)
Infiltration rate modified f	or monthly v	wind speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Au	g Sep	Oct	Nov	Dec	
Monthly average wind spe	ed from Tab	ole U2										_
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	0 4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4												_
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	3 1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (a	allowing for	shelter and	l wind fact	or) (21) x	(22a)m		1				1	-
0.42	0.42	0.41	0.37	0.36	0.32	0.32	0.3	1 0.33	0.36	0.37	0.39	(22b)
Calculate effective air char	nge rate for	the applica	ble case:									٦
If mechanical ventilatio	n: air chang	e rate thro	ugh system	1							N/A	_ (23a)
It balanced with heat re	ecovery: effi	ciency in %	allowing f	or in-use	tactor from	Table 4h					N/A	(23c)
d) natural ventilation o	r whole hou	se positive	input vent	liation fro	om loft	-	1.		1 - 1	-	-	
0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.5	5 0.56	0.56	0.57	0.58	_ (24d)
Effective air change rate -	enter (24a) o	or (24b) or	(24c) or (2	4d) in (25)				I	c =	1	
0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.5	0.56	0.56	0.57	0.58	(25)



Element Gross Openings Net area LI-value A x II W/K K-value A x K	
area, m^2 m^2 A, m^2 W/m ² K kJ/m ² .K kJ/K	
Door 1.70 x 1.00 = 1.70	(26)
Window 12.41 x 1.50 = 18.66	(27)
External wall 30.38 x 2.10 = 63.80	(29a)
External wall 31.82 x 1.38 = 43.91	(29a)
External wall 19.59 x 0.25 = 4.90	(29a)
External wall 16.55 x 0.28 = 4.63	(29a)
Roof 17.55 x 0.18 = 3.16	(30)
Roof 20.18 x 0.17 = 3.43	(30)
Total area of external elements ΣA , m ² 150.18	(31)
Fabric heat loss, $W/K = \sum (A \times U)$ (26)(30) + (32) = 144.19	(33)
Heat capacity $Cm = \sum (A \times \kappa)$ (28)(30) + (32) + (32a)(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K 250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K 22.53	(36)
Total fabric heat loss (33) + (36) = 166.72	(37)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	_
34.63 34.43 34.23 33.28 33.11 32.29 32.29 32.13 32.60 33.11 33.46 33.84	(38)
Heat transfer coefficient, W/K (37)m + (38)m	_
201.35 201.15 200.95 200.00 199.83 199.01 199.01 198.85 199.32 199.83 200.18 200.56	
Average = $\sum(39)112/12 = 200.00$	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	_
2.43 2.43 2.43 2.42 2.41 2.40 2.40 2.40 2.41 2.41 2.42 2.42	
Average = $\sum(40)112/12 = 2.42$	(40)
4. Water heating energy requirement	
Assumed occupancy, N 2.51	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 93.89	(43)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	_
103.28 99.52 95.76 92.01 88.25 84.50 84.50 88.25 92.01 95.76 99.52 103.28	
$\Sigma(44)112 = 1126.65$	(44)
Energy content of not water used = 4.18 x vd,m x nm x 1m/3600 kwn/month (see Tables 10, 10 10)	7
153.16 133.95 138.22 120.51 115.63 99.78 92.46 106.10 107.37 125.13 136.59 148.32	
$\sum_{i=1}^{2} (45)112 = 1477.21$	_ (45)
22 97 20 09 20 73 18 08 17 34 14 97 13 87 15 92 16 11 18 77 20 49 22 25	(46)
Water storage loss calculated for each month (55) x (41)m	(40)
	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56) m x $[(47) - Vs] \div (47)$ else (56)	
	(57)
Primary circuit loss for each month from Table 3	
	-
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	(59)

