

Energy Strategy

Godwin and Crowndale Estate, NW1 1PA

Iceni Projects Limited on behalf of The London Borough of Camden

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CONTENTS

1.	EXECUTIVE SUMMARY	1
2.	INTRODUCTION	4
3.	PLANNING AND REGULATORY CONTEXT	7
4.	ENERGY ASSESSMENT	15
5.	SUMMARY AND CONCLUSIONS	27

APPENDICES

- A1. SITE PLAN
- A2. DER/TER WORKSHEETS
- A3. RENEWABLE ENERGY FEASIBILITY ASSESSMENT
- A4. DOMESTIC OVERHEATING ASSESSMENT
- A5. GENERAL NOTES

1. EXECUTIVE SUMMARY

- 1.1 Iceni Projects Ltd was commissioned by the London Borough of Camden to produce an Energy Strategy for the proposed development at the Godwin and Crowndale Estate.
- 1.2 This document details the carbon dioxide (CO₂) emissions reduction measures adopted by the proposed development and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme.
- 1.3 The objective of the proposals is to replace an underused MUGA and area of private car parking with 10 high-quality and sustainable family-sized dwellings along with associated public realm and landscaping improvements to the wider estate.
- 1.4 The proposed scheme is a pilot for the off-site manufacturing programme. If successful, it is anticipated that the methods, approaches and technical solutions developed for the pilot project will be applied to other development projects within Camden's community investment programme (CIP), forming an off-site manufacturing programme of works. Additionally, the approach could also be scaled up to assist with the development of other larger CIP schemes.
- 1.5 The energy strategy for the proposed development has been assessed using the Greater London Authority's (GLA) methodology set out in the London Plan and associated documents. This approach is consistent with that required by the London Borough of Camden Local Plan Policy CC1, and therefore represents best practice in meeting the required standards of energy efficiency and carbon dioxide (CO₂) emissions reduction.
- 1.6 The proposed energy strategy is based upon the principles of the Energy Hierarchy on the basis that it is preferable to reduce carbon dioxide emissions through reduced energy consumption above decarbonisation through alternative energy sources.
- 1.7 The key measures proposed to minimise carbon dioxide emissions from the proposed development are set out below.
- 1.8 The proposed 'Be Lean' measures include:
 - High levels of building fabric insulation to minimise heat loss
 - A balanced proportion of façade glazing to ensure natural daylight provision without increasing overheating risk
 - High levels of air tightness to reduce heat loss through infiltration

- The use of accredited construction details to minimise heat loss through thermal bridging
- Low energy LED lighting to minimise artificial lighting energy consumption
- Mechanical ventilation with heat recovery to provide fresh air, with heat recovered from extract air
- A high specification of heating controls to ensure operational efficiency
- 1.9 The 'Be Green' measures include:
 - Employment of highly efficient, air source heat pump (ASHP) systems
- 1.10 Incorporation of the measures outlined above will deliver savings of 11.14 tCO₂ per year for the proposed dwellings, which equates to a 54.8% improvement over the Part L 2013 baseline. The level of domestic emissions reduction achieved for each stage of the Energy Hierarchy is shown below.



Figure 1.1 Carbon dioxide emissions savings after each stage of the Energy Hierarchy

	Carbon dioxide emissions for domestic buildings (Tonnes CO₂ per annum)
Baseline: Part L 2013 of the Building Regulations Compliant Development	20.34
After energy demand reduction	16.45
After renewable energy	9.20

 Table 1.1
 Carbon dioxide emissions after each stage of the Energy Hierarchy

Table 1.2	Regulated	carbon	dioxide	savings	from	each	stage	of the	Energy	Hierarchy
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	Regulated domestic c	arbon dioxide savings
	(Tonnes CO₂ per annum)	(%)
Savings from energy demand reduction	3.89	19.1%
Savings from renewable energy	7.25	35.6%
Cumulative on-site savings	11.14	54.8%
Carbon shortfall	9.20	
	(Tonne	es CO ₂)
Cumulative savings for offset payment	27	76
Cash in-lieu contribution	£26,	224

1.11 Overall, the proposals are therefore in accordance with national, local and regional policy requirements, and will provide a development that seeks to promote these principles in operation.

2. INTRODUCTION

2.1 Iceni Projects Ltd was commissioned by the London Borough of Camden to produce an Energy Strategy for the proposed development at the Godwin and Crowndale Estate.

Report Objective

- 2.2 This document details the carbon dioxide (CO₂) emissions reduction measures adopted by the proposed development and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme. The Energy Strategy report headlines will provide a framework for the project team to operate consistently within sustainability guidelines set out by the Greater London Authority and the London Borough of Camden.
- 2.3 The report is structured to meet these guidelines as follows:
 - Section 3 discusses the planning context and policies which are relevant to energy;
 - Section 4 discusses the development response to the policy drivers for energy; and
 - Section 5 summarises the development's design response.

Site and Surroundings

- 2.4 The application site (Appendix A1) is situated on the Godwin and Crowndale Estate, to the northwest of Chalton Street, approximately 0.3 miles east of Mornington Crescent Underground Station.
- 2.5 The site currently comprises a car park and Multi-Use Games Area (MUGA) with the southern boundary of the Godwin and Crowndale Estate.
- 2.6 The site lies adjacent to the pedestrianised continuation of Chalton Street and close to the junction with Charrington Street. Part of the site is currently accessed through the existing open space of Godwin Court, whilst the existing enclosed car parking element of the site is accessed via the Crowndale Court access road.

The Proposed Development

2.7 The scheme proposes the redevelopment of the site to provide a total of 10 new residential dwellings to provide additional social rented units for the Godwin and Crowndale Estate. The single terrace of three storey dwellings each has four bedrooms.

- 2.8 The project is part of the Council's Community Investment Programme (CIP). The CIP is London Borough of Camden's 15-year plan (2010-2025) to invest money in schools, homes and community facilities. To help deliver the CIP vision, Camden are investigating procurement options for the provision of new housing to meet the housing need within the Borough. Initial studies have identified that modern methods of construction could offer substantial benefits to the Council in meeting this need. Off-site manufacturing in particular has been noted as providing a good fit to the Council's development drivers.
- 2.9 The proposed scheme is a pilot for the off-site manufacturing programme. If successful, it is anticipated that the methods, approaches and technical solutions developed for the pilot project will be applied to other development projects within the CIP, forming an off-site manufacturing programme of works. Additionally, the approach could also be scaled up to assist with the development of other larger CIP schemes.
- 2.10 The site was initially identified through a wider assessment of the estate and due it its location, urban context and restricted vehicular access, it was considered a good test for off-site manufacturing approaches to construction, delivering 10 family sized, social rent, car-free homes for the estate.
- 2.11 The objective of the proposals is to replace an underused MUGA and area of private car parking with 10 high-quality and sustainable family-sized dwellings along with associated public realm and landscaping improvements to the wider estate.
- 2.12 The images below show elevations of the scheme.









2.13 Overall, the proposals would provide the following floor areas and unit mix.

Residential Unit	Mix	Proposed GIA (m ²)
Unit 1	4 bed 6 persons	137
Unit 2	4 bed 6 persons	113
Unit 3	4 bed 6 persons	113
Unit 4	4 bed 6 persons	113
Unit 5	4 bed 6 persons	113
Unit 6	4 bed 6 persons	113
Unit 7	4 bed 6 persons	113
Unit 8	4 bed 6 persons	113
Unit 9	4 bed 6 persons	113
Unit 10	4 bed 6 persons	117
TOTAL		1,412

Table 2.1Development area and unit mix

3. PLANNING AND REGULATORY CONTEXT

3.1 Built environment energy efficiency and carbon dioxide emissions are incorporated within policy and regulation at a national, regional and local level, as set out below.

National

Climate Change Act 2008

- 3.2 On 26th November 2008, the UK Government published the Climate Change Act 2008; the world's first long-term legally binding framework to mitigate against climate change. Within this framework, the Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target set out in the Energy White Paper, to 80% by 2050.
- 3.3 As required under Section 34 of the Climate Change Act, the Fifth Annual Carbon Budget was accepted by the Government in June 2016. This sets out a budget for UK emissions for the period 2028 – 2032.

	Climate Change Act 2008	
	CHAPTER 27	
	CONTENTS	
	PART 1	
	CARBON TARGET AND BUDGETING	- 1
	The larget for 2050	- 1
123	The target for 2050 Amendment of 2050 target or baseline year Consultation on order amending 2050 target or baseline year	
	Carbon budgeting	- 1
4	Carbon budgets	- 1
6	Amendment of target percentages	- 1
7	Consultation on order setting or amending target percentages Setting of carbon budgets for budgetary periods	- 1
9 10	Consultation on carbon budgets Matters to be taken into account in connection with carbon budgets	- 1
	Limit on use of corbon write	- 1
11	Limit on use of carbon units	- 1
	Indiative annual ranges	- 1
12	Duty to provide indicative annual ranges for net UK carbon account	- 1
	Proposals and policies for meeting carbon budgets	- 1
13	Duty to prepare proposals and policies for meeting carbon budgets Duty to report on proposals and policies for meeting carbon budgets	- 1
15	Duty to have regard to need for UK domestic action on climate change	- 1
		- 8

3.4 Following a commitment in June 2019, the ClimateChange Act has been amended to target net zero carbon emissions by 2050.

National Planning Policy Framework

- 3.5 The Ministry of Housing, Communities & Local Government determines national policies on different aspects of planning and the rules that govern the operation of the system. Accordingly, the National Planning Policy Framework (NPPF), which came into force in March 2012 and was updated in February 2019, aims to strengthen local decision making.
- 3.6 Paragraphs 10 and 11 of the NPPF confirms that the heart of this document is a "*presumption in favour of sustainable development*", and that development proposals that accord with an up-to-date development plan should be approved without delay.



Building Regulations Part L

- 3.7 Part L of the Building Regulations relates to the conservation of fuel and power, and applies to both new and existing buildings. The current edition covers the energy efficiency requirements of the building regulations as set out in Part L of Schedule 1 to the Building Regulations. Technical guidance is contained in four Part L Approved Documents and two building services compliance guides.
- 3.8 The documents of relevance to this scheme include:
 - Approved Document L1A:2013. This provides the methodology for new build, domestic buildings to meet current energy efficiency standards, including backstop U-values, carbon dioxide emissions calculations and minimising the risk of overheating. Carbon dioxide emissions reductions are prescribed for 'regulated' emissions only, and relate to heating, hot water, lighting, auxiliary and cooling (where specified). Emissions from domestic appliances (cooking, for example) are considered to be unregulated emissions, and are excluded from the analysis.
 - Domestic Building Services Compliance
 Guide. This provides minimum building services efficiencies for domestic buildings.





Regional

3.9 Within Greater London, key sustainable development principles for economic, environmental and social improvement are set out below:

The London Plan (March 2016)

- 3.10 The London Plan is the overall strategic plan for London and includes policies for sustainable development and energy within Chapter 5 (London's response to climate change). Key policies of relevance to this scheme are as follows:
 - Policy 5.2 Minimisina Carbon Dioxide Emissions. This states that development proposals should make the fullest contribution to dioxide minimising carbon 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



- Policy 5.3 Sustainable Design and Construction. This states that development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.
- Policy 5.6 Decentralised Energy in Development Proposals. This states that 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;
- Policy 5.7 Renewable Energy. This states that major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

- Policy 5.9 Overheating and Cooling. This states that 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).

Sustainable Design and Construction Supplementary Planning Guidance (SPG) (April 2014)

3.11 This document provides guidance on the implementation of London Plan policy 5.3 'Sustainable Design and Construction' as well as a range of policies relating to environmental sustainability. The document contains best practice and priority targets for a wide range of issues related to sustainable design and construction, grouped into three categories: resource management, adapting to climate change and greening the city, and pollution management.



Energy Planning – GLA guidance on preparing energy assessments (October 2018)

- 3.12 The guidance note provides further detail on addressing the London Plan's energy hierarchy through the provision of an energy assessment to accompany planning applications. The document sets out the expected carbon dioxide emissions targets for the following building types:
 - New build residential buildings are expected to meet a zero-carbon target. This is made up of a minimum 35% reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100%, are to be offset through a cash in lieu contribution to the relevant borough to



be ring fenced to secure delivery of carbon dioxide savings elsewhere.

3.13 The latest "Energy Assessment Guidance" (October 2018) states that from January 2019 "planning applicants are encouraged to use the SAP 10 emission factors for applications when estimating CO₂ emission performance against London Plan policies".

Local

3.14 In determining the local context, the London Borough of Camden policy is gained through the Camden Local Plan, adopted in July 2017.

Camden Local Plan (adopted July 2017)

- 3.15 The Camden Local Plan is the key strategic document in Camden's development plan. It sets out the vision for shaping the future of the Borough and contains policies for guiding planning decisions. Policies of relevance to this project in the context of sustainability and energy are as follows:
 - Policy CC1 (Climate change mitigation) states that the Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. The Council will:



- Promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;
- Require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;
- Ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;
- o Support and encourage sensitive energy efficiency improvements to existing buildings;
- Require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and
- Expect all developments to optimise resource efficiency.

The Council will promote decentralised energy by:

- Working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;
- Protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and
- Requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.

- Policy CC2 (Adapting to Climate Change) states that the Council will promote and measure sustainable design and construction by:
 - Ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation; and
 - Encouraging new build residential development to use the Home Quality Mark and Passivhaus design standards.

Camden Planning Guidance: Energy Efficiency and Adaptation (March 2019)

3.16 This document supports the policies outlines in the Camden Local Plan 2017. This planning guidance document provides information on key energy and resource issues within Camden, and supports Local Plan Policies CC1 (Climate change mitigation) and CC2 (Adapting to climate change).

> London Borough of Camden Sustainability Statements in Planning Applications website (accessed April 2020)

3.17 This states that, from January 2020, the Council considers a carbon offset cost of £95 per tonne for 30 years to be appropriate. This would equate to £2,850 per tonne of residual carbon dioxide emitted by the development.



Declaration of a Climate Emergency (April 2019)

3.18 In April 2019, Camden Council declared a Climate Emergency, alongside a commitment to achieve a target of net zero emissions by 2030. In July 2019, Camden held the UK's first Citizens' Assembly on the climate crisis. The Assembly proposals will inform a new Climate Action Plan for Camden, which will be published in 2020.