	-	1			1							1	1	7
	50.96	45.81	48.80	45.37	44.97	41.67	43.06	44.97	45.37	4	48.80	49.08	50.96	(61)
Total heat requir	red for wate	er heating o	alculated f	or each mo	onth 0.85 x	(45)m + (4	6)m + (57)m + (59)m	n + (61)m					
	204.11	179.76	187.03	165.88	160.60	141.45	135.52	151.07	152.74	1	.73.93	185.66	199.28	(62)
Solar DHW input	calculated	using Appe	endix G or A	Appendix H										
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	(63)
Output from wat	ter heater f	for each mo	nth (kWh/	month) (62	2)m + (63)m					_] ()
		170.70	107.02			1 4 4 4 5	125.52	151.07	152.74	1	72.02	105.00	100.20	7
	204.11	1/9.76	187.03	165.88	160.60	141.45	135.52	151.07	152.74	1	./3.93	185.00	199.28	
											∑(64)1	.12 = 2	2037.04	(64)
Heat gains from	water heat	ing (kWh/n	10nth) 0.25	5 × [0.85 ×	(45)m + (61)m] + 0.8 ×	[(46)m +	(57)m + (5	9)m]					_
	63.66	55.99	58.16	51.41	49.69	43.59	41.51	46.52	47.04	!	53.80	57.68	62.06	(65)
E lateral acto														
5. Internal gain	S													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		Oct	Nov	Dec	
Metabolic gains	(Table 5)													
	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	150.79	1	.50.79	150.79	150.79	(66)
Lighting gains (ca	alculated in	Appendix	L, equation	L9 or L9a),	also see Ta	ble 5								
	53.04	47.11	38.31	29.01	21.68	18.30	19.78	25.71	34.51		43.81	51.14	54.51	(67)
Appliance gains	calculated	in Appendi	x L. equatio	on L13 or L	13a). also se	e Table 5							1	
	225.00	220.47	220.60	211.09	700 27	266 19	251.26	247.07	256.66	1	75.26	208 07	221 16	(69)
Cooking going (or				511.50	200.57	200.10	231.30	247.87	230.00		.75.50	290.97	521.10	_ (08)
COOKING gains (Ca	alculated in		L, equation	LIS OF LIS	a), also see	Table 5							1	٦
	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59	52.59		52.59	52.59	52.59	(69)
Pump and fan ga	ins (Table !	5a)												_
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00		3.00	3.00	3.00	(70)
Losses e.g. evapo	oration (Tal	ble 5)												
	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	3 -100.53	-1	100.53	-100.53	-100.53	(71)
Water heating g	-100.53 ains (Table	-100.53 5)	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	3 -100.53	-1	100.53	-100.53	-100.53	(71)
Water heating g	-100.53 ains (Table	-100.53 5)	-100.53	-100.53	-100.53	-100.53	-100.53	-100.53	65 34	-1	100.53	-100.53	-100.53) (71)
Water heating g	-100.53 ains (Table 85.57	-100.53 5) 83.32	-100.53 78.17	-100.53 71.41	-100.53 66.79	-100.53 60.55	-100.53 55.79	-100.53 62.53	3 -100.53 65.34	-1	72.32	-100.53 80.12	-100.53] (71)] (72)
Water heating ga Total internal ga	-100.53 ains (Table 85.57 ins (66)m +	-100.53 5) 83.32 + (67)m + (6	-100.53 78.17 58)m + (69)	-100.53 71.41 m + (70)m	-100.53 66.79 + (71)m + (7	-100.53 60.55 72)m	-100.53	62.53	3 -100.53 65.34		72.32	-100.53	-100.53 83.41] (71)] (72)
Water heating ga Total internal ga	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 8)m + (69) 553.03	-100.53 71.41 m + (70)m 518.25	-100.53 66.79 + (71)m + (7 482.70	-100.53 60.55 72)m 450.89	-100.53 55.79 432.78	-100.53 62.53 441.97	3 -100.53 65.34 7 462.36	-1	100.53 72.32 97.35	-100.53 80.12 536.08	-100.53 83.41 564.94) (71)) (72)] (73)
Water heating ga Total internal ga	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03	-100.53 71.41 m + (70)m 518.25	-100.53 66.79 + (71)m + (7 482.70	-100.53 60.55 72)m 450.89	-100.53 55.79 432.78	-100.53 62.53 441.97	3 -100.53 65.34 462.36	-1	100.53 72.32 97.35	-100.53 80.12 536.08	-100.53 83.41 564.94] (71)] (72)] (73)
Water heating ga Total internal ga 6. Solar gains	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 8)m + (69) 553.03	-100.53 71.41 m + (70)m 518.25	-100.53 66.79 + (71)m + (7 482.70	-100.53 60.55 72)m 450.89	-100.53 55.79 432.78	-100.53 62.53 441.97	3 -100.53 65.34 462.36	4	100.53 72.32 197.35	-100.53 80.12 536.08	-100.53 83.41 564.94] (71)] (72)] (73)
Water heating ga Total internal ga 6. Solar gains	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 68)m + (69) 553.03 Access f Table	-100.53 71.41 m + (70)m 518.25 factor 6d	-100.53 66.79 + (71)m + (7 482.70 Area m ²	-100.53 60.55 72)m 450.89 Sola	-100.53 55.79 432.78 ar flux //m ²	-100.53 62.53 441.97	3 -100.53 65.34 462.36 g ecific data		100.53 72.32 97.35 FF pecific c	-100.53 80.12 536.08	-100.53 83.41 564.94 Gains W] (71)] (72)] (73)
Water heating ga Total internal ga 6. Solar gains	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03 Access f Table	-100.53 71.41 m + (70)m 518.25 factor 6d	-100.53 66.79 + (71)m + (7 482.70 Area m ²	-100.53 60.55 72)m 450.89 Sola V	-100.53 55.79 432.78 ar flux //m ²	-100.53 62.53 441.97	 3 -100.53 65.34 462.36 g ecific data Table 6b 		100.53 72.32 97.35 FF pecific c or Table	-100.53 80.12 536.08 data 6c	-100.53 83.41 564.94 Gains W] (71)] (72)] (73)
Water heating ga Total internal ga 6. Solar gains	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03 Access f Table	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50	-100.53 60.55 72)m 450.89 Sola W	-100.53 55.79 432.78 ar flux //m ² 9.64	 -100.53 62.53 441.97 \$	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 		100.53 72.32 197.35 FF pecific c or Table 0.70	-100.53 80.12 536.08	-100.53 83.41 564.94 Gains W 45.21] (71)] (72)] (73)
Water heating ga Total internal ga 6. Solar gains East South	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69)i 553.03 Access f Table	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1 30	-100.53 60.55 72)m 450.89 Sola V X 1 x 1 x 1	-100.53 55.79 432.78 ar flux //m ² 9.64	62.53 441.97 62.53	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 		100.53 72.32 97.35 FF pecific c or Table 0.70 0.70	-100.53 80.12 536.08	-100.53 83.41 564.94 Gains W 45.21 21.52] (71)] (72)] (73)] (76)] (76)] (78)
Water heating ga Total internal ga 6. Solar gains East South	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 (8)m + (69) 553.03 Access f Table	-100.53 71.41 m + (70)m 518.25 factor 6d 7	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 4	-100.53 55.79 432.78 ar flux //m ² 9.64	62.53 62.53 441.97 62.53	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.72 		100.53 72.32 197.35 FF pecific c or Table 0.70 0.70	-100.53 80.12 536.08	-100.53 83.41 564.94 Gains W 45.21 21.52 20.56] (71)] (72)] (73)] (73)] (76)] (76)] (78)
Water heating ga Total internal ga 6. Solar gains East South West	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 (8)m + (69) 553.03 Access f Table 0.7 0.7	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1	-100.53 55.79 432.78 ar flux //m ² 9.64 9.64	62.53 62.53 441.97 62.53	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.73 0.73 		100.53 72.32 197.35 FF pecific c or Table 0.70 0.70 0.70	-100.53 80.12 536.08 data 6c = [= [=] = [-100.53 83.41 564.94 Gains W 45.21 21.52 29.56] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (80)] (72)
Water heating ga Total internal ga 6. Solar gains East South West North	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [7 x [7 x [7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36	-100.53 60.55 72)m 450.89 Sol: W 2 x 1 x 1 x 4 x 1 x 1 x 1 x 1	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 1 0.63	<pre>62.53 62.53 441.97 441.97 \$</pre>	 3 -100.53 65.34 462.36 geoific data Table 6b 0.73 0.73 0.73 0.73 0.73 	 	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70	-100.53 80.12 536.08	-100.53 83.41 564.94 Gains W 45.21 21.52 29.56 1.36] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa	-100.53 ains (Table 85.57 ins (66)m + 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69)i 553.03 Access f Table 0.7' 0.7' 0.7' 0.7'	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [7 x [7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36	-100.53 60.55 72)m 450.89 Sola W 2 x 1 x 1 x 1 x 1 x 1 x 1	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64	62.53 62.53 441.97 62.53	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.73 0.73 0.73 	 4 	100.53 72.32 197.35 FF pecific c or Table 0.70 0.70 0.70 0.70	-100.53 80.12 536.08 data 6c = [= [= [] = [-100.53 83.41 564.94 Gains W 45.21 21.52 29.56 1.36] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (80)] (74)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa	-100.53 ains (Table 85.57 ins (66)m + 580.45 580.45	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 290.17	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 X 1 X 1 X 1	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 0.63	 -100.53 62.53 441.97 spa or x 0.9 x x 416.26 	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.73 0.73 0.73 332.34 	- <u>-</u>	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70	-100.53 80.12 536.08 data 6c = [= [=] = [] = [] = []	-100.53 83.41 564.94 Gains W 45.21 21.52 29.56 1.36 81.21] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - inter	-100.53 ains (Table 85.57 ins (66)m 4 580.45 580.45 tts Σ(74)m 97.65 rnal and so	-100.53 5) 83.32 + (67)m + (6 575.76	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 290.17 (83)m	-100.53 71.41 m + (70)m 518.25 518.25 6d 7 x [7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93	-100.53 60.55 72)m 450.89 Sola X 1 x 1 x 1 x 1 x 1 x 1 x 1 x 1	-100.53 55.79 432.78 ar flux //m ² 9.64 9.64 9.64 9.64 9.64 9.64 9.64 9.63	<pre>-100.53 62.53 441.97 441.97 \$</pre>	 3 -100.53 65.34 462.36 8 ecific data Table 6b 0.73 0.73 0.73 0.73 0.73 332.34 	 	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70	-100.53 80.12 536.08 Jata 6 c = [] = [] = [] = [] = [] 120.41	-100.53 83.41 564.94 Gains W 45.21 21.52 29.56 1.36 1.36 81.21] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - inter	-100.53 ains (Table 85.57 ins (66)m + 580.45 580.45 tts Σ(74)m 97.65 rnal and so 678.10	-100.53 5) 83.32 + (67)m + (6 575.76 (82)m 184.10 olar (73)m + 759.86	-100.53 78.17 i8)m + (69)i 553.03 Access f Table 0.7 0.7 0.7 0.7 0.7 (0.7 (0.7) 0.7 (0.7)(-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [] x [7 x [] x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 Sola X 1 X 1 X 1 X 1 X 1 X 1	-100.53 55.79 432.78 ar flux //m ² 9.64 9.64 9.64 0.63 478.83 911.61	 -100.53 62.53 441.97 441.97 spin or x 0.9 x x 16.26 858.22 	 3 -100.53 65.34 462.36 462.36 7 able 6b 0.73 0.73 0.73 0.73 332.34 794.70 	 	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65	-100.53 80.12 536.08 data 6c = [] = [] = [] = [120.41	-100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 81.21] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)] (84)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - inter	-100.53 ains (Table 85.57 ins (66)m + 580.45 580.45 tts ∑(74)m 97.65 rnal and so 678.10	-100.53 5) 83.32 + (67)m + (6 575.76 (82)m 184.10 olar (73)m + 759.86	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 290.17 (83)m 843.20	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x] 7 x [7 x] x] 7 x [7 x] x] 7 x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 Sola X 1 Sola X	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 9.64 9.64 9.64 9.63	 -100.53 62.53 441.97 spanning spanning	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.73 0.73 332.34 2 794.70 		100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65	-100.53 80.12 536.08 data 6c = [= [=] = [] = [] 120.41	-100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 81.21 81.21] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)] (84)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - internal 7. Mean internal	-100.53 ains (Table 85.57 ins (66)m + 580.45 580.45 tts Σ(74)m 97.65 rnal and so 678.10 al tempera	-100.53 5) 83.32 + (67)m + (6 575.76 575.76 (82)m 184.10 olar (73)m + 759.86 ture (heati	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 (0.7 (0.7 (0.7) 0.7 (0.7)(-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 Sol1.81	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 0.63 1 478.83 911.61	 -100.53 62.53 441.97 441.97 spinor or x 0.9 x x 0.9 x x 0.9 x x 0.9 x 416.26 858.22 	 3 -100.53 65.34 462.36 8 ecific data Table 6b 0.73 0.73 0.73 0.73 332.34 794.70 	 	100.53 72.32 197.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65	-100.53 80.12 536.08 data 6c = [] = [] = [] = [120.41	-100.53 83.41 564.94 Gains W 45.21 21.52 29.56 1.36 81.21 646.16] (71)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)] (84)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - intern Temperature du	-100.53 ains (Table 85.57 ins (66)m 4 580.45 580.45 tts Σ(74)m 97.65 rnal and so 678.10 al tempera ring heating	-100.53 5) 83.32 + (67)m + (6 575.76 575.76 184.10 olar (73)m + 759.86 ture (heati g periods in	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 290.17 (83)m 843.20 the living a	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x [7 x [7 x [7 x [7 x] 7 x]	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 Sol.81 Sol.81	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 0.63	 -100.53 62.53 441.97 spa or x 0.9 x x 16.26 858.22 	 3 -100.53 65.34 462.36 g ecific data Table 6b 0.73 0.73 0.73 0.73 332.34 794.70 	- <u>-</u> 4 4 4 2 2	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65	-100.53 80.12 536.08 data 6c = [] = [] = [] = [] = [] 120.41	-100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 81.21 81.21 646.16] (71)] (72)] (73)] (73)] (73)] (73)] (80)] (74)] (83)] (84)] (85)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - intern 7. Mean intern Temperature du	-100.53 ains (Table 85.57 ins (66)m 4 580.45 580.45 580.45 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8	-100.53 5) 83.32 + (67)m + (6 575.76 575.76 (82)m 184.10 olar (73)m + 759.86 ture (heati g periods in Feb	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 0.7 (83)m 843.20 k843.20 ng season) the living a Mar	-100.53 71.41 m + (70)m 518.25 518.25 6 6 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 8 7 7 8 7 7 8 7 7 8 9 8 8 8 7 8 8 7 8 7	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63 975.63	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 X 1 Sol.81 X 501.81	-100.53 55.79 432.78 ar flux //m ² 9.64 9.64 9.64 9.64 9.64 9.64 9.64 9.64	 -100.53 62.53 441.97 spe or 0.9 x <0.9 x	 3 -100.53 65.34 462.36 geoific data Table 6b 0.73 0.73 0.73 0.73 332.34 794.70 Sep 	 	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65	-100.53 80.12 536.08 536.08 6c = [] = [] = [] = [] = [] 120.41 656.49	 -100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 81.21 81.21 646.16 646.16 21.00 Dec] (71)] (72)] (73)] (73)] (76)] (76)] (78)] (80)] (74)] (83)] (83)] (84)] (85)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - intern Temperature du Utilisation factor	-100.53 ains (Table 85.57 ins (66)m + 580.45 580.45 tts $\Sigma(74)m$ 97.65 rnal and so 678.10 al tempera ring heating Jan for gains for	-100.53 5) 83.32 + (67)m + (6 575.76 575.76 184.10 blar (73)m + 759.86 ture (heati g periods in Feb or living are	-100.53 78.17 i8)m + (69)i 553.03 Access f Table 0.7 0.7 0.7 0.7 0.7 (83)m 843.20 ng season) the living a Mar ea n1,m (se	-100.53 71.41 m + (70)m 518.25 factor 6d 7 x [7 x] 7 x [7 x [7 x] 7	-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63 975.63	-100.53 60.55 72)m 450.89 Sola W 2 X 1 X 1 X 1 X 1 X 1 Sol.81 Sol.81 Sol.81 (°C) Jun	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 0.63 20.63 478.83 911.61	 -100.53 62.53 441.97 spanning or on x on y x (0.9 x) (0.9 x)	 3 -100.53 65.34 65.34 462.36 8 ecific data Table 6b 0.73 0.73 0.73 0.73 0.73 332.34 794.70 Sep 	 	100.53 72.32 197.35 FF pecific c or Table 0.70 0.70 0.70 0.70 0.70 214.65	-100.53 80.12 536.08 data 6c = [] = [] = [] = [] 120.41 656.49	-100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 81.21 81.21 646.16 21.00 Dec] (71)] (72)] (73)] (73)] (73)] (73)] (80)] (74)] (83)] (83)] (84)] (85)
Water heating ga Total internal ga 6. Solar gains East South West North Solar gains in wa Total gains - intern Temperature du Utilisation factor	-100.53 ains (Table 85.57 ins (66)m 4 580.45 580.45 580.45 7 97.65 rnal and so 678.10 al tempera ring heating Jan for gains f	-100.53 5) 83.32 + (67)m + (6 575.76 575.76 184.10 blar (73)m + 759.86 ture (heati g periods in Feb or living are 0.99	-100.53 78.17 i8)m + (69) 553.03 Access f Table 0.7 0.7 0.7 0.7 0.7 0.7 (83)m 843.20 rg season) the living a Mar ea n1,m (se 0.98	-100.53 71.41 m + (70)m 518.25 5actor 6d 7 x [7 x [] x [7 x [] x [-100.53 66.79 + (71)m + (7 482.70 Area m ² 6.50 1.30 4.25 0.36 492.93 975.63 975.63 Fable 9, Th1 May	-100.53 60.55 72)m 450.89 Sola X 1 X 1 X 1 X 1 X 1 X 1 Sol.81 Sol.81 Sol.81	-100.53 55.79 432.78 ar flux //m ² 9.64 6.75 9.64 9.64 9.64 9.64 9.64 9.64 9.64 9.64	 -100.53 62.53 441.97 spa or 0.9 x <0.9 x <0.77 	 3 -100.53 65.34 462.36 8 ecific data Table 6b 0.73 0.73 0.73 0.73 332.34 2 794.70 Sep 0.90 	 	100.53 72.32 97.35 FF pecific c or Table 0.70 0.70 0.70 0.70 114.65 '12.00 '12.00	-100.53 80.12 536.08 data 6c = [= [= [] = [] = [-100.53 83.41 564.94 564.94 45.21 21.52 29.56 1.36 1.36 81.21 646.16 21.00 Dec 0.99] (71)] (72)] (72)] (73)] (73)] (76)] (78)] (80)] (74)] (83)] (84)] (85)] (85)