Other Considerations

The Draft London Plan (December 2017 and updated July 2019)

- 3.19 Although not formally adopted, it is expected that the updated London Plan will be adopted in 2020. Given the relative weight attributed to this document, there are a number of key policies of relevance to this scheme, as follows:
 - Policy SI2 Minimising Greenhouse Gas Emissions. This policy extends the zero-carbon requirement to new non-domestic buildings. The policy adds a fourth layer to the energy hierarchy which requires development to monitor, verify and report on energy performance in operation. In addition, development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-



Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

- Policy SI3 Energy Infrastructure. This policy recognises that combined heat and power installations can have negative effects on London's air quality and shifts the focus of decentralised energy networks to the use of waste or secondary heat sources, where available. The policy also recognises that, compared to increasingly decarbonised electricity generation, gas-fired heat will become comparatively more carbon intensive as the electricity grid is further decarbonised.
- Policy SI4 Managing Heat Risk. This policy sets out the standards that should be used to assess and mitigate overheating risk in new developments. CIBSE TM59 should be used for domestic developments and CIBSE TM52 should be used for non-domestic developments. In addition, CIBSE TM49 guidance and datasets should also be used to ensure that all new development is designed for the climate it will experience over its design life.

4. ENERGY ASSESSMENT

- 4.1 The energy strategy for the proposed development has been assessed using the Greater London Authority's (GLA) methodology set out in the London Plan and associated documents. This approach is consistent with that required by the London Borough of Camden, and therefore represents best practice in meeting the required standards of energy efficiency and carbon dioxide (CO₂) emissions reduction.
- 4.2 In line with the GLA London Plan Policy 5.2 and Camden policy CC1, the scheme will aim to achieve a minimum 35% carbon dioxide emissions reduction through on-site means. In addition, the residual emissions will be offset to zero via cash in-lieu payment to the London Borough of Camden. The London Borough of Camden's suggested price of £95 per tonne over 30 years will be employed.
- 4.3 As outlined in Section 3, the October 2018 update to the GLA Guidance on Energy Assessments encourages the use of SAP 10 carbon emission factors from January 2019 onward. This is due to the significant progress in decarbonising the UK electricity grid since the previous update of Part L in April 2014. The SAP 10 carbon emission factors, which are used within this Energy Assessment, are as follows:
 - Natural Gas: 0.210 kgCO₂/kWh
 - Electricity: 0.233 kg/CO₂/kWh

Energy Strategy

- 4.4 With reference to the policy requirements, guidance and industry best practice detailed in Section 3, a comprehensive energy and carbon dioxide (CO₂) emissions assessment has been carried out for the proposed development. The energy performance of the scheme has been analysed and evaluated to target a high level of CO₂ emissions performance when assessed against Part L 2013 of the Building Regulations and associated policies, accounting for economic, technical and functional feasibility.
- 4.5 The proposed energy strategy is based upon the principles of the Energy Hierarchy on the basis that it is preferable to reduce carbon dioxide emissions through reduced energy consumption above decarbonisation through alternative energy sources.
- 4.6 The tiers of the Energy Hierarchy are:
 - Be Lean Use less energy
 - Be Clean Supply energy efficiently

Be Green Use renewable energy





'Be Lean' (Use Less Energy)

4.7 Within the first stage of the energy hierarchy, it is proposed to incorporate high levels of passive and energy efficient design measures in order to reduce the development's energy consumption and associated CO₂ emissions.



- 4.8 It is technically possible to exceed Building Regulations requirements (Part L 2013) through demand reduction measures alone and it is an expectation that new buildings are able achieve this as a means of demonstrating the extent to which passive design principles have been incorporated into the development, without reliance on renewable energy generation.
- 4.9 The proposed development includes a wide range of energy efficiency measures, intended to reduce energy demand.
- 4.10 The massing and orientation of the individual dwellings are constrained by the overall masterplan in terms of delivering the required density, preventing overlooking and ensuring daylight and sunlight provision. Despite this, passive design of the dwellings includes a number of specific energy efficiency features.
- 4.11 The following U-values are proposed as a means of limiting heat loss through the building fabric.

Building Fabric Element	Part L1A:2013 backstop U- values (W/m²K)	Proposed U-values (W/m²K)
Ground floor	0.25	0.12
External wall	0.30	0.15
Roofs	0.20	0.12
Windows	2.00 (including frame)	1.50 (including frame)
Doors	2.00 (including frame)	1.40 (including frame)

Table 4.1 Proposed building fabric U-values

- 4.12 The glazing will be double glazed, argon filled with a low emissivity coating. Although this has yet to be formally specified, it is expected that window U-values will be 1.5 W/m²K or better (including frame), with a g-value of 0.63 and light transmission of ~70% to improve natural daylight penetration.
- 4.13 A high level of air tightness is proposed, where a level equal to or below 3m³/h/m² shall be targeted, meaning that air infiltration between the internal and the external environment will be largely controlled, and space heating/cooling demand further reduced.
- 4.14 The other significant means of heat loss from dwellings is due to thermal (or cold) bridging. This is typically a construction detail which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer. Thermal bridges result in an overall reduction in thermal resistance of the building elements and should be designed out where possible to minimise unwanted heat loss. In order to minimise heat loss through thermal bridges, accredited construction details have been assumed, with an equivalent y-value of 0.05 for each dwelling.
- 4.15 High efficiency plant, equipment and controls are proposed to limit the energy consumed in order to provide the required level of indoor environmental performance and control. Performance efficiency values were tested and improved in energy models to benchmark the resulting predicted CO₂ reduction.
 - Low energy LED lighting will be installed throughout the dwellings.
 - In order to meet the requirements of the GLA's Energy Planning Guidance document under the 'Be Lean' scenario, space and water heating demand within the residential units is served by individual gas-fired boilers with an efficiency of 89%.

- Residential units are provided with opening windows to mitigate against overheating and to provide outside air during warmer months.
- In order to meet outside air supply requirements during other times of the year, a mechanical ventilation with heat recovery (MVHR) unit will be provided with a specific fan power of approximately 0.59 W/l/s and a heat exchange efficiency of 89%. A summer bypass will be included for use in warmer months.
- Energy usage for each dwelling will be separately metered to ensure that charging for energy is linked to usage.
- Heating will be controlled via the suitable arrangement of plumbing and electrical services.
- 4.16 Energy modelling of the proposed scheme has been undertaken using the Standard Assessment Procedure (SAP) for one of the proposed units, located in a mid-terrace. This was deemed to be an effective means of assessment, given the high level of similarity between the dwellings. Carbon dioxide emissions results from the test dwelling have then been extrapolated to match the total floor area proposed.
- 4.17 The carbon dioxide emissions for the residential component, under the 'Be Lean' tier of the Energy Hierarchy, and using the SAP 10 carbon emission factors, are shown below. DER and TER worksheets showing the 'Be Lean' performance of the sample dwelling modelled are provided in Appendix A2.



Figure 4.3 Domestic carbon dioxide emissions (Be Lean)

 Table 4.2
 Domestic carbon dioxide emissions (Be Lean)

TER: Baseline: Part L 2013 Emissions (Tonnes CO ₂ per annum)	DER: Proposed 'Be Lean' Emissions (Tonnes CO ₂ per annum)	Emissions Savings (Tonnes CO₂ per annum)	Emissions Savings (%)
20.34	16.45	3.89	19.1%

4.18 The above analysis shows that the proposed development achieves a carbon dioxide emissions saving of 19.1% through energy efficiency measures alone, under the 'Be Lean' scenario.

'Be Clean' (Supply Energy Efficiently)

4.19 The potential for the proposed development to incorporate a low carbon heating/cooling system has been reviewed for the scheme, in line with the hierarchy presented in London Plan policy 5.6, copied below.



- 1. Connection to existing heating or cooling networks;
- 2. Site wide CHP network; and
- 3. Communal heating and cooling;

- 4.20 The London Heat Map is a tool provided by the Mayor of London to identify opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study.
- 4.21 The image below is an extract from the London Heat Map, showing the area in the vicinity of the site. It illustrates;
 - Heat demand (areas of heat demand are shown in red, with areas with a high density of heat demand appearing more opaque and areas of zero heat demand appearing transparent);
 - Existing heat networks (shown as red lines); and
 - Proposed heat networks (shown as orange lines).

Figure 4.5 Extract from the London heat map



4.22 The extract above indicates that the proposed development site is located within an area of medium heat density. It is located approximately 400m from part of the proposed Euston Road district heat network.



- 4.23 An extract from the London Borough of Camden Borough Wide Heat Demand and Heat Source Mapping report is shown above. This indicates that there are potential sources of heat in the area, with an existing heat network in the vicinity.
- 4.24 However, given the relatively small scale of the development and connection costs, it is unlikely that connecting to nearby district heating schemes will be feasible. Approximate costs are likely to be in the region of £1,500 £2,000 per metre, giving a connection cost of £600,000 £800,000 for 400m of additional district heating infrastructure. There are also a number of utility constraints on the site, including a gas main and LV cable. Potential diversions are required for combined sewer, water and LV, subject to the adopted construction methodology, which would add to the technical complexity of connection to a district heat network.
- 4.25 The use of CHP is also considered to be unviable for the proposed site, based on the most up-todate GLA energy guidance, which looks to move away from the use of natural gas to meet space and water heating demands. It is therefore recommended that an air source heat pump (ASHP) system is employed to service the development. The incorporation of heat pump technology is discussed in greater detail in the 'Be Green' section.
- 4.26 'Be Clean' carbon dioxide emissions are therefore identical to those set out under the 'Be Lean' scenario.

'Be Green' (Utilise Renewable Technologies)

4.27 A full review of potentially applicable renewable technologies has been carried out, considering both the effectiveness and viability of the different technologies. Full details of the assessment and outcomes are provided in Appendix A3.



- 4.28 Given the site location, lack of viable existing or proposed heat networks, and the emergence of the draft SAP 10 carbon factors, it is proposed that air source heat pump (ASHP) technology is employed to serve the heating and hot water demands of the proposed scheme.
- 4.29 Highly efficient, individual air source heat pump (ASHP) systems will be employed to serve both the space and water heating demand. Typical manufacturer specifications for the proposed system quote a heating coefficient of performance of 4.35. Whilst the specified system operates quietly, as the design progresses, acoustic measures to further limit the noise generated by the outside unit of the system during operation will be considered.
- 4.30 Although the placement of rooftop PV panels would provide renewable electricity generation on-site, further reducing development carbon dioxide emissions, the orientation of the site and roofs means that only 50% of the roof space faces south-west. Roofs facing north-east will receive less solar gain. In addition, a significant portion of the site is overshadowed by a large tree to the south. Both of these factors would reduce the output of PV panels considerably, and it is therefore considered that rooftop PV is unsuitable for this development.



Figure 4.6 The site and surrounding tall trees

4.31 The domestic 'Be Green' energy analysis was carried out on the same dwellings as detailed above.

4.32 The carbon dioxide emissions for the residential component, under the 'Be Green' tier of the Energy Hierarchy, and using the SAP 10 carbon emission factors, are shown below. DER and TER worksheets showing the 'Be Green' performance of the sample dwelling modelled are provided in Appendix A2.





 Table 4.3
 Domestic carbon dioxide emissions (Be Green)

TER: Baseline: Part L 2013 Emissions (Tonnes CO ₂ per annum)	DER: Proposed 'Be Green' Emissions (Tonnes CO ₂ per annum)	Cumulative Emissions Savings (Tonnes CO ₂ per annum)	Cumulative Emissions Savings (%)
20.34	9.20	11.14	54.8%

4.33 The above analysis shows that the proposed development achieves a carbon dioxide emissions saving of 54.8% through energy efficiency measures and renewable technologies, under the 'Be Green' scenario.

Carbon Offsetting

- 4.34 As per the requirements of London Plan policy 5.2, new build residential buildings are expected to meet a zero-carbon target. Where the residential component of a development is unable to meet the zero-carbon target through on-site means alone, the remaining regulated carbon dioxide emissions, to 100%, are to be offset through a cash in lieu contribution to local authorities to be ringfenced to secure delivery of carbon dioxide savings elsewhere.
- 4.35 Based on the information presented in Table 4.7 above, a total of 276 tonnes of residual carbon dioxide are required to be offset from the residential component over a period of 30 years. Using the Council's proposed carbon dioxide price of £95 per tonne, the 276 tonnes therefore result in an offset cost of £26,224.





Cooling and Overheating

4.36 The design of both the residential and non-domestic elements has been developed in line with the GLA's recommended 'Cooling Hierarchy' approach, detailed in London Plan policy 5.9 and Camden Local Plan policy CC2. This applies a similar principle to the thorough decision-making process of the Energy Hierarchy, with the aim of reducing CO₂ emissions from cooling and minimising the risk of overheating where no cooling is present:

Minimisation of internal heat generation through energy efficient design

- Heat gain from lighting is kept to a minimum as a result of an energy-efficient lighting design solution.
- The availability of natural light is maximised by optimising the light transmittance of the glass elements of the façade.
- Heat gains from equipment will be minimised through the specification of low energy systems.
- Heat distribution pipework will be fully insulated to prevent unwanted heat loss.
- The scheme will use individual air source heat pumps, which is a low temperature distribution system, leading to lower internal heat gains from distribution pipework.

Reduction of the amount of heat entering the building in summer

- The building's façades have a limited amount of glazing to mitigate direct solar heat gain while optimising daylight penetration.
- The use of blinds will provide solar shading and glare protection to houses.

Management of the heat within the building through exposed thermal mass and high ceilings

- Generous floor to ceiling heights of 2.7m (ground and first floors) and up to 3.4m (second floor) will allow internal heat to rise and stratify above occupied areas.
- The habitable rooms are distributed across three storeys allowing heat to rise and exit the building due to the stack effect.

Passive ventilation

- Openable windows on multiple aspects will provide a passive ventilation strategy that utilises crossflow ventilation to maximise the potential for natural ventilation within the scheme.
- Trickle ventilation will be provided for ground floor spaces.