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

	18.53	18.71	19.08	19.59	20.11	20.56	20.81	20.76	20.39	19.72	19.03	18.49	(87)
Temperature du	uring heating	g periods in	the rest of	dwelling fi	rom Table 9	9, Th2(°C)]
·	19.06	19.06	19.06	19.07	19.07	19.08	19.08	19.08	19.07	19.07	19.07	19.07	(88)
Utilisation facto	r for gains for	or rest of d	welling n2,	n				1		1	1	1], ,
	0.99	0.98	0.97	0.94	0.87	0.72	0.50	0.55	0.82	0.95	0.98	0.99	(89)
Mean internal to	emperature	in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	c)	1		1	1], ,
	16.94	17.13	17.49	18.00	18.50	18.89	, 19.04	19.02	18.76	18,14	17.46	16.91	(90)
Living area fract	ion	1/120	27110	10.00	10.00	10.00	20101	10:01	Liv	ving area ÷	(4) =	0.41	(91)
Mean internal te	emperature	for the wh	ole dwellin	g fLA x T1 +	-(1 - fLA) x T	2			_			0112] (0 -)
	17 59	17 78	18 14	18.65	19.16	19 57	19 76	19 74	19.43	18 78	18 10	17 56	(92)
Annly adjustme	nt to the me	an internal	l temperatu	re from Ta	hle 4e whe	re annronr	iate	15.74	15.45	10.70	10.10	17.50] (32)
	17 50	17.78	18 14	18.65	10.16	10 57	10.76	19.74	10/13	18.78	18 10	17.56	(03)
	17.59	17.78	10.14	18.05	19.10	19.57	19.70	19.74	19.43	10.70	18.10	17.50] (33)
8. Space heating	ng requirem	ent											
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains, r	յՠ											
	0.99	0.98	0.97	0.94	0.88	0.76	0.60	0.64	0.84	0.95	0.98	0.99	(94)
Useful gains, ηπ	nGm, W (94)m x (84)m	I										_
	668.64	744.49	814.91	868.48	854.80	723.38	543.32	551.98	668.56	675.05	642.83	638.31	(95)
Monthly average	e external te	emperature	e from Tabl	e U1								1], ,
, 0	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate fo	or mean inte	ernal tempe	erature. Lm	. W [(39)m	x [(93)m -	(96)ml] ()
	2676 19	2590.03	2339 52	1950 25	1490 71	989 80	629 30	663 39	1062.28	1635 39	2202.23	2678 48	(97)
Space heating re	equirement.	kWh/mon	th 0.024 x	[(97)m - (9	5)ml x (41)r	n	010.00	000.00	1001.10	1000.00		2070110] (57)
	, ,	•			, , , ,								
	1493.62	1240.20	1134.32	778.88	473.11	0.00	0.00	0.00	0.00	714.49	1122.77	1517.89]
	1493.62	1240.20	1134.32	778.88	473.11	0.00	0.00	0.00	0.00	714.49	1122.77	1517.89 475 27]] (98)
Space heating re	1493.62	1240.20 kWh/m²/ye	1134.32	778.88	473.11	0.00	0.00	0.00	0.00 Σ(98	714.49 8)15, 10	1122.77 .12 = 8 $\div (4)$	1517.89 475.27 102 41]] (98)] (99)
Space heating re	1493.62	1240.20 kWh/m²/ye	1134.32 ear	778.88	473.11	0.00	0.00	0.00	0.00 Σ(98	714.49 8)15, 10 (98)	1122.77 .12 = 8 ÷ (4) 2	1517.89 475.27 102.41]] (98)] (99)
Space heating re 9a. Energy req	1493.62 equirement uirements -	1240.20 kWh/m²/ye individual	1134.32 ear heating sys	778.88 stems inclu	473.11 ding micro	0.00 -CHP	0.00	0.00	0.00 Σ(98	714.49 8)15, 10 (98)	1122.77 .12 = 8 ÷ (4) 1	1517.89 475.27 102.41]] (98)] (99)
Space heating re 9a. Energy req Space heating	1493.62 equirement uirements -	1240.20 kWh/m²/ye individual	1134.32 ear heating sys	778.88 stems inclu	473.11 ding micro	0.00 -CHP	0.00	0.00	0.00 Σ(98	714.49 8)15, 10 (98)	1122.77 .12 = 8 ÷ (4) 2	1517.89 475.27 102.41]] (98)] (99)
Space heating re 9a. Energy req Space heating Fraction of space	equirement uirements - e heat from	1240.20 kWh/m²/ye individual secondary,	1134.32 ear heating sys /supplemen	778.88 stems inclu	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	0.00 Σ(98	714.49 8)15, 10 (98)	1122.77 .12 = 8 ÷ (4) 2	1517.89 475.27 102.41 0.00]] (98)] (99)] (201)
Space heating re 9a. Energy req Space heating Fraction of spac Fraction of spac	equirement uirements - e heat from e heat from	1240.20 kWh/m²/ye individual secondary, main syste	1134.32 ear heating sys /supplemen em(s)	778.88 stems inclu	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	0.00 Σ(98	714.49 3)15, 10 (98) 1 - (20	1122.77 12 = 8 ÷ (4) 2 01) = 0	1517.89 475.27 102.41 0.00 1.00]] (98)] (99)] (201)] (202)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space	equirement uirements - e heat from e heat from e heat from	1240.20 kWh/m²/ye individual secondary, main syste main syste	1134.32 ear heating sys /supplemen em(s) em 2	778.88 stems inclu	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	0.00 Σ(98	714.49 3)15, 10 (98) 1 - (20	1122.77 .12 = 8 ÷ (4) 2 	1517.89 475.27 102.41 0.00 1.00 0.00]] (98)] (99)] (201)] (202)] (202)
Space heating re 9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of spac	equirement uirements - e heat from e heat from e heat from l space heat	1240.20 kWh/m²/ye individual secondary, main syste main syste from main	1134.32 ear heating sys /supplemen em(s) em 2 system 1	778.88 stems inclu	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	<u>0.00</u> Σ(98	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20	1122.77 .12 = 8 ÷ (4)	1517.89 475.27 102.41 0.00 1.00 0.00 1.00]] (98)] (99)] (201)] (202)] (202)] (202)] (204)
Space heating req 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total	equirement uirements - e heat from e heat from e heat from l space heat l space heat	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2	778.88	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	0.00 Σ(98	714.49 3)15, 10 (98) 1 - (20)2) x [1- (20 (202) x (20	1122.77 .12 = 8 ÷ (4) 2 	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00]] (98)] (99)] (201)] (202)] (202)] (204)] (205)
Space heating re 9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of total Fraction of total Efficiency of ma	equirement uirements - e heat from e heat from e heat from l space heat i space heat in system 1	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%)	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2	778.88 stems inclu	473.11 ding micro m (table 11	0.00 -CHP)	0.00	0.00	<u>0.00</u> Σ(98	714.49 3)15, 10 (98) 1 - (20)2) x [1- (20 (202) x (20	1122.77 12 = 8 ÷ (4) 2 01) = 2 3)] = 2 03) = 2 122.77 122.77 122.77 122.77 122.77 122.77 123.77 123.77 124.77 125.77 1	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80] (98) (99) (201) (202) (202) (202) (204) (205) (206)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Fraction of total Efficiency of ma	equirement uirements - e heat from e heat from e heat from l space heat l space heat in system 1 Jan	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar	778.88 stems inclu ntary system	473.11 ding micro m (table 11 May	0.00 -CHP) Jun	0.00	0.00	0.00 Σ(98 (20 Sep	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 Oct	1122.77 12 = 8 ÷ (4) 2 01) = 2 3)] = 2 03) = 2 Nov	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma	equirement uirements - e heat from e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%) Feb stem 1), kW	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Wh/month	778.88 stems inclu ntary system	473.11 ding micro m (table 11 May	0.00 -CHP) Jun	0.00 Jul	0.00 Aug	0.00 Σ(98 (20 Sep	714.49 3)15, 10 (98) 1 - (20)2) x [1- (20 (202) x (20 Oct	1122.77 12 = 8 ÷ (4) 1 01) = 1 3)] = 1 03) = 1 Nov	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec] (98) (99) (201) (202) (202) (202) (204) (205) (206)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu	1493.62 equirement uirements - e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00	0.00 Jul	0.00 Aug	0.00 Σ(98 (20 Sep 0.00	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 (202) × (20 Oct 745.82	1122.77 12 = 8 ÷ (4) 2 01) = 2 3)] = 2 Nov 1171.99	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu	equirement uirements - e heat from e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00	0.00 Jul 0.00	0.00 Aug 0.00	0.00 Σ(98 (20 Sep 0.00 Σ(21)	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 0ct 745.82 1)15, 10	1122.77 12 = 8 ÷ (4) 2 01) = 2 03) = 2 Nov 1171.99 12 = 8	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of ma Space heating fu	1493.62 equirement uirements - e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00	0.00 Jul	0.00 Aug 0.00	0.00 Σ(98 (20 Sep 0.00 Σ(21:	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 0ct 745.82 1)15, 10	1122.77 12 = 8 ÷ (4) 2 01) = 2 03) = 2 Nov 1171.99 .12 = 8	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of was	1493.62 equirement uirements - e heat from e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00	0.00 Jul 0.00	0.00 Aug 0.00	0.00 Σ(98 (20 Sep 0.00 Σ(21:	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 Oct 745.82 1)15, 10	1122.77 12 = 8 ÷ (4) 2 01) = 2 3)] = 2 03) = 2 Nov 1171.99 .12 = 8	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84]] (98)] (99)] (201)] (202)] (202)] (202)] (204)] (205)] (206)]] (211)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating for Water heating Efficiency of wat	1493.62 equirement uirements - e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10 ter heater	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00	0.00 Jul 0.00	0.00 Aug 0.00	0.00 Σ(98 (20 Sep 0.00 Σ(21:	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 0ct 745.82 1)15, 10	1122.77 12 = 8 ÷ (4) 2 01) = 2 03) = 2 Nov 1171.99 .12 = 8	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)]] (211)] (217)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat	1493.62 equirement uirements - e heat from e heat from e heat from l space heat l space heat l space heat l space heat usystem 1 Jan uel (main sys 1559.10 ter heater 94.58	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 1294.57	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02 94.03	473.11 ding micro m (table 11 May 493.86	0.00 -CHP) Jun 0.00 86.50	0.00 Jul 0.00 86.50	0.00 Aug 0.00 86.50	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50	714.49 3)15, 10 (98) 1 - (20)2) x [1- (20 (202) x (20 Oct 745.82 1)15, 10 93.83	1122.77 12 = 8 ÷ (4) 2 01) = 2 03) = 2 Nov 1171.99 .12 = 8 94.36	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (217)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating Water heating fu	1493.62 equirement uirements - e heat from e heat from e heat from l space heat l space heat in system 1 Jan uel (main sys 1559.10 ter heater 94.58 uel, kWh/ma	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57 94.51 onth	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05	778.88 stems inclu ntary system Apr 813.02 94.03	473.11 ding micro m (table 11 May 493.86 93.26	0.00 -CHP) Jun 0.00 86.50	0.00 Jul 0.00 86.50	0.00 Aug 0.00 86.50	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50	714.49 3)15, 10 (98) 1 - (20)2) × [1- (20 (202) × (20 0ct 745.82 1)15, 10 93.83	1122.77 12 = 8 ÷ (4) 2 01) = 2 03) = 2 Nov 1171.99 .12 = 8 94.36	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84 94.62]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)]] (211)] (217)]
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat	1493.62 equirement uirements - e heat from e heat from e heat from l space heat l space heat l space heat l space heat u system 1 Jan uel (main system 1559.10 ter heater 94.58 uel, kWh/ma	1240.20 kWh/m²/ye individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 1294.57 94.51 onth 190.19	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05 94.36 94.36	778.88 stems inclu ntary system Apr 813.02 94.03 176.42	473.11 ding micro m (table 11 May 493.86 93.26	0.00 -CHP) Jun 0.00 86.50 86.50	0.00 Jul 0.00 86.50 156.67	0.00 Aug 0.00 86.50 174.65	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50 176.58	714.49 8)15, 10 (98) 1 - (20)2) x [1- (20 (202) x (20 Oct 745.82 1)15, 10 93.83 185.37 5(210-)1	1122.77 $12 = 8$ $\div (4) 22$ $(4) 22$ $(4) 23$ $(4) 23$ $(4) 23$ $(5) 23$	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84 94.62 94.62 210.61]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (217)]] (217)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating fu Water heating fu	1493.62 equirement uirements - e heat from e heat from e heat from l space heat in system 1 Jan Jel (main sys 1559.10 ter heater 94.58 uel, kWh/ma	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57 94.51 onth 190.19	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05 94.36	778.88 stems inclu ntary system Apr 813.02 94.03 176.42	473.11 ding micro m (table 11 May 493.86 93.26	0.00 -CHP) Jun 0.00 86.50 86.50	0.00 Jul 0.00 86.50 156.67	0.00 Aug 0.00 86.50 174.65	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50 176.58	714.49 $3)15, 10$ (98) $1 - (20)$ $(202) \times [1 - (20)$ $(202) \times (20)$ $0ct$ 745.82 $1)15, 10$ 93.83 185.37 $\Sigma(219a)1$	1122.77 $12 = 8$ $\div (4) 2$ $01) = 2$ $03) = 2$ $03) = 2$ $103) = 2$ 1171.99 $12 = 8$ 94.36 196.76 $12 = 2$	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84 94.62 94.62 210.61 217.02]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (205)] (206)] (211)] (217)] (217)] (219)
Space heating re 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of ma Space heating fu Water heating Efficiency of wat Water heating fu	1493.62 equirement uirements - e heat from e heat from e heat from l space heat l space heat l space heat l space heat usystem 1 Jan uel (main sys 1559.10 ter heater 94.58 uel, kWh/ma	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57 94.51 onth 190.19	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05 94.36 198.20	778.88 stems inclu ntary system Apr 813.02 94.03 176.42	473.11 ding micro m (table 11 May 493.86 93.26 172.21	0.00 -CHP) Jun 0.00 86.50 163.53	0.00 Jul 0.00 86.50 156.67	0.00 Aug 0.00 86.50 174.65	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50 176.58	714.49 $3)15, 10$ (98) $1 - (20)$ $(202) \times [1- (20)$ (202) $\times (20)$ Oct Oct 745.82 1)15, 10 93.83 185.37 Σ (219a)1	1122.77 $12 = 8$ $\div (4) 22$ $(4) 23$ $(4) 23$ $(4) 23$ $(4) 23$ $(5) 23$	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84 94.62 210.61 217.02]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (211)] (217)] (219)]
Space heating real 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of total Efficiency of mail Space heating for Water heating for Water heating for Annual totals Space heating for	1493.62 equirement uirements - e heat from e heat from e heat from l space heat in system 1 Jan Jel (main sys 1559.10 ter heater 94.58 uel, kWh/mi 215.82	1240.20 kWh/m²/ye individual secondary, main syste from main from main (%) Feb stem 1), kW 1294.57 94.51 onth 190.19	1134.32 ear heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 1184.05 94.36	778.88 stems inclu ntary system Apr 813.02 94.03 176.42	473.11 ding micro m (table 11 May 493.86 93.26	0.00 -CHP) Jun 0.00 86.50 163.53	0.00 Jul 0.00 86.50 156.67	0.00 Aug 0.00 86.50 174.65	0.00 Σ(98 (20 Sep 0.00 Σ(21: 86.50 176.58	714.49 $3)15, 10$ (98) $1 - (20)$ $(202) \times [1 - (20)$ (202) $\times (20)$ (20	1122.77 $12 = 8$ $\div (4) 2$ $01) = 2$ $03) = 2$ $03) = 2$ $103) = 2$ 1171.99 $12 = 8$ 94.36 196.76 $12 = 2$ 8	1517.89 475.27 102.41 0.00 1.00 0.00 1.00 0.00 95.80 Dec 1584.43 846.84 94.62 210.61 217.02 846.84]] (98)] (99)] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (217)] (217)] (219)]