Mechanical and active cooling

• Cooling is not proposed.

- 4.37 An overheating assessment of a sample of the dwellings has been carried out using dynamic thermal modelling. This assessment has employed the guidance set out in CIBSE TM59 to reliably model overheating in residential properties. The overheating assessment made use of the Design Summer Years for London specified in CIBSE TM49 to predict overheating risk for three different weather scenarios.
 - DSY1. 1989: a moderately warm summer (current design year for London).
 - DSY2. 1976: a year with a prolonged period of sustained warmth.
 - DSY3. 2003: a year with a very intense single warm spell.
- 4.38 To account for the urban heat island effect in the locality of the development, weather data from the London Weather Centre has been employed as the basis for the analysis, as this location most closely matches Camden as an urban location.
- 4.39 The risk of overheating has been assessed using the guidance contained in CIBSE TM52, which details the limits of thermal comfort.
- 4.40 Full details of the overheating assessment are provided in Appendix A4, and a summary is given below.
- 4.41 All dwellings pass the TM59 overheating criteria for the DSY1 weather file. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.
- 4.42 If overheating was found to be an issue in the future for these dwellings, the following mitigation measures should be explored:
 - Retrofitted solar control film to minimise solar gain
 - Additional external shading to limit solar gain
 - Improved blinds to reduce solar gain
 - Increased MVHR flow rates for additional purge ventilation
 - Use of free-standing fans in extreme cases

5. SUMMARY AND CONCLUSIONS

- 5.1 This Energy Strategy provides an overview as to how the proposed development at Godwin and Crowndale Estate contributes to achieve CO₂ emissions reduction and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme.
- 5.2 Section 4 of this statement demonstrates that the siting and design of the proposals support relevant policy relating to energy guidelines set out by the Greater London Authority and the London Borough of Camden.
- 5.3 The energy assessment has shown that the proposed development will adopt the Mayor of London's 'Energy Hierarchy' and the proposed strategy shall achieve a 54.8% reduction in carbon dioxide emissions through on-site means alone.
- 5.4 The measures proposed at each level of the Energy Hierarchy are set out below.
- 5.5 The proposed 'Be Lean' measures include:
 - High levels of building fabric insulation to minimise heat loss
 - A balanced proportion of façade glazing to ensure natural daylight provision without increasing overheating risk
 - High levels of air tightness to reduce heat loss through infiltration
 - The use of accredited construction details to minimise heat loss through thermal bridging
 - Low energy LED lighting to minimise artificial lighting energy consumption
 - Mechanical ventilation with heat recovery to provide fresh air, with heat recovered from extract air
 - A high specification of heating controls to ensure operational efficiency
- 5.6 District and communal heat systems have not been deemed to be appropriate due to the relatively small scale of the development, estimated connection costs and utility constraints.
- 5.7 The 'Be Green' measures include:
 - Employment of highly efficient, individual air source heat pump (ASHP) systems.

5.8 The level of site-wide emissions reduction achieved for each stage of the Energy Hierarchy is shown below.



Figure 5.1 Site-wide regulated carbon dioxide emissions and savings

 Table 5.1
 Site-wide carbon dioxide emissions after each stage of the Energy Hierarchy

	Site-wide carbon dioxide emissions (Tonnes CO ₂ per annum)
Baseline: Part L 2013 of theBuildingRegulationsCompliant Development	20.34
After energy demand reduction	16.45
After renewable energy	9.20

	Regulated domestic carbon dioxide savings					
	(Tonnes CO₂ per annum)	(%)				
Savings from energy demand reduction	3.89	19.1%				
Savings from renewable energy	7.25	35.6%				
Cumulative on-site savings	11.14	54.8%				
Carbon shortfall	9.20					
	(Tonne	es CO ₂)				
Cumulative savings for offset payment	27	76				
Cash in-lieu contribution	£26,224					

Table 5.2Site-wide regulated carbon dioxide emissions after each stage of the EnergyHierarchy

- 5.9 The assessment concludes that the proposals have maximised all available opportunities for on-site regulated carbon emissions reduction. The proposed energy strategy achieves an on-site emissions reduction of 54.8%. 276 tonnes of CO₂ per annum of residential emissions from the development are proposed to be offset through a cash-in-lieu contribution.
- 5.10 Overall, the proposals for the scheme are in line with the policy requirements of the planning authority for energy statements and will provide a development that seeks to promote these principles in operation.

A1. SITE PLAN



A2. DER/TER WORKSHEETS

DER WorkSheet: New dwelling design stage

User Details:														
Assessor Name: Software Name:	Stroma FSAP 20	12		Stroma Number: Software Version: Versi					on: 1.0.4.25					
		Р	roperty.	Address	: House	1 (Boiler) S2A							
Address :														
1. Overall dwelling dimensi	ons:			()										
One word file an			Area	a(m²)		Av. Hei	ght(m)		Volume(m ³)	٦				
Ground floor			;	39.1	(1a) x	2	.7	(2a) =	105.57	(3a)				
First floor				43.3	(1b) x	2	.7	(2b) =	116.91	(3b)				
Second floor				31	(1c) x	3	.4	(2c) =	105.4	(3c)				
Total floor area TFA = (1a)+	(1b)+(1c)+(1d)+(1	e)+(1r	ו) 🛛 1	13.4	(4)									
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+	.(3n) =	327.88	(5)				
2. Ventilation rate:										-				
	main s heating	secondar heating	У	other		total			m ³ per hour					
Number of chimneys	0 +	0	+	0] = [0	x -	40 =	0	(6a)				
Number of open flues	0 +	0	 +	0	_ _ = _	0	x	20 =	0	(6b)				
Number of intermittent fans					- Ē	0	x	10 =	0	(7a)				
Number of passive vents					Ē	0	x	10 =	0	(7b)				
Number of flueless gas fires					Ī	0	X ·	40 =	0	(7c)				
										- 1r				
Air cha									יי ז ₍₈₎					
If a pressurisation test has been	carried out or is intend	led. procee	d to (17).	otherwise o	continue fr	om (9) to (16)	- (0) -	0					
Number of storeys in the o	dwelling (ns)	,					,		0	(9)				
Additional infiltration	0 ()						[(9)	-1]x0.1 =	0	(10)				
Structural infiltration: 0.25	for steel or timber	frame or	0.35 fo	r masoni	ry constr	ruction			0	(11)				
if both types of wall are prese	nt, use the value corre	sponding to	the great	ter wall are	a (after					-				
If suspended wooden floo	r, enter 0.2 (unsea	aled) or 0	.1 (seale	ed), else	enter 0				0	1 (12)				
If no draught lobby, enter	0.05, else enter 0	,	,	,,					0	(13)				
Percentage of windows ar	nd doors draught s	stripped							0	(14)				
Window infiltration	-			0.25 - [0.2	2 x (14) ÷ 1	= [00			0	(15)				
Infiltration rate				(8) + (10)	+ (11) + (1	12) + (13) +	· (15) =		0	(16)				
Air permeability value, q50), expressed in cu	bic metre	s per ho	our per s	quare m	etre of e	nvelope	area	3	(17)				
If based on air permeability	value, then (18) = [(17) ÷ 20]+(8	B), otherw	ise (18) = ((16)				0.15	(18)				
Air permeability value applies if a	a pressurisation test ha	as been dor	ne or a deg	gree air pe	rmeability	is being us	ed			_				
Number of sides sheltered									2	(19)				
Shelter factor				(20) = 1 -	[0.075 x (1	[9)] =			0.85	(20)				
Infiltration rate incorporating	shelter factor	_		(21) = (18) x (20) =				0.13	(21)				
Infiltration rate modified for r	nonthly wind spee	d T.	i	<u>.</u>	_			<u> </u>	1					
Jan Feb Ma	ir Apr May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	J					
Monthly average wind speed	from Table 7								1					
(22)m= 5.1 5 4.9	4.4 4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	J					
Wind F	actor (2	22a)m =	(22)m ÷	4										
-----------------------	----------------------	------------------------	----------------------	----------------------	-----------------------	-------------------------	----------------------	----------------------	-----------------	----------------	-------------	-----------	------------------	-----------
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18]	
Adjust	ed infiltr	ation rat	e (allow	ing for sl	nelter an	d wind s	peed) =	(21a) x	(22a)m	-			-	
	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15]	
Calcul	ate effe	<i>ctive air</i>	change	rate for t	he appli	cable ca	se	-	-	-	-	-		(220)
lf exh	aust air h	eat pump	using App	endix N. (2	3b) = (23a	a) x Fmv (e	equation (I	N5)), othe	rwise (23ł	(23a) = (23a)			0.5	(238)
If bala	anced wit	h heat rec	overy: effic	viency in %	allowing f	or in-use f	actor (fron	n Table 4h) =	., ()			75.65	(230)
a) If	balance	ed mech	, anical ve	entilation	with he	at recove	∙rv (MVI	HR) (24;	′ a)m = (2	2b)m + (23b) x [*	1 – (23c)	$1001 \div 1001$	(200)
(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27]	(24a)
b) If	balance	ed mech	anical ve	entilation	without	heat rec	ı overy (N	u MV) (24t	m = (2)	1 2b)m + (j	23b)		1	
, (24b)m=	0	0	0	0	0	0	0	0	0	0	0	0]	(24b)
c) If	whole h	iouse ex	tract ver	ntilation of	or positiv	ve input v	ventilatio	n from o	outside	1	1		1	
i	if (22b)r	n < 0.5 >	< (23b), 1	then (24	c) = (23b	o); otherv	wise (24	c) = (22l	o) m + 0	.5 × (23b	o)			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural if (22b)r	ventilati n = 1, th	on or wh en (24d)	ole hous m = (221	e positiv c)m othe	ve input v erwise (2	ventilatio 4d)m =	on from 0.5 + [(2	loft 2b)m² x	0.5]				
(24d) <mark>m=</mark>	0	0	0	0	0	0	0	0	0	0	0	0		(24d)
Effe	ctive air	change	rate - er	nter (24a) or (24t	o) or (24	c) or (24	d) in bo	(25)				,	
(25)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27		(25)
3 He	at losse	s and he	eat loss	naramet	ar.									
ELEN	/IENT	Gro	SS	Openin	gs	Net Ar	ea	U-val	ue	AXU		k-value	9	AXk
Doors		area	(1112)	II	ا ۲	A ,r				(V V /	N)	KJ/M2•I	n	KJ/K (26)
Windo		- 1				3.30		/[1/(1 5)+	- 0.041 -	4.720	4			(20)
Windo	ws Type	2 2				0.9		/[1/(1.5)+	0.041 _	1.27	\exists			(27)
Windo	ws Type	22				1.0		/[1/(1.5)+	0.041 _	2.12	\exists			(27)
Windo	ws Type	2 4				2.20		/[1/(1.5)+	0.041 -	5.23	\exists			(27)
Windo	ws Type	e 5				3.7	^	/[1/(1.5)+	0.04] =	5 24	\exists			(27)
Windo	ws Type	e 6				3.2	x1	- /[1/(1.5)+	0.04] =	4.53	=			(27)
Floor 7	Type 1					39.1	×	0.12		4.692	= r			(28)
Floor 7	Гуре 2					4.2	×	0.12	=	0.503999	99		\dashv	(28)
Walls		97.0	05	22.8	5	74.2	x	0.15	=	11.13	i F		\dashv	(29)
Roof		43.	3	0		43.3	×	0.12	=	5.2	i F		\dashv	(30)
Total a	area of e	elements	s, m²			183.6	5	•			L			(31)
* for win	dows and	l roof wind	lows, use e	effective wi	ndow U-va	alue calcul	ated using	g formula 1	/[(1/U-vali	ue)+0.04] a	as given in	paragraph	n 3.2	

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

Fabric heat loss, $W/K = S (A \times U)$	(26)(30) + (32) =	53.81	(33)
Heat capacity $Cm = S(A \times k)$	((28)(30) + (32) + (32a)(32e) =	5442.45	(34)
Thermal mass parameter (TMP = $Cm \div TFA$) in kJ/m ² K	Indicative Value: Medium	250	(35)
For design assessments where the details of the construction are not known	precisely the indicative values of TMP in Table 1f		-

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

can be ι	used inste	ad of a de	tailed calc	ulation.											
Therm	al bridg	es : S (L	x Y) cal	culated u	using Ap	pendix l	K						9.28	(36)	
if details	of therma	al bridging	are not kn	own (36) =	= 0.05 x (3	1)								_	
Total f	abric he	at loss							(33) +	(36) =			63.09	(37)	
Ventila	ation hea	at loss ca	alculated	monthl	/				(38)m	= 0.33 × (25)m x (5)				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
(38)m=	30.76	30.42	30.07	28.35	28	26.28	26.28	25.93	26.97	28	28.69	29.38		(38)	
Heat ti	ransfer o	coefficie	nt, W/K						(39)m	= (37) + (3	38)m				
(39)m=	93.86	93.51	93.17	91.44	91.1	89.37	89.37	89.03	90.06	91.1	91.79	92.48			
Hoat k		motor (l		/m2k			•	-	(40)m	Average =	Sum(39) _{1.}	12 /12=	91.35	(39)	
(40)m-	0.83			0.81	0.8	0.79	0.79	0.79	0.79	- (00)m .	0.81	0.82]		
(40)11-	0.00	0.02	0.02	0.01	0.0	0.75	0.75	0.75	0.15	Average -	Sum(40),	0.02 m/12-	0.81	(40)	
Numbe	er of day	/s in mo	nth (Tab	le 1a)			-	-	,		Guin(40)1	12712-	0.01		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)	
4. Wa	4. Water heating energy requirement: kWh/year:														
													1		
Assumed occupancy, N 2.83 (42) if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)															
if TF	if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9) if TFA £ 13.9, N = 1														
Ann <mark>ua</mark>	if TFA \pounds 13.9, N = 1 Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 101.5 (43)														
Reduce	the annua	al average litres per	hot water	usage by : day (all w	5% if the a	welling is	designed : Id)	to achieve	a water us	se target o	f				
notmon						iot und oo						_	1		
Hot wat	Jan	heb	Mar day for e	Apr	May Vd m – fa	Jun	Jul Table 1c x	Aug	Sep	Oct	Nov	Dec			
(14)		1 407 50	400.50		05.44				00.47	400.50	407.50	444.05			
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65	1010.00		
Energy	content of	hot water	used - cal	culated mo	onthly $= 4$.	190 x Vd,r	m x nm x D)))))))))))))))))))) kWh/mor	nth (see Ta	m(44) ₁₁₂ = ables 1b, 1	= c, 1d)	1218.02	(44)	
(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35			
									-	Total = Su	m(45) ₁₁₂ =	-	1597.02	(45)	
lf instan	taneous v	/ater heati	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46,) to (61)		-				
(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05		(46)	
Storage	storage	IOSS:	includir		alar ar M		ctorago	within or		col		•	1	(47)	
Sillay				iy ariy su		ntor 110	Sillaye	(47)		501		0		(47)	
Otherv	nunity r vise if n	stored	hot wate	nk in aw r (this in	ielling, e Indudes i	nter 110 nstantar		(47) mbi boil	ers) ente	r '0' in <i>(</i>	(47)				
Water	storage	loss:	not wate			notantai				51 0 111	,				
a) If m	nanufac	urer's de	eclared I	oss facto	or is kno	wn (kWł	n/day):					0		(48)	
Tempe	erature f	actor fro	m Table	2b								0		(49)	
Energy	y lost fro	m water	· storage	, kWh/ye	ear			(48) x (49)	=			0		(50)	
b) If m	nanufac	urer's de	eclared of	cylinder l	oss fact	or is not	known:						1		
Hot wa	ater stor	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ay)					0		(51)	
It com	munity h	from T-	ee secti	on 4.3									1		
Tempe	e lacior araturo f	actor fro	ule 28 m Tahla	2h								0		(52)	
, surbe												0]	(00)	

Energy Enter	y lost fro (50) or	om water (54) in (5	storage	e, kWh/ye	ear			(47) x (51)) x (52) x (53) =		0]	(54)
Water	storage	loss cal	culated	for each	month			((56)m = (55) × (41)ı	m		0]	(00)
(56)m-			0		0	0	0			0	0	0	1	(56)
If cylinde	er contain	s dedicate	d solar sto	prage, (57)	m = (56)m	x [(50) – (H11)] ÷ (50	0), else (5	7)m = (56)	m where (H11) is fro	m Append	l lix H	(00)
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primar	v circuit	: loss (ar	nual) fro	om Table	9 3	•						0	j	(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(mo	dified by	factor f	rom Tab	le H5 if t	here is s	solar wat	er heatir	ng and a	cylinde	r thermo	stat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
Combi	i loss ca	lculated	for each	month ((61)m =	(60) ÷ 36	65 × (41))m						
(61)m=	50.96	46.03	50.96	49.05	48.62	45.05	46.55	48.62	49.05	50.96	49.32	50.96		(61)
Total h	neat req	uired for	water h	eating ca	alculated	for eac	h month	(62)m =	0.85 × ((45)m +	(46)m +	(57)m +	(59)m + (61)r	n
(62)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31		(62)
Solar DI	HW input	calculated	using App	endix G or	Appendix	KH (negati	ve quantity	/) (enter '0	' if no sola	r contribut	ion to wate	er heating)	-	
(add a	dditiona	l lines if	FGHRS	and/or \	NWHRS	applies	, see Ap	pendix (G)			•		
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Outpu	t from w	ater hea	ter											
(64)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31		_
	Output from water heater (annual) ₁₁₂ 2183.15 (64)													
Heat g	jains fro	m water	heating.	, kWh/m	onth 0.2	5 ´ [0.85	× (45)m	+ (61)m	n] + 0.8 x	(<mark>46)m</mark>	+ (57)m	<mark>+ (</mark> 59)m]	
(65)m=	67.79	59.66	62.43	55.58	53.72	47.13	44.87	50.29	50.86	57.72	61.43	66.06		(65)
inclu	ude (57)	m in calo	culation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	ate <mark>r is f</mark> r	om com	munity h	neating	
5. In	ternal ga	ains (see	e Table 5	5 and 5a):									
Metab	olic gair	is (Table	e 5), Wat	ts		i		r				i	, <u> </u>	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69		(66)
Lightin	ig gains	(calcula	ted in Ap	opendix	L, equat	ion L9 o	r L9a), a	lso see	Table 5			. <u></u>	1	
(67)m=	24.63	21.88	17.79	13.47	10.07	8.5	9.19	11.94	16.03	20.35	23.75	25.32		(67)
Applia	nces ga	ins (calc	ulated ir	n Append	dix L, eq	uation L	13 or L1	3a), also	see Ta	ble 5			1	
(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16		(68)
Cookir	ng gains	(calcula	ted in A	ppendix	L, equat	tion L15	or L15a)	, also se	e Table	5			1	
(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17		(69)
Pumps	s and fa	ns gains	(Table \$	5a)	i	i		r			i	.	1	
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10		(70)
Losse	s e.g. e\	aporatic	on (nega	tive valu	es) (Tab	ole 5)								
(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35		(71)
Water	heating	gains (T	able 5)											
(72)m=	91.12	88.78	83.91	77.2	72.2	65.46	60.32	67.6	70.64	77.58	85.31	88.79]	(72)
Total i	internal	gains =	:			(66)	m + (67)m	1 + (68)m +	+ (69)m + ((70)m + (7	1)m + (72))m	1	
(73)m=	467.61	465.38	449.2	422.78	394.97	368.4	351.75	358.92	373.27	399.92	430.48	453.77		(73)
6. So	lar gain	S:												

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

Orientation:	Access Factor Table 6d	-	Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.77	x	0.9	x	36.79	x	0.63	x	0.8] =	11.57	(77)
Southeast 0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.8	i =	19.28	(77)
Southeast 0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.8	=	29.3	(77)
Southeast 0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.8	=	53.97	– (77)
Southeast 0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.8] =	19.7	(77)
Southeast 0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.8] =	32.84	(77)
Southeast 0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.8] =	49.91	(77)
Southeast 0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.8] =	91.94	(77)
Southeast 0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.8	=	26.96	(77)
Southeast 0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.8] =	44.93	(77)
Southeast 0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.8] =	68.29	(77)
Southeast 0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.8] =	125.79	(77)
Southeast 0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.8	=	33.4	(77)
Southeast 0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.8	=	55.67	(77)
Southeast 0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.8] =	84.61	– (77)
Southeast 0.9x	0.77	x	4.2	x	106.25	х	0.63	х	0.8	=	155.87	(77)
Southeast 0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.8	j -	37.41	(77)
Southeast 0.9x	0.77	x	1.5	x	119.01	×	0.63	x	0.8] =	62.35	– (77)
Southeast 0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.8	j =	94.77	– (77)
Southeast 0.9x	0.77	x	4.2	x	119.01	x	0.63	x	0.8	=	174.58	(77)
Southeast 0.9x	0.77	x	0.9	x	118.15	x	0.63	x	0.8] =	37.14	– (77)
Southeast 0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.8	=	61.9	(77)
Southeast 0.9x	0.77	x	2.28	×	118.15	x	0.63	x	0.8] =	94.09	(77)
Southeast 0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.8] =	173.32	(77)
Southeast 0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.8] =	35.81	(77)
Southeast 0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.8] =	59.68	(77)
Southeast 0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.8	=	90.71	(77)
Southeast 0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.8	=	167.1	(77)
Southeast 0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.8	=	32.81	(77)
Southeast 0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.8	=	54.69	(77)
Southeast 0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.8	=	83.13	(77)
Southeast 0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.8	=	153.13	(77)
Southeast 0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.8	=	29.19	(77)
Southeast 0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.8	=	48.65	(77)
Southeast 0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.8] =	73.94	(77)
Southeast 0.9x	0.77	x	4.2	×	92.85	x	0.63	x	0.8] =	136.21	(77)
Southeast 0.9x	0.77	x	0.9	×	69.27	x	0.63	x	0.8	=	21.77	(77)
Southeast 0.9x	0.77	x	1.5	×	69.27	x	0.63	x	0.8] =	36.29	(77)
Southeast 0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.8] =	55.16	(77)