Water heating fuel				2217.02]
Electricity for pumps, fans and electric keep-hot (Table 4f)					
central heating pump or water pump within warm air heating	unit		30.00		(230c)
Total electricity for the above, kWh/year				30.00	(231)
Electricity for lighting (Appendix L)				374.68	(232)
Total delivered energy for all uses		(2	11)(221) + (231) + (232)(237b) =	11468.54	(238)
10a. Fuel costs - individual heating systems including micro-CH	Ρ				
	Fuel kWh/year		Fuel price	Fuel cost £/year	
Space heating - main system 1	8846.84	х	3.48 x 0.01 =	307.87	(240)
Water heating	2217.02	х	3.48 x 0.01 =	77.15	(247)
Pumps and fans	30.00	х	13.19 x 0.01 =	3.96	(249)
Electricity for lighting	374.68	x	13.19 x 0.01 =	49.42	(250)
Additional standing charges				120.00	(251)
Total energy cost			(240)(242) + (245)(254) =	558.40	(255)
11a. SAP rating - individual heating systems including micro-CH	IP				
Energy cost deflator (Table 12)				0.42	(256)
Energy cost factor (ECF)				1.84	(257)
SAP value				74.39]
SAP rating (section 13)				74	(258)
SAP band				С]
12a. CO ₂ emissions - individual heating systems including micro	D-CHP				
12a. CO ₂ emissions - individual heating systems including micro	Energy		Emission factor	Emissions	
12a. CO ₂ emissions - individual heating systems including micro	Energy kWh/year		Emission factor kg CO ₂ /kWh	Emissions kg CO₂/year	1
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1	Energy kWh/year 8846.84	x	Emission factor kg CO ₂ /kWh	Emissions kg CO ₂ /year 1910.92] (261)
 12a. CO₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating 	Energy kWh/year 8846.84 2217.02	x x	Emission factor $kg CO_2/kWh$ 0.216 = 0.216 =	Emissions kg CO ₂ /year 1910.92 478.88] (261)] (264)
 12a. CO₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating 	Energy kWh/year 8846.84 2217.02	x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79] (261)] (264)] (265)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans	Energy kWh/year 8846.84 2217.02 30.00	x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57] (261)] (264)] (265)] (267)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x x	Emission factor $kg CO_2/kWh$ 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265) (271)	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46] (261)] (264)] (265)] (267)] (268)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) + (4)	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82) (261)) (264)] (265)] (267)] (268)] (272)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) ÷ (4) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41] (261)] (264)] (265)] (267)] (268)] (272)] (273)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73) (261) (264) (265) (267) (268) (272) (273)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73] (261)] (264)] (265)] (267)] (268)] (272)] (273)]] (274)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = $(272) \div (4) =$	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C] (261)] (264)] (265)] (267)] (268)] (272)] (273)]] (274)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro	Energy kWh/year 8846.84 2217.02 30.00 374.68 ro-CHP Energy kWh/year	x x x	Emission factor kg CO ₂ /kWh 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) = Primary factor	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)
12a. CO2 emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO2, kg/year Dwelling CO2 emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro Space heating - main system 1	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x	Emission factor $kg CO_2/kWh$ 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = 0.519 = (265)(271) = (272) ÷ (4) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14] (261)] (264)] (265)] (267)] (268)] (272)] (273)]] (274)]
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro Space heating - main system 1 Water heating	Energy kWh/year 8846.84 2217.02 30.00 374.68 ro-CHP Energy kWh/year 8846.84 2217.02	x x x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) = Primary factor 1.22 = 1.22 =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14 2704.76] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)] (274)] (261)] (261)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) = Primary factor 1.22 = 1.22 = (261) + (262) + (263) + (264) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14 2704.76 13497.90] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)] (261)] (261)] (265)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) \div (4) = Primary factor 1.22 = (261) + (262) + (263) + (264) = 3.07 =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14 2704.76 13497.90 92.10] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)] (274)] (261)] (261)] (265)] (265)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	Energy kWh/year 8846.84 2217.02 30.00 374.68	x x x x x x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) ÷ (4) = Primary factor 1.22 = (261) + (262) + (263) + (264) = 3.07 = 3.07 =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14 2704.76 13497.90 92.10 1150.28] (261)] (264)] (265)] (267)] (268)] (272)] (273)] (274)] (274)] (261)] (261)] (265)] (265)] (267)] (268)
12a. CO ₂ emissions - individual heating systems including micro Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13a. Primary energy - individual heating systems including micr Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Primary energy kWh/year	Energy kWh/year 8846.84 2217.02 30.00 374.68 374.68 2217.02 Skewh/year 8846.84 2217.02 30.00 374.68 30.00 30.00 374.68	x x x x x x x x	Emission factor $kg CO_2/kWh$ 0.216 = 0.216 = (261) + (262) + (263) + (264) = 0.519 = (265)(271) = (272) ÷ (4) = Primary factor 1.22 = (261) + (262) + (263) + (264) = = (261) + (262) + (263) + (264) = = (3.07) =	Emissions kg CO ₂ /year 1910.92 478.88 2389.79 15.57 194.46 2599.82 31.41 72.73 73 C Primary Energy kWh/year 10793.14 2704.76 13497.90 92.10 1150.28 14740.28] (261)] (264)] (265)] (267)] (272)] (273)] (273)] (274)] (261)] (264)] (265)] (267)] (268)] (272)

SAP Worksheet Design - Draft



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

Assessor name	Mr Spyrid	don Karnez	is						Assesso	or num	nber	865	8		
Client									Last mo	dified	I	12/	08/20	16	
Address	6 11-12 0	Grenville, C	amden, W	C1											
1. Overall dwelling dimer	nsions														
					Ar	rea (m²)			Average s height	torey (m)	,		Volun	ne (m³)	
Lowest occupied						46.08	(1a) x		2.25](2a) =		103	3.68	(3a)
Total floor area	(1a)	+ (1b) + (1	c) + (1d)((1n) = 🗌		46.08	(4)								
Dwelling volume									(3a) + (3l	o) + (3	c) + (3d)(3	3n) = 🗌	103	3.68	(5)
2. Ventilation rate															
													m³ pe	er hour	
Number of chimneys									0		x 40 =	: [0	(6a)
Number of open flues									0		 x 20 =	: [0	(6b)
Number of intermittent fai	าร								2		 x 10 =	: [2	20	(7a)
Number of passive vents									0		 x 10 =	· [0	(7b)
Number of flueless gas fire	S								0		x 40 =	· [0	(7c)
											_	A	ir cha ho	nges per our	-
Infiltration due to chimney	s, flues, fans	s, PSVs		(6a)	+ (6b) + (7	a) + (7b) +	(7c) =	20		÷ (5) =	- [0.	.19	(8)
If a pressurisation test has	been carried	d out or is i	ntended, p	proceed t	to (1	7), otherw	vise continu	ie fron	n (9) to (16)					
Air permeability value, q50	, expressed	in cubic m	etres per h	iour per	squ	are metre	of envelop	e area					5.	.00	(17)
If based on air permeability	y value, ther	n (18) = [(1	7) ÷ 20] + (8), othei	rwis	e (18) = (1	6)						0.	.44	(18)
Number of sides on which	the dwelling	g is sheltere	ed											2	(19)
Shelter factor										1 -	- [0.075 x (1	9)] = 🗌	0.	.85	(20)
Infiltration rate incorporation	ng shelter fa	actor									(18) x (2	20) =	0.	.38	(21)
Infiltration rate modified for	or monthly v	wind speed	:												
Jan	Feb	Mar	Apr	May	/	Jun	Jul	A	ıg S	ер	Oct	Nov	,	Dec	
Monthly average wind spe	ed from Tab	le U2					-				1				-
5.10	5.00	4.90	4.40	4.30)	3.80	3.80	3.	70 4	.00	4.30	4.50)	4.70	(22)
Wind factor (22)m ÷ 4	_						-								1
1.28	1.25	1.23	1.10	1.08	3	0.95	0.95	0.	93 1	.00	1.08	1.13	3	1.18	(22a)
Adjusted infiltration rate (a	allowing for	shelter and	l wind fact	or) (21)	x (2)	2a)m	-								1
0.48	0.47	0.46	0.41	0.40)	0.36	0.36	0.	35 0	.38	0.40	0.42	2	0.44	(22b)
Calculate effective air char	ige rate for t	the applica	ble case:									Г			
If mechanical ventilatio	n: air change	e rate thro	ugn systen	1 									N	/A] (23a)
d) patural ventilation	covery: ettic	ciency in %	allowing f	or in-use	e tac	tor from T	able 4h					L	N	/A] (23C)
	whole hous				, oth		0.50			F7	0.50	0.50	<u> </u>	0.00	
Effective air change rate	10.61	0.01	0.59	0.58	5)	0.56	0.56	0.	0 0	.57	0.58	0.55	,	U.6U	j (240)
chective air change rate - 6) (240) Or	(24C) OF (2	4u) in (2	5)	0.50	0.50		-	F7	0.50	0.50		0.60	(25)
0.62	0.01	0.01	0.59	0.58)	0.50	0.50	0.	0 טכ	.57	0.58	0.55	,	0.00] (25)