Southeast 0.9x 0.77 × 4.2 × 69.27 × 0.63 × 0.8 = 101.61 (77) Southeast 0.9x 0.77 × 1.5 × 44.07 × 0.63 × 0.8 = 23.09 (77) Southeast 0.9x 0.77 × 1.5 × 44.07 × 0.63 × 0.8 = 23.09 (77) Southeast 0.9x 0.77 × 1.5 × 44.07 × 0.63 × 0.8 = 23.09 (77) Southeast 0.9x 0.77 × 1.5 × 44.07 × 0.63 × 0.8 = 9.9 (77) Southeast 0.9x 0.77 × 1.5 × 31.49 × 0.63 × 0.8 = 16.5 (77) Southeast 0.9x 0.77 × 1.5 × 31.49 × 0.63 × 0.8 = 25.08 (77) Southeast 0.9x 0.77 × 1.5 × 31.49 × 0.63 × 0.8 = 25.08 (77) Southeast 0.9x 0.77 × 1.5 × 22.8 × 31.49 × 0.63 × 0.8 = 25.08 (77) Southeast 0.9x 0.77 × 1.5 × 2.28 × 31.49 × 0.63 × 0.8 = 25.08 (77) Southeast 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (77) Southeast 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (77) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (77) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (77) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (77) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (71) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (71) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (71) Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 25.08 (71) Northwest 0.9x 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 172.61 (61) Northwest 0.9x 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 172.61 (61) Northwest 0.9x 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 175.84 (71) Northwest 0.9x 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 175.84 (71) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 175.86 (71) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 102.09 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 105.3 (71) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 105.3 (71) Northwest 0.9x 0.77 × 3.2 × 50.42 × 0.63 × 0.8 = 105.3 (71) Northwest													
Southeast 0.9x 0.77 x 0.9 x 44.07 x 0.63 x 0.8 = 13.86 (7) Southeast 0.9x 0.77 x 1.5 x 44.07 x 0.63 x 0.8 = 23.09 (7) Southeast 0.9x 0.77 x 2.28 x 44.07 x 0.63 x 0.8 = 35.1 (7) Southeast 0.9x 0.77 x 2.28 x 44.07 x 0.63 x 0.8 = 0.9 (7) Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 0.9 (7) Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 0.9 (7) Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 25.08 (7) Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 25.08 (7) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 25.08 (7) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 25.08 (7) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 25.08 (7) Northwest 0.9x 0.77 x 3.2 x 11.28 x 0.63 x 0.8 = 25.08 (7) Northwest 0.9x 0.77 x 3.2 x 11.28 x 0.63 x 0.8 = 22.16 (9) Northwest 0.9x 0.77 x 3.2 x 11.28 x 0.63 x 0.8 = 25.08 (9) Northwest 0.9x 0.77 x 3.2 x 22.97 x 0.63 x 0.8 = 25.68 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 25.68 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 25.67 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 25.67 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 25.67 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 75.68 (8) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 75.68 (8) Northwest 0.9x 0.77 x 3.2 x 67.66 x 0.63 x 0.8 = 75.68 (8) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 75.68 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 236.7 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 31.37 (9) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 31.37 (9) Northwest 0.9x 0.77 x 3.2 x 92.0 x 0.63 x 0.8 = 31.37 (9) Northwes	Southeast 0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.8	=	101.61	(77)
Southeast 0.9x 0.77 X 1.5 X 44.07 X 0.63 X 0.8 = 23.09 (77) Southeast 0.9x 0.77 X 2.28 X 44.07 X 0.63 X 0.8 = 64.65 (77) Southeast 0.9x 0.77 X 0.9 X 31.49 X 0.63 X 0.8 = 64.65 (77) Southeast 0.9x 0.77 X 1.5 X 31.49 X 0.63 X 0.8 = 64.65 (77) Southeast 0.9x 0.77 X 2.28 X 31.49 X 0.63 X 0.8 = 25.08 (77) Northwest 0.9x 0.77 X 3.7 X 11.28 X 0.63 X 0.8 = 62.16 (81) Northwest 0.9x 0.77 X 3.7 X 2.297 X 0.63 X 0.8 = 62.56 (81) Northwest 0.9x 0.77 X 3.2 X 41.38	Southeast 0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.8	= [13.85	(77)
Southeast 0.9x 0.77 X 2.28 X 44.07 X 0.63 X 0.8 = 36.1 (77) Southeast 0.9x 0.77 X 4.2 X 44.07 X 0.63 X 0.8 = 9.9 (77) Southeast 0.9x 0.77 X 1.5 X 31.49 X 0.63 X 0.8 = 9.9 (77) Southeast 0.9x 0.77 X 2.28 X 31.49 X 0.63 X 0.8 = 46.19 (77) Southeast 0.9x 0.77 X 3.2 X 11.28 X 0.63 X 0.8 = 46.19 (77) Northwest 0.9x 0.77 X 3.2 X 11.28 X 0.63 X 0.8 = 65.9 6.81 (81) Northwest 0.9x 0.77 X 3.2 X 2.297 X 0.63 X 0.8 = 65.9 6.81 (81) Northwest 0.9x 0.77 X 3.7 X 41.38 X	Southeast 0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.8	=	23.09	(77)
Southeast 0.9x 0.77 x 4.2 x 44.07 x 0.63 x 0.8 = 64.65 (77) Southeast 0.9x 0.77 x 0.9 x 31.49 x 0.63 x 0.8 = 9.9 (77) Southeast 0.9x 0.77 x 1.5 x 31.49 x 0.63 x 0.8 = 16.5 (77) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 20.16 (81) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 29.16 (81) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 25.67 (81) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 25.67 (81) Northwest 0.9x 0.77 x 3.2 x <	Southeast 0.9x	0.77	x	2.28	x	44.07	x	0.63	x	0.8	=	35.1	(77)
Southeast 0.9x 0.77 x 0.9 x 31.49 x 0.63 x 0.8 = 9.9 (77) Southeast 0.9x 0.77 x 1.5 x 31.49 x 0.63 x 0.8 = 16.5 (77) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 16.5 (77) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 25.08 (77) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 12.61 (81) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 105.95 (81) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 175.64 (81) Northwest 0.9x 0.77 x 3.2 91.35	Southeast 0.9x	0.77	x	4.2	x	44.07	×	0.63	x	0.8	= [64.65	(77)
Southeast 0.9x 0.77 x 1.5 x 31.49 x 0.63 x 0.8 = 16.5 (77) Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 25.08 (77) Northwest 0.9x 0.77 x 3.2 x 11.28 x 0.63 x 0.8 = 24.619 (77) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 12.61 611 Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 25.67 611 Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 12.61 611 Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 175.64 611 Northwest 0.9x 0.77 x 3.7 97.38	Southeast 0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.8	= [9.9	(77)
Southeast 0.9x 0.77 x 2.28 x 31.49 x 0.63 x 0.8 = 25.08 (77) Southeast 0.9x 0.77 x 4.2 x 31.49 x 0.63 x 0.8 = 25.08 (77) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 29.16 (61) Northwest 0.9x 0.77 x 3.7 x 11.28 x 0.63 x 0.8 = 12.61 (61) Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 59.36 (61) Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 59.36 (61) Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 25.67 (61) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 106.95 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 40.063 (61) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 91.35 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 40.20 (61) Northwest 0.9x 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 40.25 (61) Northwest 0.9x 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 40.26 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 40.26 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.32 (61) Northwest 0.9x 0.77 x 3.7 x 42.807 x 0.63 x 0.8 = 40.3 (61) Northwest 0.9x 0.77 x	Southeast 0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.8	= [16.5	(77)
Southeas $0.9x$ 0.77 × 4.2 × 31.49 × 0.63 × 0.8 = 46.19 (77) Northwes $0.9x$ 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 29.16 (61) Northwes $0.9x$ 0.77 × 3.2 × 11.28 × 0.63 × 0.8 = 12.61 (61) Northwes $0.9x$ 0.77 × 3.7 × 22.97 × 0.63 × 0.8 = 59.36 (61) Northwes $0.9x$ 0.77 × 3.2 × 22.97 × 0.63 × 0.8 = 59.36 (61) Northwes $0.9x$ 0.77 × 3.2 × 22.97 × 0.63 × 0.8 = 25.67 (61) Northwes $0.9x$ 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 106.95 (61) Northwes $0.9x$ 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 106.95 (61) Northwes $0.9x$ 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 175.64 (61) Northwes $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 175.64 (61) Northwes $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 175.95 (61) Northwes $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.7 × 91.3 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.7 × 91.4 × 0.63 × 0.8 = 102.09 (61) Northwes $0.9x$ 0.77 × 3.7 × 91.4 × 0.63 × 0.8 = 108.46 (61) Northwes $0.9x$ 0.77 × 3.7 × 92.87 × 0.63 × 0.8 = 101.82 (61) Northwes $0.9x$ 0.77 × 3.7 × 12.807 × 0.63 × 0.8 = 101.82 (61) Northwes $0.9x$ 0.77 × 3.7 × 12.807 × 0.63 × 0.8 = 130.32 (61) Northwes $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 130.32 (61) Northwes $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 13.37 (61) Northwes $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 15.87 (61) Northwes $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 15.87 (61) Northwes $0.9x$ 0.77 × 3.7 × 92.1 × 0.63 × 0.8 = 13.82 (61) Northwes $0.9x$ 0.77 × 3.7 × 92.1 × 0.63 × 0.8 = 13.82 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (61) Northwes $0.9x$ 0.77 × 3.2 × 92.1 × 0.63 × 0.8 = 13.87 (6	Southeast 0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.8	= [25.08	(77)
Northwest 0.9x 0.77 × 3.7 × 11.28 × 0.63 × 0.8 = 29.16 (61) Northwest 0.9x 0.77 × 3.7 × 22.97 × 0.63 × 0.8 = 12.61 (61) Northwest 0.9x 0.77 × 3.7 × 22.97 × 0.63 × 0.8 = 12.65 (61) Northwest 0.9x 0.77 × 3.7 × 41.38 × 0.63 × 0.8 = 25.67 (61) Northwest 0.9x 0.77 × 3.7 × 41.38 × 0.63 × 0.8 = 166.55 (61) Northwest 0.9x 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 175.64 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 175.64 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 175.64 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 169.56 (61) Northwest 0.9x 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 169.20 (61) Northwest 0.9x 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 122.60 (61) Northwest 0.9x 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 122.60 (61) Northwest 0.9x 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 122.60 (61) Northwest 0.9x 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 128.64 (61) Northwest 0.9x 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 128.64 (61) Northwest 0.9x 0.77 × 3.2 × 91.4 × 0.63 × 0.8 = 138.44 (61) Northwest 0.9x 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 138.44 (61) Northwest 0.9x 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 138.44 (61) Northwest 0.9x 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 138.44 (61) Northwest 0.9x 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 131.77 (61) Northwest 0.9x 0.77 × 3.7 × 22.607 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 50.42 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 15.87 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 130.32 (61) Northwest 0.9x 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 130.3 (61) Northwest 0	Southeast 0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.8	= [46.19	(77)
Northwest 0.sx 0.77 x 3.2 x 11.28 x 0.63 x 0.8 = 12.61 (61) Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 56.36 (61) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 25.67 (61) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 175.64 (61) Northwest 0.9x 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 75.95 (61) Northwest 0.9x 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 75.95 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 75.95 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 226.09 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 226.09 (61) Northwest 0.9x 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 226.17 (61) Northwest 0.9x 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 226.17 (61) Northwest 0.9x 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 226.17 (61) Northwest 0.9x 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.7 x 92.38 x 0.63 x 0.8 = 226.7 (61) Northwest 0.9x 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 226.7 (61) Northwest 0.9x 0.77 x 3.7 x 92.63 x 0.63 x 0.8 = 226.7 (61) Northwest 0.9x 0.77 x 3.7 x 92.63 x 0.63 x 0.8 = 103.20 (61) Northwest 0.9x 0.77 x 3.7 x 92.63 x 0.63 x 0.8 = 103.20 (61) Northwest 0.9x 0.77 x 3.7 x 92.63 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 92.63 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 92.4 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 92.4 x 0.63 x 0.8 = 31.37 (61) Northwest 0.9x 0.77 x 3.7 x 92.4 x 0.63 x 0.8 = 33.37 (61) Northwest 0.9x 0.77 x 3.7 x 92.1 x 0.63 x 0.8 = 156.35 (61) Northwest 0.9x 0.77 x 3.7 x 92.1 x 0.63 x 0.8 = 15.87 (61) Northwest 0.9x 0.77 x 3.7 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 92.1	Northwest 0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.8	= [29.16	(81)
Northwest 0.9x 0.77 x 3.7 x 22.97 x 0.63 x 0.8 = 59.36 (61) Northwest 0.9x 0.77 x 3.2 x 22.97 x 0.63 x 0.8 = 25.67 (61) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 106.95 (81) Northwest 0.9x 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 46.25 (61) Northwest 0.9x 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 175.64 (61) Northwest 0.9x 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 75.95 (61) Northwest 0.9x 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 97.38 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 97.38 x 0.63 x 0.8 = 102.09 (61) Northwest 0.9x 0.77 x 3.2 x 97.38 x 0.63 x 0.8 = 101.20 (61) Northwest 0.9x 0.77 x 3.2 x 97.38 x 0.63 x 0.8 = 101.82 (61) Northwest 0.9x 0.77 x 3.2 x 97.8 x 0.63 x 0.8 = 101.82 (61) Northwest 0.9x 0.77 x 3.2 x 91.1 x 0.63 x 0.8 = 101.62 (61) Northwest 0.9x 0.77 x 3.2 x 92.1 x 0.63 x 0.8 = 101.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 103.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest 0.9x 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 13.37 (61) Northwest 0.9x 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest 0.9x 0.77 x 3.2	Northwest 0.9x	0.77	x	3.2	x	11.28	x	0.63	x	0.8] = [12.61	(81)
Northwest $0.9x$ 0.77 x 3.2 x 22.97 x 0.63 x 0.8 = 25.67 (61) Northwest $0.9x$ 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest $0.9x$ 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest $0.9x$ 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 175.64 (61) Northwest $0.9x$ 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 235.46 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 101.82 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 101.82 (61) Northwest $0.9x$ 0.77 x 3.7 x 27.63 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 20.4 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 31.37 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 238.26 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x	Northwest 0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.8] = [59.36	(81)
Northwest $0.9x$ 0.77 x 3.7 x 41.38 x 0.63 x 0.8 = 106.95 (61) Northwest $0.9x$ 0.77 x 3.2 x 41.38 x 0.63 x 0.8 = 46.25 (61) Northwest $0.9x$ 0.77 x 3.7 x 67.96 x 0.63 x 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 x 3.2 x 67.96 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.2 x 91.35 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 102.09 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 251.7 (61) Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 235.46 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 x 3.7 x 22.63 x 0.63 x 0.8 = 108.64 (61) Northwest $0.9x$ 0.77 x 3.7 x 22.63 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 22.87 72.63 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 22.807 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 31.37 (61) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 31.37 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 238.26 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 238.2 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 238.2 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.	Northwest 0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.8		25.67	(81)
Northwest $0.9x$ 0.77 × 3.2 × 41.38 × 0.63 × 0.8 = 46.25 (61) Northwest $0.9x$ 0.77 × 3.7 × 67.96 × 0.63 × 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 75.95 (61) Northwest $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 236.09 (61) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (61) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (61) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 254.6 (61) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 254.6 (61) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 108.84 (61) Northwest $0.9x$ 0.77 × 3.7 × 22.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 15.87 (61) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 15.87 (61) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 15.87 (61) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.6	Northwest 0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.8	= [106.95	(81)
Northwest $0.9x$ 0.77 × 3.7 × 67.96 × 0.63 × 0.8 = 175.64 (81) Northwest $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 76.95 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.35 × 0.63 × 0.8 = 236.09 (81) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 102.09 (81) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (81) Northwest $0.9x$ 0.77 × 3.2 × 91.1 × 0.63 × 0.8 = 255.46 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 108.84 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 111.22 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 111.22 (81) Northwest $0.9x$ 0.77 × 3.7 × 50.42 × 0.63 × 0.8 = 111.7 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 156.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 156.35 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 33.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 15.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 15.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 15.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 15.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 33.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 33.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 33.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81)	Northwest 0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.8	=	46.25	(81)
Northwest $0.9x$ 0.77 × 3.2 × 67.96 × 0.63 × 0.8 = 75.95 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.35 × 0.63 × 0.8 = 102.09 (81) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 125.17 (81) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 128.44 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 118.24 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 1187.71 (81) Northwest $0.9x$ 0.77 × 3.7 × 50.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 250.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 260.7 × 0.63 × 0.8 = 55.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 280.7 × 0.63 × 0.8 = 131.0.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 280.7 × 0.63 × 0.8 = 131.0.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 280.7 × 0.63 × 0.8 = 131.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81)	Northwest 0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.8	=	175.64	(81)
Northwest $0.9X$ 0.77 × 3.7 × 91.35 × 0.63 × 0.8 = 236.09 (81) Northwest $0.9X$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 102.09 (81) Northwest $0.9X$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (81) Northwest $0.9X$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 108.84 (81) Northwest $0.9X$ 0.77 × 3.2 × 91.1 × 0.63 × 0.8 = 101.82 (81) Northwest $0.9X$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9X$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9X$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9X$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9X$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9X$ 0.77 × 3.7 × 50.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9X$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9X$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9X$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9X$ 0.77 × 3.7 × 9.21 ×	Northwest 0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.8	=	75.95	(81)
Northwest $0.9x$ 0.77 × 3.2 × 91.35 × 0.63 × 0.8 = 102.09 (81) Northwest $0.9x$ 0.77 × 3.7 × 97.38 × 0.63 × 0.8 = 251.7 (81) Northwest $0.9x$ 0.77 × 3.2 × 91.1 × 0.63 × 0.8 = 108.84 (81) Northwest $0.9x$ 0.77 × 3.2 × 91.1 × 0.63 × 0.8 = 101.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 101.82 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 15.67 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81)	Northwest 0.9x	0.77	x	3.7	x	91.35	x	0.63	x	0.8	=	236.09	(81)
Northwest $0.9x$ 0.77 x 3.7 x 97.38 x 0.63 x 0.8 = 251.7 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 235.46 (61) Northwest $0.9x$ 0.77 x 3.7 x 91.1 x 0.63 x 0.8 = 101.82 (61) Northwest $0.9x$ 0.77 x 3.7 x 72.63 x 0.63 x 0.8 = 187.71 (61) Northwest $0.9x$ 0.77 x 3.7 x 72.63 x 0.63 x 0.8 = 187.71 (61) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 130.32 (61) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 56.35 (61) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 56.35 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 31.37 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 15.87 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 15.87 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.8 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.8 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (61) Nort	Northwest 0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.8	[102.09	(81)
Northwest $0.9x$ 0.77 × 3.2 × 97.38 × 0.63 × 0.8 = 108.84 (81) Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 235.46 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 101.82 (81) Northwest $0.9x$ 0.77 × 3.7 × 72.63 × 0.63 × 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 × 3.7 × 50.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.7 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.7 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.7 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 33.7 (81	Northwest 0.9x	0.77	x	3.7	x	97.38] ×	0.63	x	0.8	=	251.7	(81)
Northwest $0.9x$ 0.77 × 3.7 × 91.1 × 0.63 × 0.8 = 235.46 (81) Northwest $0.9x$ 0.77 × 3.2 × 91.1 × 0.63 × 0.8 = 101.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 × 3.2 × 72.63 × 0.63 × 0.8 = 1101.82 (81) Northwest $0.9x$ 0.77 × 3.7 × 50.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.2 × 50.42 × 0.63 × 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 (83)	Northwest 0.9x	0.7 <mark>7</mark>	x	3.2	x	97.38	x	0.63	x	0.8	=	108.84	(81)
Northwest $0.9x$ 0.77 x 3.2 x 911 x 0.63 x 0.8 = 101.82 (81) Northwest $0.9x$ 0.77 x 3.7 x 72.63 x 0.63 x 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 x 3.2 x 72.63 x 0.63 x 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 31.37 (81)	Northwest 0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.8	_ = [235.46	(81)
Northwest $0.9x$ 0.77 x 3.7 x 72.63 x 0.63 x 0.8 = 187.71 (81) Northwest $0.9x$ 0.77 x 3.2 x 72.63 x 0.63 x 0.8 = 81.17 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 81.17 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 = 130.32 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 x 3.2 x 28.07 x 0.63 x 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 15.87 (81)	Northwest 0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.8	=	101.82	(81)
Northwest $0.9x$ 0.77 x 3.2 x 72.63 x 0.63 x 0.8 $=$ 81.17 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 $=$ 130.32 (81) Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 $=$ 56.35 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 $=$ 72.54 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 $=$ 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 $=$ 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 $=$ 15.87 (81) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 $=$ 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 $=$ 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 $=$ 10.3 (81) Northwest $0.9x$ 0.77 x	Northwest 0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.8	=	187.71	(81)
Northwest $0.9x$ 0.77 x 3.7 x 50.42 x 0.63 x 0.8 $=$ 130.32 (81) Northwest $0.9x$ 0.77 x 3.2 x 50.42 x 0.63 x 0.8 $=$ 56.35 (81) Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 $=$ 72.54 (81) Northwest $0.9x$ 0.77 x 3.2 x 28.07 x 0.63 x 0.8 $=$ 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 $=$ 36.69 (81) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 $=$ 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 $=$ 23.82 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 $=$ 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 $=$ 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 $=$ 10.3 (81) Northwest $0.9x$ 0.77 x </td <td>Northwest 0.9x</td> <td>0.77</td> <td>x</td> <td>3.2</td> <td>x</td> <td>72.63</td> <td>x</td> <td>0.63</td> <td>x</td> <td>0.8</td> <td> = [</td> <td>81.17</td> <td>(81)</td>	Northwest 0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.8	= [81.17	(81)
Northwest $0.9x$ 0.77 × 3.2 × 50.42 × 0.63 × 0.8 = 56.35 (81) Northwest $0.9x$ 0.77 × 3.7 × 28.07 × 0.63 × 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 × 3.2 × 28.07 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 × 3.7 × 14.2 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.2 × 14.2 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 × 3.7 × 9.21 × 0.63 × 0.8 = 10.3 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 × 3.2 × 9.21 × 0.63 × 0.8 × 0	Northwest 0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.8	=	130.32	(81)
Northwest $0.9x$ 0.77 x 3.7 x 28.07 x 0.63 x 0.8 = 72.54 (81) Northwest $0.9x$ 0.77 x 3.2 x 28.07 x 0.63 x 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.77 x (3.2 x 9.21 x 0.63 x 0.8 = (10.3) (81) Northwest $0.9x$ 0.8 x 0.8	Northwest 0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.8	=	56.35	(81)
Northwest $0.9x$ 0.77 x 3.2 x 28.07 x 0.63 x 0.8 = 31.37 (81) Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (81) Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 (83)	Northwest 0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.8	= [72.54	(81)
Northwest $0.9x$ 0.77 x 3.7 x 14.2 x 0.63 x 0.8 = 36.69 (81) Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (81) Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 (83)	Northwest 0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.8] = [31.37	(81)
Northwest $0.9x$ 0.77 x 3.2 x 14.2 x 0.63 x 0.8 = 15.87 (81) Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (81) Solar gains in watts, calculated for each month $(83)m = Sum(74)m \dots (82)m$ $(83)m = Sum (74)m \dots (82)m$ <td< td=""><td>Northwest 0.9x</td><td>0.77</td><td>x</td><td>3.7</td><td>x</td><td>14.2</td><td>x</td><td>0.63</td><td>x</td><td>0.8</td><td> = [</td><td>36.69</td><td>(81)</td></td<>	Northwest 0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.8	= [36.69	(81)
Northwest $0.9x$ 0.77 x 3.7 x 9.21 x 0.63 x 0.8 = 23.82 (81) Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (81) Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 (83)	Northwest 0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.8	= [15.87	(81)
Northwest $0.9x$ 0.77 x 3.2 x 9.21 x 0.63 x 0.8 = 10.3 (81) Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 (83)	Northwest 0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.8] = [23.82	(81)
Solar gains in watts, calculated for each month $(83)m = Sum(74)m \dots (82)m$ $(83)m = 155.89$ 279.41419.16581.13707.3726.99690.58592.66474.66318.75189.25131.77(83)	Northwest 0.9x	0.77	x	3.2	x	9.21	x	0.63	×	0.8	= [10.3	(81)
(83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77 $ (83)m = 155.89 279.41 419.16 581.13 707.3 726.99 690.58 592.66 474.66 318.75 189.25 131.77$	Solor going in	wotto colori	otod	for oach man	th		(92)~	$\sim - Sum(74)m$	(82)~				
	(83)m= 155.89	279.41 410	ated	581.13 707 3		26.99 690.58	(03)m 592	.66 474.66	318.7	5 189.25	131,77		(83)
Total gains – internal and solar (84)m = (73)m + (83)m , watts	Total gains –	internal and s	solar	(84)m = (73)n	n + (83)m , watts			5.0.1				(/

7. Mean internal temperature (heating season)

868.36

(84)m=

623.5

744.8

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

1003.92 1102.28 1095.4

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

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

1042.33

951.58

847.93

718.67

619.73

585.54

21

(84)

(85)

(86)m=	1	1	0.98	0.91	0.73	0.52	0.38	0.43	0.71	0.96	1	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 9c)					
(87)m=	20.17	20.33	20.56	20.83	20.97	21	21	21	20.98	20.77	20.42	20.15		(87)
Temp	erature	durina h	eating r	eriods ir	n rest of	u dwelling	from Ta	able 9 Tl	և h2 (°C)					
(88)m=	20.23	20.23	20.23	20.25	20.25	20.26	20.26	20.27	20.26	20.25	20.25	20.24		(88)
Utilisa	ation fac	tor for a	ains for	rest of d	wellina.	h2.m (se	e Table	9a)						
(89)m=	1	0.99	0.97	0.88	0.69	0.46	0.31	0.36	0.64	0.94	0.99	1		(89)
Mean	interna	l temper	ature in	the rest	of dwelli	ing T2 (f	l ollow ste	ens 3 to 7	L 7 in Tahl				1	
(90)m=	19.1	19.34	19.68	20.05	20.22	20.26	20.26	20.27	20.24	19.99	19.48	19.08		(90)
									f	L LA = Livin	g area ÷ (4	4) =	0.22	(91)
N 4	·		- 1		- 1 - 1	()		. (4 4						
	Interna	10.56	ature (fc 10.97	r the wh		lling) = Il 20.42	LA X 11	+(1-IL)	A) × 12	20.16	10.60	10.22		(92)
	adjusta	opt to t	19.07	20.23	temper	ature fro	m Table	20.43			19.09	19.52	1	(52)
(93)m=	19.34	19.56	19.87	20.23	20.39	20.43	20.43	20.43	20.41	20.16	19.69	19.32		(93)
8. Spa	ace hea	tina real	uirement											
Set Ti	i to the r	nean int	ernal tei	mperatur	re obtair	ned at ste	ep 11 of	Table 9	o, so tha	t Ti.m=(76)m an	d re-calc	ulate	
the ut	ilisation	factor fo	or gains	using Ta	ble 9a		-1 -				- /			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Util <mark>isa</mark>	ation fac	tor for g	ains, hm	1:										
(94)m=	1	0.99	0.97	0.88	0.69	0.47	0.33	0.38	0.66	0.94	0.99	1		(94)
Usefu	l <mark>l g</mark> ains,	hmGm ,	W = (9	4)m x (84	4)m									
(95)m=	<mark>62</mark> 1.91	738.72	842.75	887.5	765.68	519.08	342.05	358.54	555.48	674.52	615.33	584.52		(95)
Month	nly avera	age exte	rnal terr	perature	e from Ta	able 8								(22)
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat	oss rate	e for mea	an interr	al tempe	erature,	Lm , W =	=[(39)m	x [(93)m	– (96)m]	4455 70	4000.07	l	(07)
(97)m=	1411.87	1370.79	1245.93	1035.83	791.38	520.73	342.15	358.8	568.21	8/1.1/	1155.73	1398.07	l	(97)
Space	e neatin	g require		r each m	100000		$\ln = 0.02$	24 X [(97)m – (95)mj x (4 ⁻	1)m	605.29		
(90)11=	567.75	424.75	299.90	100.0	19.12	0	0	U Tata	0	140.3	369.09	005.20	0570.04	
_								Tota	i per year	(kvvn/year) = Sum(9	8)15,912 =	2579.04	(98)
Space	e heatin	g require	ement in	kWh/m ²	/year								22.74	(99)
9a. En	ergy rec	luiremer	nts – Ind	ividual h	eating s	ystems i	ncluding	micro-C	CHP)					
Spac	e heatir	ng:		_										
Fracti	on of sp	ace hea	it from s	econdary	y/supple	mentary	system						0	(201)
Fracti	on of sp	ace hea	it from m	nain syst	em(s)			(202) = 1 -	– (201) =				1	(202)
Fracti	on of to	tal heatii	ng from	main sys	stem 1			(204) = (2	02) × [1 –	(203)] =			1	(204)
Efficie	ency of r	main spa	ace heat	ing syste	em 1								89	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heatin	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Αυσ	Sep	Oct	Nov	Dec	kWh/	 vear
Space	e heatin	a reauire	ement (c	alculate	d above)		I			1101	200		,
-1-0.00	587.73	424.75	299.96	106.8	19.12	0	0	0	0	146.3	389.09	605.28		
(211)m) = {[(98)m x (20	4)] } x 1	00 ± (20)6)		1							(211)
(<u> </u>	660.37	477.25	337.03	120	21.48	0	0	0	0	164.39	437.18	680.09		(=)
			l	1	l	1	1	Tota	l (kWh/yea	ar) =Sum(2	211) _{15,1012}	=	2897.79	(211)
													1	1 1

Space heating fuel (secondary), kWh/month

= {[(98)m x (20	01)]}x1	00 ÷ (20	8)		-			-			_		
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		_
								Tota	l (kWh/yea	ar) =Sum(2	2 15) _{15,101}	2=	0	(215)
Water	heating													
Output	216.54	ater nea 190.84	200.39	ulated al 179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31		
Efficier	ncy of w	ater hea	ter										. 89	(216)
(217)m=	89	89	89	89	89	89	89	89	89	89	89	89		(217)
Fuel fo (219)m	r water = (64)	heating, m x 100	kWh/mo) ÷ (217)	onth m					-		-	-		
(219)m=	243.3	214.43	225.16	201.5	195.09	171.82	164.62	183.51	185.54	209.25	221.32	237.43		
								Tota	I = Sum(2'	19a) ₁₁₂ =			2452.98	(219)
Annua	l totals	fuelues	مأ مو ما	o	4					k	Wh/yea	r	kWh/year	- -
Space	neating	tuel use	ed, main	system	1								2897.79	ļ
Water	heating	fuel use	d										2452.98	
Electric	city for p	oumps, fa	ans and	electric	keep-ho	t								
mech	anical v	entilatior	n - balan	iced, ext	ract or p	ositive ir	nput fror	n outside	Э			295.01		(230a)
centra	al heatin	g pump:										120		(230 <mark>c</mark>)
Tota <mark>l e</mark>	lectricity	for the	above, k	kWh/yea	r			sum	of (230a).	<mark>(2</mark> 30g) =	:		415.01	(231)
Electric	city for li	ghting											435.02	(232)
12a. (CO <mark>2 em</mark>	issions -	– Individ	ual h <mark>eat</mark> i	ng syste	ems inclu	uding mi	cro-CHP						
						En kW	ergy /h/year			Emiss kg CO	ion fac 2/kWh	tor	Emissio ns kg CO2/yea	ar
Space	heating	(main s	ystem 1))		(211	l) x			0.2	16	=	625.92	(261)
Space	heating	(second	lary)			(215	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.2	16	=	529.84	(264)
Space	and wa	ter heati	ng			(261	l) + (262)	+ (263) + (264) =				1155.77	(265)
Electric	city for p	oumps, fa	ans and	electric	keep-ho	t (231	l) x			0.5	19	=	215.39	(267)
Electric	city for li	ghting				(232	2) x			0.5	19	=	225.77	(268)
Total C	CO2, kg/	year							sum o	f (265)(2	271) =		1596.93	(272)
Dwelli	ng CO2	Emissi	on Rate						(272) ·	÷ (4) =			14.08	(273)
El ratir	ng (secti	on 14)											86	(274)