3. Heat losses	and heat lo	ss paramet	er										
Element			а	Gross rea, m²	Openings m ²	Net A,	area m²	U-value W/m²K	A x U W,	/К к-v kJ,	value, /m².K	Ахк, kJ/K	
Door						1.	70 x	1.00	= 1.70				(26)
Window						6.	30 x	1.50	= 9.47				(27)
External wall						5.	40 x	1.38	= 7.45				(29a)
External wall						10	.00 x	0.25	= 2.50				(29a)
External wall						50	.40 x	0.28	= 14.11				(29a)
Roof						37	.00 x	0.18	= 6.66				(30)
Total area of ext	ternal eleme	ents ∑A, m²				110	0.80						(31)
Fabric heat loss,	W/K = ∑(A	× U)							(26)(30) + (3	32) =	41.90	(33)
Heat capacity Cr	m = ∑(А x к)							(28)	.(30) + (32) +	(32a)(32	2e) =	N/A	(34)
Thermal mass p	arameter (T	MP) in kJ/n	n²K									250.00	(35)
Thermal bridges	: Σ(L x Ψ) ca	alculated us	ing Appen	dix K								16.62] (36)
Total fabric heat	t loss		0 11							(33) + (3	36) =	58.52] (37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_ ` <i>`</i>
Ventilation heat	loss calcula	ated month	ly 0.33 x (2	25)m x (5)					,				
	21.05	20.90	20.75	20.04	19.91	19.30	19.30	19.18	19.53	19.91	20.18	20.45	(38)
Heat transfer co	efficient, W	//K (37)m +	- (38)m										
	79.57	79.41	79.26	78.56	78.43	77.81	77.81	77.70	78.05	78.43	78.69	78.97	
									Average = ∑	(39)112/	/12 =	78.56	(39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)										
	1.73	1.72	1.72	1.70	1.70	1.69	1.69	1.69	1.69	1.70	1.71	1.71]
									Average = ∑	(40)112/	/12 =	1.70	(40)
Number of days	in month (1	Fable 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
4. Water heati	ng energy r	equiremen	t										
Assumed occupa	ancy, N											1.58	(42)
Annual average	hot water u	isage in litre	es per day '	Vd,average	= (25 x N) +	36						71.62	(43)
-	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_
Hot water usage	e in litres pe	r day for ea	ch month	Vd,m = fact	tor from Tab	le 1c x (43	3)						
-	78.78	75.92	73.05	70.19	67.32	64.46	64.46	67.32	70.19	73.05	75.92	78.78	7
							1	1	1 1	Σ(44)1	.12 =	859.46	 (44)
Energy content	of hot wate	r used = 4.1	l8 x Vd,m x	nm x Tm/3	3600 kWh/m	onth (see	Tables 1b), 1c 1d)		20,			_, , <u>,</u>
07	116.83	102.18	105.44	91.93	88.21	, 76.12	70.53	80.94	81.91	95.45	104.19	113.15	7
	110.00	10110	100111	1 52.50	00.22		70.00		01.01	5(45)1	12 =	1126 89	_] (45)
Distribution loss	0.15 x (45)	lm								2(13)1		1120.05	
2.00.000.000	17 53	15 33	15.82	13 79	13.23	11 42	10.58	12 14	12.29	14 32	15.63	16.97	(46)
Water storage l		ed for each	month (55	(41)m	15.25	11.42	10.50	12.14	12.25	14.52	15.05	10.57] (40)
Water storage in					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7 (56)
If the vessel con	tains dodic	tod color s	torage or d	Lodicated M		0.00	1 0.00	0.00	0.00	0.00	0.00	0.00	_ (50)
II the vessel con						0.00	vs] · (47)		0.00	0.00	0.00	0.00	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	_ (57)
Primary circuit l				0.00		0.00	0.00	0.00		0.00	0.00	0.00	
Completer	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	_ (59)
COMUNITORS FOR E			5a, 3b or 3			24 72		24.24		27.22	27.11	101-	
Tatal best as	40.15	34.94	37.23	34.61	34.31	31.79	32.85	34.31	34.61	37.23	37.44	40.15	_ (61)
Total neat redui	red for wate	er neating (alculated f	or each mo	untri 0.85 X (45)m + (4	0)III + (5/	jin + (59)m	+ (ot)W				

	156.98	137.13	142.67	126.54	122.52	107.91	103.38	115.25	116.52	132.68	141.63	153.30 (6	62)
Solar DHW inpu	t calculated	using Appe	endix G or A	Appendix H				I			I		
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 (6	63)
Output from wa	ter heater f	or each mo	onth (kWh/i	month) (62	!)m + (63)m)						·	
	156.98	137.13	142.67	126.54	122.52	107.91	103.38	115.25	116.52	132.68	141.63	153.30	
		•								∑(64)1	.12 = 1	.556.50 (6	64)
Heat gains from	water heat	ing (kWh/m	nonth) 0.25	5 × [0.85 × ((45)m + (61)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]				
	48.88	42.71	44.37	39.22	37.91	33.26	31.66	35.49	35.89	41.04	44.00	47.66 (6	65)
		•	•								•	•	
5. Internal gair	าร												
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)										1	,	
	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54	94.54 (6	66)
Lighting gains (c	alculated in	Appendix I	L, equation	L9 or L9a),	also see Ta	ble 5			_		I	· · · · · · · · · · · · · · · · · · ·	
	32.94	29.26	23.80	18.02	13.47	11.37	12.28	15.97	21.43	27.21	31.76	33.86 (6	67)
Appliance gains	(calculated	in Appendi	x L, equatio	on L13 or L1	.3a), also se	e Table 5						1	
	204.58	206.70	201.35	189.96	175.59	162.08	153.05	150.93	156.28	167.67	182.04	195.55 (6	68)
Cooking gains (c	alculated ir	Appendix	L, equation	L15 or L15	a), also see	Table 5							
	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03	46.03 (6	69)
Pump and fan g	ains (Table !	5a)							1			·	
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00 (7	70)
Losses e.g. evap	oration (Ta	ble 5)										· · · · · · · · · · · · · · · · · · ·	
	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03	-63.03 (7	71)
Water heating g	ains (Table	5)											
		-									1		
	65.70	63.56	59.63	54.47	50.95	46.19	42.56	47.70	49.84	55.17	61.12	64.06 (7	72)
Total internal ga	65.70 ains (66)m -	63.56 + (67)m + (6	59.63 i8)m + (69)i	54.47 m + (70)m -	50.95 + (71)m + (7	46.19 72)m	42.56	47.70	49.84	55.17	61.12	64.06 (7	72)
Total internal ga	65.70 ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 68)m + (69) 365.33	54.47 m + (70)m - 342.99	50.95 + (71)m + (7 320.55	46.19 72)m 300.18	42.56 288.44	47.70 295.14	49.84 308.09	55.17 330.59	61.12 355.46	64.06 (7 374.01 (7	72) 73)
Total internal ga	65.70 ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 i8)m + (69)i 365.33	54.47 m + (70)m - 342.99	50.95 + (71)m + (7 320.55	46.19 72)m 300.18	42.56 288.44	47.70 295.14	49.84 308.09	55.17 330.59	61.12 355.46	64.06 (7 374.01 (7	72) 73)
Total internal ga 6. Solar gains	65.70 ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 58)m + (69)n 365.33 Access f	54.47 m + (70)m - 342.99	50.95 + (71)m + (7 320.55 Area	46.19 72)m 300.18 Sol a	42.56 288.44	47.70 295.14	49.84 308.09	55.17 330.59 FF	61.12 355.46	64.06 (7 374.01 (7 Gains	72) 73)
Total internal ga	65.70 Ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 (8)m + (69) 365.33 Access f Table	54.47 m + (70)m + 342.99 factor 6d	50.95 + (71)m + (7 320.55 Area m ²	46.19 72)m 300.18 Sola W	42.56 288.44 ar flux //m ²	47.70 295.14 spec	49.84 308.09 g ific data	55.17 330.59 FF specific c	61.12 355.46	64.06 (7 374.01 (7 Gains W	72) 73)
Total internal ga	65.70 Ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 8)m + (69)n 365.33 Access f Table	54.47 m + (70)m + 342.99 actor 6d	50.95 + (71)m + (7 320.55 Area m ²	46.19 72)m 300.18 Sola W	42.56 288.44 ar flux I/m ²	47.70 295.14 speci or T	g ific data able 6b	55.17 330.59 FF specific c or Table	61.12 355.46	64.06 (7 374.01 (7 Gains W	72) 73)
Total internal ga 6. Solar gains East	65.70 iins (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 (8)m + (69) 365.33 Access f Table 0.7	54.47 m + (70)m + 342.99 Factor 6d	50.95 + (71)m + (7 320.55 Area m ² 3.60	46.19 72)m 300.18 Sola W 2 x 12	42.56 288.44 ar flux //m ² 9.64 x	47.70 295.14 speci or T 0.9 x	8 308.09 6 16 17 17 17 17 17 17 17 17	55.17 330.59 FF specific c or Table 0.70	61.12 355.46 data e 6c	64.06 (7 374.01 (7 Gains W 25.04 (7	72) 73) 76)
Total internal ga 6. Solar gains East West	65.70 Ains (66)m - 383.77	63.56 + (67)m + (6 380.07	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7	54.47 m + (70)m + 342.99 factor 6d 7 x [7 x [50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70	46.19 72)m 300.18 Sola W 2 11 X 11 X 11	42.56 288.44 ar flux //m ² 9.64 x 9.64 x	47.70 295.14 spect or T 0.9 x (0 0.9 x (0	8 308.09 8 ific data able 6b 0.73 x 0.73 x	55.17 330.59 FF specific c or Table 0.70 0.70	61.12 355.46	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8	72) 73) 76) 80)
Total internal ga 6. Solar gains East West Solar gains in wa	65.70 iins (66)m - 383.77 383.77	63.56 + (67)m + (6 380.07	59.63 (8)m + (69) 365.33 Access f Table 0.7 0.7	54.47 m + (70)m + 342.99 factor 6d 7 x [7 x [50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70	46.19 72)m 300.18 Sola W] x 11 x 11	42.56 288.44 ar flux //m ² 9.64 x 9.64 x	47.70 295.14 speci or T 0.9 x (0	g ific data able 6b 0.73 x 0.73 x	55.17 330.59 FF specific c or Table 0.70 0.70	61.12 355.46 data e 6c = _ = _	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8	72) 73) 76) 80)
Total internal ga 6. Solar gains East West Solar gains in wa	65.70 iins (66)m - 383.77 383.77 43.82	63.56 + (67)m + (6 380.07 (82)m 85.72	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7 141.16	54.47 m + (70)m + 342.99 factor 6d 7 x 7 x 205.87	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31	46.19 72)m 300.18 Sola X X 1 X 1 258.28	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x	47.70 295.14 spect or T 0.9 x (0.9 x (211.22	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18	55.17 330.59 FF specific c or Table 0.70 0.70 101.71	61.12 355.46 data 6c = [= [54.63	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8	72) 73) 76) 80) 83)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - inte	65.70 ins (66)m - 383.77 383.77 43.82 ernal and sc	63.56 + (67)m + (6 380.07 (82)m 85.72 alar (73)m +	59.63 i8)m + (69)i 365.33 Access f Table 0.7 0.7 141.16 (83)m	54.47 m + (70)m + 342.99 actor 6d 7 x 7 x 205.87	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31	46.19 72)m 300.18 Sola X X 1 X 1 258.28	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 245.89	47.70 295.14 speci or T 0.9 x (0 0.9 x (0 211.22	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18	55.17 330.59 FF specific c or Table 0.70 0.70 101.71	61.12 355.46 data e 6c = [= [54.63	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8	72) 73) 76) 80) 83)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - inte	65.70 ins (66)m - 383.77 383.77 43.82 ernal and sc 427.59	63.56 + (67)m + (6 380.07 (82)m 85.72 alar (73)m + 465.78	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49	54.47 m + (70)m - 342.99 actor 6d 7 x 7 x 205.87 548.87	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85	46.19 72)m 300.18 Sola X 1: X 1: 258.28	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 245.89 534.33	47.70 295.14 speci or T 0.9 x (0 0.9 x (0 211.22 506.36	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18 472.27	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30	61.12 355.46 data 6c = = 54.63 410.10	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8 410.05 (8	72) 73) 76) 80) 83) 84)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal	65.70 ins (66)m - 383.77 383.77 43.82 ernal and sc 427.59 nal tempera	63.56 + (67)m + (6 380.07 (82)m 85.72 .lar (73)m + 465.78 ture (heating	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49 ng season)	54.47 m + (70)m + 342.99 actor 6d 7 x [7 x [7 x [205.87 548.87	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85	46.19 72)m 300.18 Sola W 258.28 558.46	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 245.89 534.33	47.70 295.14 spect or T 0.9 x (0 0.9 x (0 211.22 506.36	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18 472.27	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30	61.12 355.46 data 6c = [54.63 410.10	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8 410.05 (8	72) 73) 76) 80) 83) 84)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - international 7. Mean international Temperature du	65.70 ins (66)m - 383.77 383.77 43.82 ernal and sc 427.59 nal tempera uring heatin	63.56 + (67)m + (6 380.07 (82)m 85.72 -lar (73)m + 465.78 ture (heating periods in	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a	54.47 m + (70)m + 342.99 actor 6d 7 x 7 7 x 7 205.87 548.87	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1	46.19 72)m 300.18 Sola W 258.28 558.46 (°C)	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 245.89 534.33	47.70 295.14 speci or T 0.9 x (0 0.9 x (0 211.22 506.36	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18 472.27	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30	61.12 355.46 data 6c = = _ 54.63 410.10	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8 410.05 (8 410.05 (8	72) 73) 76) 80) 83) 84) 85)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - intern 7. Mean intern Temperature du	65.70 ains (66)m - 383.77 383.77 atts $\Sigma(74)m$ 43.82 ernal and sc 427.59 hal tempera uring heatin Jan	63.56 + (67)m + (6 380.07 (82)m 85.72 ar (73)m + 465.78 ture (heating periods in Feb	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar	54.47 m + (70)m + 342.99 actor 6d 7 x 7 7 x 7 7 x 7 205.87 548.87 area from T Apr	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May	46.19 72)m 300.18 Sola V 258.28 558.46 (°C) Jun	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 245.89 534.33	47.70 295.14 spect or T 0.9 x (0 0.9 x (0 211.22 506.36	 49.84 308.09 gific data able 6b 7.73 x 7.73 x 164.18 472.27 Sep 	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30	61.12 355.46 3355.46 3ata 6c = [] = [] = [] 54.63 410.10	64.06 (7 374.01 (7 Gains W 25.04 (7 18.78 (8 36.03 (8 410.05 (8 410.05 (8 21.00 (8 Dec	72) 73) 76) 80) 83) 84) 85)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internation 7. Mean internation Temperature du Utilisation facto	65.70 ains (66)m - 383.77 383.77 43.82 ernal and sc 427.59 al tempera uring heatin Jan r for gains f	63.56 + (67)m + (6 380.07 	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se	54.47 m + (70)m + 342.99 actor 6d 7 x 7 7 x 7 205.87 548.87 area from T Apr e Table 9a)	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May	46.19 72)m 300.18 Sola W 258.28 558.46 (°C) Jun	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 245.89 534.33	47.70 295.14 speci or T 0.9 x (0 0.9 x (0 211.22 506.36 Aug	49.84 308.09 ific data able 6b 0.73 x 0.73 x 164.18 472.27 Sep	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30	61.12 355.46 data 6c = [] = [] 54.63 410.10	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 Dec (8)	72) 73) 76) 80) 83) 84) 85)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internation 7. Mean internation Temperature du Utilisation facto	$\begin{array}{c} 65.70\\ \text{ains} (66) \text{m} \\ 383.77\\ \hline 383.77\\ \hline 383.77\\ \text{atts} \Sigma(74) \text{m}\\ 43.82\\ \text{ernal and sc}\\ 427.59\\ \hline \text{al tempera}\\ \text{uring heatin}\\ \text{Jan}\\ \text{r for gains f}\\ 0.99\\ \hline \end{array}$	63.56 ← (67)m + (6 380.07 380.07 (82)m 85.72 blar (73)m + 465.78 ture (heating g periods in Feb or living are 0.98	59.63 8)m + (69)n 365.33 Access f Table 0.77 0.77 0.77 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97	54.47 m + (70)m - 342.99 actor 6d 7 x 7 7 x 7 205.87 205.87 548.87 area from T Apr e Table 9a) 0.94	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May 0.87	46.19 72)m 300.18 Sola V 258.28 558.46 (°C) Jun 0.74	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 9.64 x 245.89 534.33 534.33	47.70 295.14 specior T 0.9 x (0 0.9 x (0 211.22 506.36 Aug 0.64	 49.84 308.09 308.09 gific data able 6b 7.73 x 7.73 x 164.18 472.27 Sep 0.84 	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 0ct 0.95	61.12 355.46 355.46 355.46 54.63 410.10 Nov 0.98	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8	72) 73) 76) 80) 83) 84) 85) 86)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal Temperature du Utilisation facto Mean internal to	$\begin{array}{c} 65.70\\ \text{ains} (66) \text{m} \\ 383.77\\ 383.77\\ 383.77\\ 43.82\\ \text{ernal and sc}\\ 427.59\\ \text{al temperal}\\ \text{aring heatin}\\ \text{Jan}\\ \text{r for gains f}\\ 0.99\\ \text{emp of livin} \end{array}$	63.56 + (67)m + (6 380.07 (82)m 85.72 lar (73)m + 465.78 ture (heating g periods in Feb or living area 0.98 g area T1 (s	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97 tteps 3 to 7	54.47 m + (70)m + 342.99 actor 6d 7 x 7 x 205.87 548.87 area from T Apr e Table 9a) 0.94 in Table 9c	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May 0.87)	46.19 72)m 300.18 Sola W 258.28 558.46 (°C) Jun 0.74	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 245.89 534.33 Jul 0.59	47.70 295.14 specior T 0.9 x (0 0.9 x (0 211.22 506.36 Aug 0.64	49.84 308.09 ific data able 6b 0.73 x 0.73 x 164.18 472.27 Sep 0.84	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 Oct 0.95	61.12 355.46 355.46 355.46 354.63 410.10 Nov 0.98	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8	72) 73) 76) 80) 83) 84) 85) 86)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal Utilisation facto Mean internal to	$\begin{array}{c} 65.70\\ \text{ains} (66) \text{m} \\ \hline 383.77\\ \hline 383.77\\ \hline 383.77\\ \hline 43.82\\ \text{ernal and sc}\\ \hline 427.59\\ \text{ral tempera}\\ \text{aring heatin}\\ \text{Jan}\\ \text{r for gains f}\\ \hline 0.99\\ \text{emp of livin}\\ \hline 19.33\\ \end{array}$	63.56 + (67)m + (6 380.07 380.07 	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97 teps 3 to 7 19.79	54.47 m + (70)m - 342.99 actor 6d 7 x 7 x 205.87 548.87 area from T Apr e Table 9a) 0.94 in Table 9c 20.20	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May 0.87) 20.57	46.19 72)m 300.18 Sola W 258.28 558.46 (°C) Jun 0.74 20.84	42.56 288.44 ar flux y/m ² 9.64 x 9.64 x 9.64 x 245.89 534.33 Jul 0.59 20.95	47.70 295.14 speci or T 0.9 x (1) 0.9 x (1) 211.22 506.36 Aug 0.64 20.93	 49.84 308.09 308.09 ific data able 6b 7.73 x 7.73 x 164.18 472.27 Sep 0.84 20.73 	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 Oct 0.95 20.25	61.12 355.46 355.46 355.46	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8 19.30 (8	72) 73) 76) 80) 83) 83) 84) 85) 86) 85)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal Utilisation facto Mean internal to Temperature du	$\begin{array}{c} 65.70\\ \text{ains} (66) \text{m} \\ 383.77\\ 383.77\\ 383.77\\ 43.82\\ \text{arnal and sc}\\ 427.59\\ \text{al temperal}\\ 127.59\\ \text{al temperal}\\ 12000\\ \text{arng heatin}\\ 19.33\\ \text{arng heatin}\\ 19.33\\ \text{arng heatin}\\ \end{array}$	63.56 ← (67)m + (6 380.07 380.07 (82)m 85.72 blar (73)m + 465.78 ture (heating g periods in Feb or living area 0.98 g area T1 (s 19.49 g periods in	59.63 (8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97 teps 3 to 7 19.79 the rest of	54.47 m + (70)m + 342.99 actor 6d 7 x 7 x 205.87 548.87 area from T Apr e Table 9a) 0.94 in Table 9c 20.20	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May 0.87) 20.57 rom Table 9	46.19 72)m 300.18 Sola W 258.28 558.46 (°C) Jun 0.74 20.84 0, Th2(°C)	42.56 288.44 ar flux 9.64 x 9.64 x 245.89 534.33 Jul 0.59 20.95	47.70 295.14 specior T 0.9 x (0) 0.9 x (0) 211.22 506.36 Aug 0.64 20.93	49.84 308.09 g ific data able 6b 0.73 x 0.73 x 164.18 472.27 Sep 0.84 20.73	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 0ct 0.95 20.25	61.12 355.46 355.46 355.46 354.63 410.10 Nov 0.98 19.72	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8 19.30 (8	72) 73) 76) 80) 83) 83) 84) 85) 86) 86)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal Utilisation facto Mean internal to Temperature du	$\begin{array}{c} 65.70\\ \text{ains} (66)m \\ 383.77\\ \hline 383.77\\ \hline 383.77\\ \hline 43.82\\ \text{ernal and sc}\\ \hline 427.59\\ \text{al temperal and sc}\\ \hline 427.59\\ \text{al temperal and sc}\\ \hline 19.75\\ \hline 19.33\\ \text{aring heatin}\\ \hline 19.52\\ \end{array}$	63.56 ← (67)m + (6 380.07 (82)m 85.72 → 465.78 ture (heating g periods in Feb or living area 0.98 g area T1 (s 19.49 g periods in 19.52	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97 theps 3 to 7 19.79 the rest of 19.53	54.47 m + (70)m + 342.99 actor 6d 7 x 7 x 205.87 548.87 area from T Apr e Table 9a) 0.94 in Table 9c 20.20 dwelling fr 19.54	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 able 9, Th1 May 0.87) 20.57 rom Table 9 19.54	46.19 72)m 300.18 Sola V 258.28 558.46 (°C) Jun 0.74 20.84 0, Th2(°C) 19.55	42.56 288.44 ar flux 9.64 x 9.64 x 9.64 x 245.89 534.33 Jul 0.59 20.95 19.55	47.70 295.14 speci or T: 0.9 x (0) 0.9 x (0) 211.22 506.36 Aug 0.64 20.93 19.55	 49.84 308.09 308.09 gific data able 6b 7.73 x 7.73 x 164.18 472.27 Sep 0.84 20.73 19.55 	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 Oct 0.95 20.25 19.54	61.12 355.46 data 6c = [] = [54.63 410.10 Nov 0.98 19.72 19.54	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8 19.30 (8 19.53 (8	72) 73) 76) 80) 83) 83) 84) 85) 86) 85) 886) 887)
Total internal ga 6. Solar gains East West Solar gains in wa Total gains - internal 7. Mean internal Utilisation facto Mean internal to Temperature du Utilisation facto	$\begin{array}{c} 65.70\\ \hline \\ \text{ains} & (66)m \\ \hline \\ 383.77\\ \hline \\ 43.82\\ \hline \\ 43.82\\ \hline \\ 427.59\\ \hline \\ \text{and scales}\\ \hline \\ 19.33\\ \hline \\ \text{and scales}\\ \hline \\ 19.33\\ \hline \\ \text{and scales}\\ \hline \\ 19.33\\ \hline \\ \text{and scales}\\ \hline \\ 19.52\\ \hline \\ \text{r for gains f} \end{array}$	63.56 ← (67)m + (6 380.07 380.07 (82)m 85.72 blar (73)m + 465.78 ture (heating g periods in Feb or living area 0.98 g area T1 (s 19.49 g periods in 19.52 or rest of do	59.63 8)m + (69)n 365.33 Access f Table 0.7 0.7 0.7 0.7 141.16 (83)m 506.49 ng season) the living a Mar ea n1,m (se 0.97 theps 3 to 7 19.79 the rest of 19.53 welling n2,1	54.47 m + (70)m - 342.99 actor 6d 7 x 7 x 205.87 548.87 area from T Apr e Table 9a) 0.94 in Table 9c 20.20 c dwelling fr 19.54 m	50.95 + (71)m + (7 320.55 Area m ² 3.60 2.70 252.31 572.85 572.85 able 9, Th1 May 0.87) 20.57 com Table 9	46.19 72)m 300.18 Sola V 258.28 558.46 (°C) Jun 0.74 20.84 0, Th2(°C) 19.55	42.56 288.44 ar flux //m ² 9.64 x 9.64 x 9.64 x 245.89 534.33 534.33 Jul 0.59 20.95 19.55	47.70 295.14 speci or T 0.9 x () 0.9 x () 211.22 506.36 Aug 0.64 20.93 19.55	 49.84 308.09 308.09 gific data able 6b 7.73 x 7.73 x 164.18 472.27 Sep 0.84 20.73 19.55 	55.17 330.59 FF specific c or Table 0.70 0.70 101.71 432.30 432.30 0.05 0.95 20.25 19.54	61.12 355.46 355.46 355.46	64.06 (7 374.01 (7 Gains (7 25.04 (7 18.78 (8 36.03 (8 410.05 (8 21.00 (8 0.99 (8 19.30 (8 19.53 (8	72) 73) 76) 80) 83) 83) 84) 85) 86) 85) 88)