				User D	Details:							
Assessor Name: Software Name:	Stroma F	SAP 201	2		Strom Softwa	a Num are Ve	ber: rsion:		Versio	on: 1.0.4.25		
			P	roperty	Address	: House	1 (Boiler	r) S2A				
Address :												
1. Overall dwelling dim	ensions:											
•				Are	a(m²)	1	Av. Hei	ight(m)	-	Volume(m ³)	-	
Ground floor					39.1	(1a) x	2	2.7	(2a) =	105.57	(3a)	
First floor					43.3	(1b) x	2	2.7	(2b) =	116.91	(3b)	
Second floor					31	(1c) x	3	3.4	(2c) =	105.4	(3c)	
Total floor area TFA = (1	a)+(1b)+(1c)+	-(1d)+(1e	e)+(1r	n)	13.4	(4)			-		-	
Dwelling volume						(3a)+(3b)+(3c)+(3d	l)+(3e)+	.(3n) =	327.88	(5)	
2. Ventilation rate:											-	
	main heating	se h	econdar leating	У	other		total			m ³ per hour		
Number of chimneys	0	+	0	+	0] = [0	X	40 =	0	(6a)	
Number of open flues	0	+	0	7 + [0] = [0	x	20 =	0	(6b)	
Number of intermittent fa	ans					- Ē	4	×	10 =	40	(7a)	
Number of passive vents	5					Ē	0	x	10 =	0	(7b)	
Number of flueless gas t	ires					Γ	0	X	40 =	0	(7c)	
									Air ch	anges per hou	- ır	
Infiltration due to chimpe	we flues and	fans - (6)	a) + (6b) + (7)	(a) + (7b) + ((7c) =	Г	40				" "	
If a pressurisation test has	been carried out (or is intende	d procee	d to (17)	otherwise (continue fr	40	(16)	÷ (5) =	0.12	(0)	
Number of storevs in t	the dwelling (r	s) IS)	<i>ia, procee</i>	<i>u</i> to (<i>11)</i> ,			0111 (0) 10 (10)		0] (9)	
Additional infiltration								[(9)	-1]x0.1 =	0	(10)	
Structural infiltration: ().25 for steel c	or timber f	frame or	0.35 fo	r masoni	ry constr	uction		-	0	(11)	
if both types of wall are p	present, use the v	alue corres	ponding to	the grea	ter wall are	a (after			l], ,	
deducting areas of open	ings); if equal use	er 0.35									-	
If suspended wooden	floor, enter 0.2	2 (unseal	ed) or 0	1 (seale	ed), else	enter 0				0	(12)	
If no draught lobby, er	iter 0.05, else	enter 0								0	(13)	
Percentage of window	's and doors d	raught st	ripped		0.05 10.0		0.01			0	(14)	
					0.25 - [0.2]	X (14) ÷ 1	[00] =	(45)		0	_(15)	
Inflitration rate	50				(8) + (10)	+(11)+(12) + (13) +	+ (15) =		0	_(16)	
Air permeability value	, q50, express	ea in cub		s per no	bur per s	quare m	etre of e	nvelope	area	5	_(17)	
Air permeability value appli	lity value, ther	$\int (10) = [(1$	$() \div 20]+(0)$	s), otherw	$\operatorname{ISE}(10) = ($	rmoobility	io hoing u	and		0.37	(18)	
Number of sides shelter	ed a pressurisat	ion lest nas	s been dor	le or a de	gree all pe	тпеаршку	is being us	seu		2	7(10)	
Shelter factor	54				(20) = 1 -	[0.075 x (1	19)] =			0.85	(13)	
Infiltration rate incorpora	iting shelter fa	ctor			(21) = (18) x (20) =				0.32](21)	
Infiltration rate modified for monthly wind speed												
Jan Feb	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Monthly average wind s	peed from Tab	ole 7										
(22)m= 5.1 5	4.9 4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7			

Wind F	actor (2	22a)m =	(22)m ÷	4										
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18		
Adjuste	ed infiltr	ation rat	e (allowi	ing for sł	nelter an	nd wind s	peed) =	(21a) x	(22a)m					
	0.4	0.4	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.36	0.37		
Calcula	ate effe	ctive air	change	rate for t	he appli	cable ca	se	•	-	•			_	
II ME	echanica			ondiv N (2	(26) - (22)		austion (I	NE)) otho	nuico (22)	(222)		l	0	(23a)
lf bala	aust all II	beat reco	worv: offic	$\frac{1}{2}$	(200) = (200)	for in-use f	ector (fron	n Table 4b	1 WISE (231	5) = (25a)		l	0	(23b)
)-)	2b)m (226) [·	1 (22a)	0	(23c)
a) II								чк) (24a 	$\frac{1}{2}$	$\frac{20}{1}$ $\frac{1}{0}$	230) × [1 - (230)	÷ 100]	(24a)
(24a)III-	bolonor				without	hoot roo			$\int \frac{1}{\sqrt{2}}$	$\frac{1}{2}$	22h)	0		(244)
(24b)m-								VIV) (241.	D = (2	$\frac{20}{1}$ $\frac{1}{0}$	230)			(24b)
(240)III-			tractiver				untilatio			0	0	0		(210)
c) ii	f (22b)r	$0.5 \times 0.5 $	(23b), 1	then (24	c) = (23t)): otherv	vise (24	c) = (22b)	b) m + 0	.5 x (23b))			
(24c)m=	0	0	0				0			0	0	0		(24c)
) If	natural	L ventilatio	l on or wh	L Iole hous	L	L I	ventilatio	I on from l	L loft	I	1			
u) II i	f (22b)r	n = 1, the	en (24d)	m = (22)	o)m othe	erwise (2	4d)m =	0.5 + [(2	2b)m² x	0.5]				
(24d) <mark>m=</mark>	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57		(24d)
Effec	ctive air	change	rate - er	nter (24a) or (24k	o) or (240	c) or (24	d) in bo	x (25)					
(25)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57		(25)
3 He	at losse	s and he	at loss i	naramet	or.									
ELEN	IENT	Gros	SS (m2)	Openin	gs	Net Are	ea	U-val	ue	AXU		k-value		A X k
Doors		area	(112)	11	14	A , I				(\ \ \ \		KJ/III-•r		KJ/K (26)
Windo		1				3.38		1.2 /[1/(1.4.)_	- 0.041	4.05	4			(20)
Windo	wa Type					0.9		/[1/(1.4)+	0.04] =	1.19	\dashv			(27)
	ws type	÷ Z				1.5		/[1/(1.4)+	0.04] =	1.99				(27)
VVINGO	ws type	3				2.28	X1	/[1/(1.4)+	0.04] =	3.02				(27)
vvindo\	ws type —	e 4 -				4.2	x1	/[1/(1.4)+	• 0.04] =	5.57				(27)
Window	ws Type	95				3.7	x1	/[1/(1.4)+	0.04] =	4.91				(27)
Window	ws Type	e 6				3.2	x1	/[1/(1.4)+	0.04] =	4.24				(27)
Floor T	ype 1					39.1	x	0.13	=	5.083				(28)
Floor T	ype 2					4.2	x	0.13	=	0.545999	99			(28)
Walls		97.0)5	22.8	5	74.2	x	0.18	=	13.36				(29)
Roof		43.	3	0		43.3	x	0.13	=	5.63				(30)
Total a	rea of e	elements	, m²		-	183.65	5				-			(31)
* for win	dows and	l roof wind	ows, use e	effective wi	ndow U-va	alue calcula	ated using	formula 1	1/[(1/U-val	ue)+0.04] a	as given in	paragraph	3.2	

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

Fabric heat loss, $W/K = S (A \times U)$	(26)(30) + (32) =	54.49	(33)
Heat capacity Cm = S(A x k)	((28)(30) + (32) + (32a)(32e) =	5442.45	(34)
Thermal mass parameter (TMP = $Cm \div TFA$) in kJ/m ² K	Indicative Value: Medium	250	(35)
For design assessments where the details of the construction are not known r	precisely the indicative values of TMP in Table 1f		-

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

can be ι	a be used instead of a detailed calculation. ermal bridges : S (L x Y) calculated using Appendix K 4.64 (36)													
Therm	al bridge	es : S (L	x Y) cal	culated u	using Ap	pendix l	<						4.64	(36)
if details	of therma	al bridging	are not kn	own (36) =	= 0.05 x (3	1)								
Total fa	abric he	at loss							(33) +	(36) =			59.13	(37)
Ventila	tion hea	at loss ca	alculated	monthly	/				(38)m	= 0.33 × (25)m x (5)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	62.89	62.55	62.22	60.65	60.35	58.98	58.98	58.73	59.51	60.35	60.95	61.57		(38)
Heat tr	ansfer c	coefficier	nt, W/K						(39)m	= (37) + (3	38)m			
(39)m=	122.02	121.68	121.35	119.77	119.48	118.11	118.11	117.86	118.64	119.48	120.07	120.7		
	L								/	Average =	Sum(39)1	.12 /12=	119.77	(39)
Heat Ic	oss para	meter (F	HLP), W/	m²K			1		(40)m	= (39)m ÷	(4)		I	
(40)m=	1.08	1.07	1.07	1.06	1.05	1.04	1.04	1.04	1.05	1.05	1.06	1.06		-
Numbe	er of day	rs in moi	nth (Tab	le 1a)					/	Average =	Sum(40)1	.12 /12=	1.06	(40)
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
4 \M/2	4. Water heating energy requirement: kWh/year:													
Assumed occupancy, N 2.83 (42)														
	A > 13.9	9, N = 1	+ 1.76 x	[1 - exp	(-0.0003	849 x (11	-A -13.9)2)] + 0.0	0013 x (I	IFA -13.	9)			
Annua	averad	e hot wa	ater usad	ae in litre	s per da	v Vd.av	erage =	(25 x N)	+ 36		10	15		(43)
Reduce	the annua	al average	hot water	usage by a	5% if the a	welling is	designed t	to achieve	a water us	se target o	f	1.0		(10)
not more	e that 125	litres per _l	person pel	day (all w	ater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage il	n litres per	^r day for ea	ach month	Vd,m = fa	ctor from	Table 1c x	(43)						
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65		
										Total = Su	m(44) ₁₁₂ =	:	1218.02	(44)
Energy o	content of	hot water	used - cal	culated mo	onthly $= 4$.	190 x Vd,r	m x nm x D	0Tm / 3600	kWh/mon	nth (see Ta	ables 1b, 1	c, 1d)		
(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35		
										Total = Su	m(45) ₁₁₂ =		1597.02	(45)
If instant	taneous w	ater heatii	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46)) to (61)				L	
(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05		(46)
Storag	slorage o volum	OSS.	includir		Nor or M		ctorado	within or		col			l	(47)
Sillay		e (iiies)		ig any so		/ V I K S			ine ves	Sei)		(47)
II COM	nunity n	eating a	hot wate	nk in aw ar (this in	elling, e cludes i	nter 110		(47) mbi boil	are) onto	ar 'O' in (47)			
Water	storage	loss:	not wate		iciuues i	nstantai			ers) ente		47)			
a) If m	anufact	urer's de	eclared I	oss facto	or is kno	wn (kWł	n/day):)		(48)
Tempe	erature fa	actor fro	m Table	2b		,	,					- ז		(49)
Energy	lost fro	m water	storage	k\Wh/ve	ar			(48) x (49)	_			<u> </u>		(50)
b) If m	anufact	urer's de	eclared of	ylinder l	oss facto	or is not	known:	(10) x (10)				5		(00)
Hot wa	iter stora	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ay)				(0		(51)
If comr	nunity h	eating s	ee secti	on 4.3										
Volum	e factor	from Ta	ble 2a								()		(52)
Tempe	erature fa	actor fro	m Table	2b							(C		(53)

Energy Enter	y lost fro (50) or	om water (54) in (5	• storage 55)	e, kWh/ye	ear			(47) x (51)) x (52) x (53) =		0		(54) (55)
Water	storage	loss cal	culated	for each	month			((56)m = (55) × (41)r	m	L		1	
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0		(56)
If cylinde	er contain	s dedicate	l d solar sto	l orage, (57)	I m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	I lix H	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primar	y circuit	loss (ar	nual) fro	om Table	e 3							0]	(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m ovlindov	r tharma	(ctot)			
(110) (59)m=												0]	(59)
Combi			for oook	month	(61)m -	(60) • 20	SE w (41)		_	-				
(61)m-	50.96		50.96		(01)(11) =	(60) - 36	46 55	48.62	49.05	50.96	49.32	50.96		(61)
Total k		uired for	water b			for eac	h month	(62)m -	0.85 v ((45)m +	$(16)m \pm$	(57)m +	 (50)m ± (61)m	(0.)
(62)m-	216 54	190.84	200 39	179 34	173.63	152 92	146 51	(02)III =	165 13	186.23	196.98	211 31	(59)II + (61)II]	(62)
Solar Di								() (enter '0	if no sola	r contributi	ion to wate			(0-)
(add a	dditiona	l lines if	FGHRS	and/or \	NWHRS	applies	, see Ap	pendix (G)	Contribut		or nearing)		
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	t from w	ater hea	ter	1									1	
(64)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31		
								Outp	out from wa	ater heate	r (annual)₁	12	2183.15	(64)
Heat g	jains fro	m water	heating	, kWh/m	onth 0.2	5 ′ [0.85	× (45)m	+ (61)m	n] + 0.8 x	(46)m	+ (57)m	+ (59)m]	
(65)m=	<mark>6</mark> 7.79	59.66	62.43	55.58	53.72	47.13	44.87	50.29	50.86	57.72	61.43	66.06		(65)
in <mark>clu</mark>	ude (57)	m in calo	culation	of (65)m	only if c	ylinder i	s in the c	dwelling	or hot w	ate <mark>r is f</mark> r	om com	munity h	eating	
5. Int	ternal ga	ains (see	e Table {	5 and 5a):									
Metab	olic gair	is (Table	e 5). Wat	ts										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69		(66)
Lightin	ig gains	(calcula	ted in Ap	opendix	L, equat	ion L9 o	r L9a), a	lso see	Table 5					
(67)m=	24.79	22.02	17.91	13.56	10.13	8.56	9.24	12.02	16.13	20.48	23.9	25.48		(67)
Applia	nces ga	ins (calc	ulated ir	n Append	dix L, eq	uation L	13 or L1	3a), also	see Tal	ble 5			-	
(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16		(68)
Cookir	ng gains	(calcula	ted in A	ppendix	L, equat	ion L15	or L15a)), also se	e Table	5			-	
(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17		(69)
Pumps	s and fa	ns gains	(Table \$	5a)										
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losses	s e.g. ev	vaporatio	on (nega	tive valu	es) (Tab	le 5)								
(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35		(71)
Water	heating	gains (T	able 5)											
(72)m=	91.12	88.78	83.91	77.2	72.2	65.46	60.32	67.6	70.64	77.58	85.31	88.79		(72)
Total i	internal	gains =				(66)	m + (67)m	n + (68)m -	⊦ (69)m + ((70)m + (7	1)m + (72))m	_	
(73)m=	460.77	458.52	442.32	415.87	388.04	361.46	344.81	352	366.38	393.05	423.63	446.93		(73)
6. So	lar gains	S:												