	0.99	0.98	0.96	0.92	0.82	0.63	0.42	0.47	0.75	0.93	0.98	0.99	(89)
Mean internal t	emperature	in the rest	of dwelling	g T2 (follow	steps 3 to	7 in Table 9	e)						
	18.07	18.22	18.52	18.92	19.27	19.48	19.54	19.53	19.41	18.99	18.47	18.04	(90)
Living area fract	tion								Li	ving area ÷	(4) =	0.46	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	18.64	18.80	19.10	19.50	19.86	20.11	20.18	20.17	20.02	19.56	19.04	18.62	(92)
Apply adjustme	nt to the me	ean interna	l temperati	ure from Ta	ble 4e whe	ere appropr	iate						
	18.64	18.80	19.10	19.50	19.86	20.11	20.18	20.17	20.02	19.56	19.04	18.62	(93)
8. Space heati	ng requirem	ent											
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	or for gains,	nm							b	•••			
	0.98	0.98	0.96	0.92	0.83	0.67	0.50	0.55	0.78	0.93	0.97	0.99	(94)
Useful gains, nn	nGm, W (94	l)m x (84)m	0.00	0.01	0.00	0.07	0.00	0.00	0.70	0.55	0.07	0.00] (5.)
0 / 1	420.31	454.39	485.24	502.68	475.25	376.68	266.64	276.05	368.24	401.98	399.22	404.01	(95)
Monthly averag	ge external to	emperature	e from Tabl	e U1	1	1		<u> </u>	I		1	1	
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate fo	or mean inte	ernal tempe	erature, Lm	, W [(39)m	x [(93)m -	(96)m]							_
	1141.26	1103.89	998.65	833.07	640.26	428.37	278.91	293.30	461.71	703.07	939.63	1138.52	(97)
Space heating r	equirement,	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m							
	536.39	436.46	381.97	237.88	122.77	0.00	0.00	0.00	0.00	224.01	389.09	546.47]
									Σ(98	8)15, 10	12 =	2875.05	(98)
Space heating r	equirement	kWh/m²/yo	ear							(98)	÷ (4)	62.39	(99)
		ا میں امنیں امیں	heating av	stores in alu		CUD							
9a. Energy req	uirements -	individual	heating sys	stems inclu	iding micro	-CHP							
9a. Energy req Space heating	uirements -	individual	heating sys	stems inclu	iding micro	-CHP						0.00	(201)
9a. Energy req Space heating Fraction of space	uirements -	individual secondary	heating sys /supplements	stems inclu ntary system	iding micro m (table 11	-CHP .)				1 (2)	01) -	0.00] (201)] (202)
9a. Energy req Space heating Fraction of space Fraction of space	uirements - ce heat from ce heat from	secondary main syste	heating sys /supplementer em(s)	stems inclu ntary system	nding micro m (table 11	- CHP .)				1 - (20)1) =	0.00] (201)] (202)] (202)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of space	uirements - ce heat from ce heat from ce heat from L space heat	secondary main syste main syste	heating sys /supplement em(s) em 2 system 1	stems inclu	nding micro m (table 11	- CHP .)			(20	1 - (20)1) =	0.00 1.00 0.00) (201)) (202)) (202)) (202)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Eraction of tota	uirements - ce heat from ce heat from ce heat from I space heat I space heat	individual secondary main syste main syste from main from main	heating sys /supplementer em(s) em 2 system 1 system 2	stems inclu	ding micro m (table 11	- CHP)			(20	1 - (20)2) x [1- (20 (202) x (20	01) = 3)] = 33) =	0.00 1.00 0.00 1.00 0.00] (201)] (202)] (202)] (202)] (204)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	uirements - ce heat from ce heat from ce heat from I space heat I space heat	individual secondary main syste main syste from main from main (%)	heating sys /supplement em(s) em 2 system 1 system 2	stems inclu	ding micro	- CHP .)			(20	1 - (20 02) x [1- (20 (202) x (20	01) = 3)] = 03) =	0.00 1.00 0.00 1.00 0.00 95.80) (201)) (202)) (202)) (202)) (204)] (205)] (206)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	uirements - ce heat from ce heat from ce heat from I space heat I space heat in system 1 Jan	individual secondary main syste main syste from main from main (%) Feb	heating sys /supplemen em(s) em 2 system 1 system 2 Mar	stems inclu ntary system Apr	ding micro m (table 11 May) Jun	lut	Aug	(20 Sep	1 - (20 02) x [1- (20 (202) x (20 Oct	01) = 3)] = 03) = Nov	0.00 1.00 0.00 1.00 0.00 95.80 Dec] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating fr	uirements - ce heat from ce heat from ce heat from I space heat I space heat in system 1 Jan uel (main sy	individual secondary main syste main syste from main from main (%) Feb stem 1), kV	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month	stems inclu ntary system Apr	nding micro m (table 11 May) Jun	Jul	Aug	(20 Sep	1 - (20 02) x [1- (20 (202) x (20 Oct	01) = 3)] = 03) = Nov	0.00 1.00 0.00 1.00 0.00 95.80 Dec] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating fr	uirements - ce heat from ce heat from l space heat l space heat in system 1 Jan uel (main sy 559.90	individual secondary main syste main syste from main from main (%) Feb stem 1), kW 455.60	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	stems inclu ntary system Apr 248.31	May 128.15	-CHP .) Jun 0.00	Jul 0.00	Aug	(20 Sep 0.00	1 - (20 02) x [1- (20 (202) x (20 Oct 233.84	01) = 3)] = 03) = Nov 406.15	0.00 1.00 0.00 1.00 0.00 95.80 Dec 570.43] (201)] (202)] (202)] (204)] (205)] (206)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating fr	uirements - ce heat from ce heat from l space heat l space heat l space heat in system 1 Jan uel (main sy 559.90	individual secondary main syste from main from main (%) Feb stem 1), kW 455.60	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	Apr 248.31	May 128.15	-CHP .) Jun 0.00	Jul 0.00	Aug	(20 Sep 0.00 Σ(21:	1 - (20 02) × [1- (20 (202) × (20 Oct 233.84 1)15, 10	01) = 3)] = 03) = Nov 406.15 12 =	0.00 1.00 0.00 1.00 95.80 Dec 570.43 3001.09] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating	uirements - ce heat from ce heat from l space heat l space heat in system 1 Jan uel (main sy 559.90	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	Apr 248.31	May 128.15	-CHP .) Jun 0.00	Jul 00.0	Aug	(20 Sep 0.00 Σ(21:	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10	01) = 3)] = 03) = Nov 406.15 12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 570.43 3001.09] (201)] (202)] (202)] (204)] (205)] (206)]] (211)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa 	ter heater	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	Apr 248.31	May 128.15	-CHP) Jun 0.00	Jul	Aug	(20 Sep 0.00 Σ(21:	1 - (20)2) × [1- (20 (202) × (20 Oct 233.84 1)15, 10	01) = 3)] = 03) = Nov 406.15 12 =	0.00 1.00 0.00 95.80 Dec 570.43 3001.09] (201)] (202)] (202)] (204)] (205)] (206)] (211)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa	uirements - ce heat from ce heat from ce heat from I space heat I space heat in system 1 Jan uel (main sy 559.90 ter heater 93.52	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	Apr 248.31 92.35	May 128.15	-CHP) Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	(20 Sep 0.00 Σ(21: 86.50	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10	01) = 3)] = 03) = Nov 406.15 12 = 93.13	0.00 1.00 0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (217)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating Efficiency of water Water heating for 	uirements - ce heat from ce heat from ce heat from I space heat I space heat in system 1 Jan uel (main sy 559.90 ter heater 93.52 Fuel, kWh/m	individual secondary main syste from main from main (%) Feb stem 1), kW 455.60 93.40 onth	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72	Apr 248.31 92.35	May 128.15	-CHP) Jun 0.00 86.50	Jul 0.00 86.50	Aug 0.00 86.50	(20 Sep 0.00 Σ(21: 86.50	1 - (20 02) x [1- (20 (202) x (20 Oct 233.84 1)15, 10	01) = 3)] = 3)] = Nov 406.15 12 = 93.13	0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (217)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating Water heating for 	uirements - ce heat from ce heat from ce heat from I space heat I spac	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08	Apr 248.31 92.35	May 128.15 90.92	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) × [1- (20 (202) × (20 Oct 233.84 1)15, 10 92.12	01) = 3)] = 03) = Nov 406.15 12 = 93.13 152.08	0.00 1.00 0.00 1.00 95.80 Dec 570.43 3001.09 93.60 163.78] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (211)] (217)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating Water heating for 	uirements - ce heat from ce heat from ce heat from l space heat l space heat l space heat in system 1 Jan uel (main sy 559.90 ter heater 93.52 fuel, kWh/m 167.85	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82	heating sys /supplement em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08	Apr 248.31 92.35 137.02	May 128.15 90.92	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	01) = 3)] = 3)] = 03) = Nov 406.15 12 = 93.13 152.08 12 =	0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 163.78 1711.83] (201)] (202)] (202)] (204)] (205)] (206)] (206)] (211)] (211)] (217)] (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating Efficiency of water Water heating for Mater heating for Annual totals 	uirements - ce heat from ce heat from ce heat from I space heat I spac	individual secondary main syste from main from main (%) Feb stem 1), kW 455.60 93.40 onth 146.82	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08 153.28	Apr 248.31 92.35 137.02	May 128.15 90.92	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) × [1- (20 (202) × (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	01) = 3)] = 03) = Nov 406.15 12 = 93.13 152.08 12 =	0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 163.78 1711.83] (201)] (202)] (202)] (204)] (205)] (206)] (206)] (211)] (211)] (217)] (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating for Water heating for Annual totals Space heating for 	uirements - ce heat from ce heat from ce heat from I space heat I space heat in system 1 Jan uel (main sy 559.90 ter heater 93.52 cuel, kWh/m 167.85	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82	heating sys /supplement em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08	Apr 248.31 92.35 137.02	May 128.15 90.92	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	01) = 3)] = 03) = Nov 406.15 12 = 93.13 152.08 12 =	0.00 1.00 0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 163.78 1711.83] (201)] (202)] (202)] (204)] (205)] (206)] (206)] (211)] (211)] (217)] (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating for Annual totals Space heating for Water heating for 	uirements - ce heat from ce heat from ce heat from l space heat l space l space heat l space l space heat l space l space heat l space l space	individual secondary main syste from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82	heating sys /supplement em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08	Apr 248.31 92.35 137.02	May 128.15 90.92	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	D1) = 3)] = D3) = Nov 406.15 12 = 93.13 152.08 12 = 	0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 163.78 1711.83 3001.09] (201)] (202)] (202)] (204)] (205)] (206)] (210)] (211)] (217)] (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating for Annual totals Space heating for Water heating for Efficiency of mail Efficiency of mail Space heating for Mater heating for Space heating for	uirements - ce heat from ce heat from ce heat from I space heat I spac	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82 ystem 1	heating sys /supplemen em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08 153.28	Apr 248.31 92.35 137.02	May 90.92 134.76	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) × [1- (20 (202) × (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	01) = 3)] = 03) = Nov 406.15 12 = 93.13 152.08 12 = 	0.00 1.00 0.00 1.00 95.80 Dec 570.43 3001.09 163.78 1711.83 30001.09 1711.83] (201)] (202)] (202)] (204)] (205)] (206)] (210)] (211)] (217)] (219)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating for Annual totals Space heating for Water heating for Water heating for Efficiency for product of product of product of product of product of product of the product of	uirements - ce heat from ce heat from ce heat from I space heat I space heat I space heat in system 1 Jan uel (main sy 559.90 ter heater 93.52 fuel, kWh/m 167.85 uel - main sy fuel umps, fans a ing pump or	individual secondary main syste from main from main (%) Feb stem 1), kV 455.60 93.40 onth 146.82 ystem 1 nd electric	heating sys /supplement em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08 153.28	Apr 248.31 92.35 137.02 Table 4f) arm air hea	May May 128.15 90.92 134.76	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70 30.00	1 - (20)2) x [1- (20 (202) x (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	D1) = 3)] = D3) = Nov 406.15 12 = 93.13 152.08 12 = 12 = 	0.00 1.00 0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 163.78 1711.83 3001.09) (201) (202) (204) (205) (206)) (206)) (211)) (217)) (217)) (219)) (230c)
 9a. Energy req Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of mail Space heating for Water heating for Annual totals Space heating for Water heating for Uater heating for Electricity for procentral heat Total electricity 	uirements - ce heat from ce heat from ce heat from l space heat l space l	individual secondary main syste from main from main (%) Feb stem 1), kW 455.60 93.40 onth 146.82 /stem 1 nd electric water pum ve, kWh/ye	heating sys /supplement em(s) em 2 system 1 system 2 Mar Vh/month 398.72 93.08 153.28	Apr 248.31 92.35 137.02 Table 4f) arm air hea	May May 128.15 90.92 134.76	-CHP) Jun 0.00 86.50 124.75	Jul 0.00 86.50 119.52	Aug 0.00 86.50 133.23	(20 Sep 0.00 Σ(21: 86.50 134.70	1 - (20)2) × [1- (20 (202) × (20 Oct 233.84 1)15, 10 92.12 144.04 Σ(219a)1	01) = 3)] = 03) = Nov 406.15 12 = 93.13 152.08 12 = 	0.00 1.00 0.00 95.80 Dec 570.43 3001.09 93.60 1711.83 3001.09 1711.83 3001.09] (201)] (202)] (202)] (204)] (205)] (206)] (211)] (211)] (217)] (217)] (219)] (219)] (230c)] (231)

Total delivered energy for all uses

(232) (238)

Toa. Fuel costs - individual heating systems including	micro-CHP				
	Fuel kWh/year		Fuel price	Fuel cost £/year	
Space heating - main system 1	3001.09	x	3.48 x 0.02	1 = 104.44 (2	240)
Water heating	1711.83	x	3.48 x 0.0	1 = 59.57 (2	247)
Pumps and fans	30.00	x	13.19 x 0.0	1 = 3.96 (2	249)
Electricity for lighting	232.72	x	13.19 x 0.0	1 = 30.70 (2	250)
Additional standing charges				120.00 (2	251)
Total energy cost			(240)(242) + (245)(2	254) = 318.66 (2	255)
11a. SAP rating - individual heating systems including	micro-CHP				
Energy cost deflator (Table 12)				0.42 (2	256)
Energy cost factor (ECF)				1.47 (2	257)
SAP value				79.50	
SAP rating (section 13)				80 (2	258)
SAP band				С	
12a. CO ₂ emissions - individual heating systems includ	ding micro-CHP				
12a. CO2 emissions - individual heating systems inclue	ding micro-CHP Energy kWh/year		Emission factor kg CO ₂ /kWh	Emissions kg CO₂/year	
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1	ding micro-CHP Energy kWh/year 3001.09	x	Emission factor kg CO ₂ /kWh	Emissions kg CO ₂ /year 648.24 (2	261)
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating	ding micro-CHP Energy kWh/year 3001.09 1711.83	x x	Emission factor kg CO ₂ /kWh 0.216 0.216	Emissions kg CO ₂ /year 648.24 (2 369.76 (2	261) 264)
12a. CO₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating	ding micro-CHP Energy kWh/year 3001.09 1711.83	x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (26) +	Emissions kg CO₂/year 648.24 (2 369.76 (2 264) = 1017.99 (2	261) 264) 265)
12a. CO₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00	x x x	Emission factor kg CO_2/kWh 0.216 2 0.216 2 0.216 2 0.216 2 0.216 2 0.216 2 0.216 2 0.216 2 0.519	Emissions kg CO ₂ /year 648.24 (2 369.76 (2 264) = 1017.99 (2 15.57 (2	261) 264) 265) 267)
12a. CO₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x x	Emission factor kg CO ₂ /kWh 0.216 0.216 $(261) + (262) + (263) + (26) + (26) + (26) + (26) + (26) + (26) + (26) + (26) + (26) + (26) + (2$	Emissions kg CO2/year 648.24 (2) 369.76 (2) $264) =$ 1017.99 (2) 15.57 (2) 120.78 (2)	261) 264) 265) 267) 268)
12a. CO₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO₂, kg/year	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (26) +	Emissions kg CO2/year 648.24 (2) 369.76 (2) 264) = 1017.99 (2) 15.57 (2) 120.78 (2) 271) = 1154.34 (2)	261) 264) 265) 267) 268) 272)
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x	Emission factor kg CO ₂ /kWh 0.216 0.216 $(261) + (262) + (263) + $	Emissions kg CO2/year 648.24 (2) 369.76 (2) $264) =$ 1017.99 (2) 15.57 (2) 120.78 (2) $271) =$ 1154.34 (2) \div (4) = 25.05 (2)	261) 264) 265) 267) 268) 272) 273)
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x	Emission factor kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (26	Emissions kg CO2/year 648.24 (2) 369.76 (2) 264) = 1017.99 (2) 15.57 (2) 120.78 (2) 271) = 1154.34 (2) \div (4) = 25.05 (2) 83.02 (2)	261) 264) 265) 267) 268) 272) 273)
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x	Emission factor kg CO ₂ /kWh 0.216 0.216 $(261) + (262) + (263) + $	Emissions kg CO ₂ /year 648.24 (2 369.76 (2 264) = 1017.99 (2 15.57 (2 271) = 1154.34 (2 4 25.05 (2 83.02 83 (2	261) 264) 265) 267) 268) 272) 273) 273)
12a. CO ₂ emissions - individual heating systems inclue Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	ding micro-CHP Energy kWh/year 3001.09 1711.83 30.00 232.72	x x x x	Emission factor kg CO ₂ /kWh 0.216 0.216 $(261) + (262) + (263) + $	Emissions kg CO_2/year 648.24 (2 369.76 (2 264) = 1017.99 (2 15.57 (2 271) = 1154.34 (2 \div (4) = 25.05 (2 83.02 83 (2 B 83 (2	261) 264) 265) 267) 268) 272) 273) 273)

	Energy kWh/year		Primary factor		Primary Energy kWh/year	,
Space heating - main system 1	3001.09	x	1.22	=	3661.33	(261)
Water heating	1711.83	х	1.22	=	2088.44	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	5749.77	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	232.72	х	3.07	=	714.45	(268)
Primary energy kWh/year					6556.33	(272)
Dwelling primary energy rate kWh/m2/year					142.28	(273)