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

Orientation:	Access Factor Table 6d	r	Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.77	x	0.9	x	36.79) x	0.63	x	0.7] =	10.12	(77)
Southeast 0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.7	i =	16.87	(77)
Southeast 0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.7	=	25.64	(77)
Southeast 0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.7	=	47.23	(77)
Southeast 0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.7] =	17.24	(77)
Southeast 0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.7	=	28.73	(77)
Southeast 0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.7] =	43.67	(77)
Southeast 0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.7	=	80.45	(77)
Southeast 0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.7] =	23.59	(77)
Southeast 0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.7] =	39.31	(77)
Southeast 0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.7] =	59.75	(77)
Southeast 0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.7] =	110.07	(77)
Southeast 0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.7] =	29.22	(77)
Southeast 0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.7] =	48.71	(77)
Southeast 0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.7] =	74.04	(77)
Southeast 0.9x	0.77	x	4.2	×	106.25	x	0.63	Х	0.7] =	136.38	(77)
Southeast 0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.7] =	32.73	(77)
Southeast 0.9x	0.77	x	1.5	х	119.01] ×	0.63	x	0.7] =	54.56	(77)
Southeast 0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.7] =	82.93	(77)
Southeast 0.9x	0.77	x	4.2	×	119.01	x	0.63	x	0.7] =	152.76	(77)
Southeast 0.9x	0.77	x	0.9	x	118.15	×	0.63	x	0.7] =	32.5	(77)
Southeast 0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.7] =	54.16	(77)
Southeast 0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.7] =	82.33	(77)
Southeast 0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.7] =	151.65	(77)
Southeast 0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.7	=	31.33	(77)
Southeast 0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.7	=	52.22	(77)
Southeast 0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.7	=	79.37	(77)
Southeast 0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.7	=	146.21	(77)
Southeast 0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.7	=	28.71	(77)
Southeast 0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.7	=	47.85	(77)
Southeast 0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.7	=	72.74	(77)
Southeast 0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.7	=	133.99	(77)
Southeast 0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.7	=	25.54	(77)
Southeast 0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.7	=	42.57	(77)
Southeast 0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.7	=	64.7	(77)
Southeast 0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.7	=	119.18	(77)
Southeast 0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.7	=	19.05	(77)
Southeast 0.9x	0.77	x	1.5	×	69.27	x	0.63	x	0.7] =	31.75	(77)
Southeast 0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.7] =	48.27	(77)

Southeast 0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.7	=	88.91	(77)
Southeast 0.9x	0.77	x	0.9	Ī×	44.07	x	0.63	x	0.7	=	12.12	(77)
Southeast 0.9x	0.77	x	1.5] x	44.07	x	0.63	x	0.7	=	20.2	(77)
Southeast 0.9x	0.77	x	2.28	۔ ۲	44.07	x	0.63	x	0.7	=	30.71	(77)
Southeast 0.9x	0.77	x	4.2	۲ × آ	44.07] x	0.63] x	0.7	=	56.57	(77)
Southeast 0.9x	0.77	x	0.9	- X	31.49	x	0.63	x	0.7	=	8.66	(77)
Southeast 0.9x	0.77	x	1.5	۔ ۲	31.49	x	0.63	x	0.7	=	14.43	(77)
Southeast 0.9x	0.77	x	2.28	Ī×	31.49	x	0.63	x	0.7	=	21.94	(77)
Southeast 0.9x	0.77	x	4.2	- X	31.49	x	0.63	x	0.7	_ =	40.42	(77)
Northwest 0.9x	0.77	x	3.7	Ī×	11.28	x	0.63	x	0.7	=	25.52	(81)
Northwest 0.9x	0.77	x	3.2	- X	11.28	x	0.63	x	0.7	_ =	11.03	(81)
Northwest 0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.7	=	51.94	(81)
Northwest 0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.7	=	22.46	(81)
Northwest 0.9x	0.77	x	3.7	x	41.38) x	0.63	x	0.7	=	93.58	(81)
Northwest 0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.7	=	40.47	(81)
Northwest 0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.7	=	153.68	(81)
Northwest 0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.7	=	66.46	(81)
Northwest 0.9x	0.77	x	3.7	X	91.35	x	0.63	Х	0.7	=	206.58	(81)
Northwest 0.9x	0.77	×	3.2	x	91.35	x	0.63	x	0.7	=	<mark>8</mark> 9.33	(81)
Northwest 0.9x	0.77	×	3.7	x	97.38] ×	0.63	x	0.7	=	220.24	(81)
Northwest 0.9x	0.7 <mark>7</mark>	×	3.2	x	97.38	x	0.63	x	0.7	=	<mark>9</mark> 5.24	(81)
Northwest 0.9x	0.77	×	3.7	x	91.1	x	0.63	x	0.7	=	2 <mark>06.03</mark>	(81)
Northwest 0.9x	0.77	×	3.2	x	91.1	x	0.63	x	0.7	=	<mark>8</mark> 9.09	(81)
Northwest 0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.7	=	164.25	(81)
Northwest 0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.7	=	71.03	(81)
Northwest 0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.7	=	114.03	(81)
Northwest 0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.7	=	49.31	(81)
Northwest 0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.7	=	63.47	(81)
Northwest 0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.7	=	27.45	(81)
Northwest 0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.7	=	32.11	(81)
Northwest 0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.7	=	13.88	(81)
Northwest 0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.7	=	20.84	(81)
Northwest 0.9x	0.77	x	3.2	x	9.21	x	0.63	x	0.7	=	9.01	(81)
Color color :		مر مدم	for oach me	**		(02)	$- \operatorname{Cum}(74)$	(02)~				
(83)m= 136.4	244.49	366.77	508.49 618.8	39 6	36.12 604.25	518	.57 415.32	278.9	165.59	115.3		(83)

(84)m=	597.18	703.01	809.08	924.36	1006.93	997.58	949.07	870.57	781.7	671.96	589.22	562.24	
7. Me	an inter	nal temp	erature	(heating	season)							
Temp	erature	during h	eating p	eriods ir	n the livir	ng area f	from Tab	ole 9, Th	1 (°C)				_

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

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

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

21

(84)

(85)

(86)m=	1	1	0.99	0.97	0.88	0.71	0.54	0.6	0.86	0.98	1	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 9c)					
(87)m=	19.79	19.94	20.2	20.53	20.81	20.96	20.99	20.99	20.88	20.51	20.09	19.77		(87)
Temp	erature	durina h	eating p	eriods ir	n rest of	dwellina	from Ta	able 9. Tl	h2 (°C)					
(88)m=	20.02	20.02	20.03	20.04	20.04	20.05	20.05	20.05	20.05	20.04	20.03	20.03		(88)
Utilisa	ation fac	tor for g	ains for	rest of d	welling,	h2,m (se	e Table	9a)						
(89)m=	1	1	0.99	0.95	0.84	0.62	0.43	0.49	0.8	0.97	1	1		(89)
Mean	interna	l temper	ature in	the rest	of dwelli	ng T2 (fe	ollow ste	eps 3 to 7	7 in Tabl	e 9c)				
(90)m=	18.4	18.62	18.99	19.48	19.85	20.02	20.05	20.04	19.94	, 19.45	18.84	18.37		(90)
									f	LA = Livin	g area ÷ (4	4) =	0.22	(91)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	llina) = fl	LA x T1	+ (1 – fL	A) x T2			•		
(92)m=	18.71	18.92	19.26	19.71	20.07	20.23	20.26	20.26	20.15	19.69	19.12	18.68		(92)
Apply	adjustn	nent to t	he mear	n internal	l temper	ature fro	m Table	e 4e, whe	ere appro	opriate				
(93)m=	18.71	18.92	19.26	19.71	20.07	20.23	20.26	20.26	20.15	19.69	19.12	18.68		(93)
8. Sp	ace hea	ting requ	uirement					-						
Set T	i to the r	mean int	ernal te	mperatu	re obtain	ed at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	llisation	Tactor IC	or gains		able 9a	lun	lul l	Aug	Son	Oct	Nov	Dee		
l Itilisa	Jan ation fac	tor for a	ains hm	Apr	Iviay	Jun	Jui	Aug	Sep	Oct	INOV	Dec		
(94)m=	1	0.99	0.98	0.95	0.84	0.64	0.45	0.51	0.81	0.97	1	1		(94)
Usefu	l gains,	hmGm .	W = (9	4)m x (84	4)m									
(95)m=	595.89	699.28	7 96.7	875.64	846.37	638.8	428.78	448.07	630.42	651.81	586.38	561.35		(95)
Mo <mark>nt</mark> ł	nly avera	age exte	rnal terr	perature	e from Ta	able 8								
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat	loss rate	e for mea	an interr	al tempe	erature,	Lm , W =	=[(39)m	x [(93)m	– (96)m]				
(97)m=	1758.04	1705.59	1548.3	1295.18	999.69	665.11	432.04	454.43	718.17	1086.19	1443.58	1747.83		(97)
Space	e heatin	g require	ement fo	r each n	nonth, k\	Nh/mont	th = 0.02	24 x [(97))m – (95)m] x (4 ⁻	1)m			
(98)m=	864.64	676.24	559.19	302.07	114.07	0	0	0	0	323.18	617.18	882.74		-
								Tota	l per year	(kWh/year) = Sum(9	8)15,912 =	4339.31	(98)
Space	e heatin	g require	ement in	kWh/m ²	?/year								38.27	(99)
9a. En	ergy rec	luiremer	nts – Ind	ividual h	eating s	ystems i	ncluding	j micro-C	CHP)					
Spac	e heatir	ng:										,		_
Fracti	on of sp	ace hea	it from s	econdar	y/supple	mentary	system						0	(201)
Fracti	on of sp	ace hea	it from n	nain syst	em(s)			(202) = 1 -	- (201) =				1	(202)
Fracti	on of to	tal heatii	ng from	main sys	stem 1			(204) = (20	02) × [1 –	(203)] =			1	(204)
Efficie	ency of r	main spa	ace heat	ing syste	em 1								93.4	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heating	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ear
Space	e heatin	g require	ement (c	alculate	d above))								
	864.64	676.24	559.19	302.07	114.07	0	0	0	0	323.18	617.18	882.74		
(211)m	n = {[(98)m x (20	4)] } x 1	00 ÷ (20)6)									(211)
	925.74	724.03	598.7	323.41	122.13	0	0	0	0	346.02	660.79	945.12		
								Tota	l (kWh/yea	ar) =Sum(2	211) _{15,1012}	=	4645.94	(211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (20	1)]}x 1	00 ÷ (20	8)				-			-	-		
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
								Tota	ll (kWh/yea	ar) =Sum(2	2 15) _{15,101}	2=	0	(215)
Water	heating	l												
Output	from wa	ater hea	ter (calc	ulated a	bove)	152.02	146 51	162.22	165 12	106.00	106.09	211.21	l	
Efficier	210.34	ator hos	200.39	179.34	173.03	152.92	140.51	103.33	105.15	100.23	190.90	211.31	90.2	(216)
(217)m=	88.18	87.96	87.5	86.35	84.02	80.3	80.3	80.3	80.3	86.43	87.73	88.26	00.3	(217)
Fuel fc	or water	heating.	kWh/ma	onth										
(219)m	n = (64)	<u>m x 100</u>) ÷ (217)	m										
(219)m=	245.56	216.95	229.03	207.68	206.65	190.44	182.46	203.4	205.64	215.48	224.53	239.43		
								Tota	II = Sum(2	19a) ₁₁₂ =			2567.24	(219)
Annua	I totals									k	Wh/yea	r	kWh/yea	r
Space	heating	fuel use	ed, main	system	1								4645.94	
Water	heating	fuel use	ed										2567.24	
Electric	city for p	umps, f	ans and	electric	keep-ho	t								
centra	al heatin	g pump	:									30		(230c)
boi <mark>ler</mark>	with a f	an-assis	sted flue									45		(230e)
Tota <mark>l e</mark>	electricity	for the	above, k	kWh/yea	r			sum	of (230a).	<mark>(2</mark> 30g) =	:		75	(231)
Electric	city for li	ghting											437.82	(232)
12a. (CO2 em	issions -	– Individ	ual heat	ing syste	ems inclu	uding mi	cro-CHF						
						_								
						En kW	ergy /h/year			Emiss kg CO	ion fac 2/kWh	tor	Emissions kg CO2/ye	s ar
Space	heating	(main s	ystem 1))		(211	l) x			0.2	16	=	1003.52	(261)
Space	heating	(second	dary)			(218	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.2	16	=	554.52	(264)
Space	and wat	ter heati	ng			(261	I) + (262)	+ (263) + ((264) =				1558.05	(265)
Electric	city for p	umps, f	ans and	electric	keep-ho	t (231	I) x			0.5	19	=	38.93	(267)
Electric	city for li	ghting				(232	2) x			0.5	19	=	227.23	(268)
Total C	CO2, kg/	year							sum o	of (265)(271) =		1824.2	(272)

TER =

16.09 (273)

			User D	etails:						
Assessor Name: Software Name:	Stroma FSAP 20)12		Strom Softwa	a Num are Ve	ber: rsion:		Versic	on: 1.0.4.25	
		P	Property .	Address	: House	1 (ASHP	P) S2A			
Address :										
1. Overall dwelling dimen	sions:		_	()						
			Area	a(m²)		Av. Hei	ght(m)		Volume(m ³)	٦
Ground floor				39.1	(1a) x	2	.7	(2a) =	105.57	(3a)
First floor				43.3	(1b) x	2	.7	(2b) =	116.91	(3b)
Second floor				31	(1c) x	3	.4	(2c) =	105.4	(3c)
Total floor area TFA = (1a)	+(1b)+(1c)+(1d)+(1e)+(1ı	n) 1	13.4	(4)					
Dwelling volume					(3a)+(3b)+(3c)+(3d))+(3e)+	.(3n) =	327.88	(5)
2. Ventilation rate:										-
	main heating	seconda heating	ry	other		total			m ³ per hour	
Number of chimneys	0 +	0	+	0] = [0	x -	40 =	0	(6a)
Number of open flues	0 +	0	+	0] = [0	x	20 =	0	(6b)
Number of intermittent fan	S				Γ	0	x	10 =	0	(7a)
Number of passive vents					Ē	0	x	10 =	0	(7b)
Number of flueless gas fire	es				Ī	0	X	40 =	0	(7c)
								Air ch	hanges per hou	ır
Infiltration due to chimneys	s, flu <mark>es an</mark> d fans =	(6a)+(6b)+(7	7a)+(7b)+(7c) =	Г	0		÷ (5) =	0	(8)
If a pressurisation test has bee	en ca <mark>rried o</mark> ut or is inter	nded, procee	ed to (17), o	otherwise o	continue fi	rom <mark>(9) to (</mark>	16)			_
Number of storeys in the	e dwelling (ns)								0	(9)
Additional infiltration							[(9)	-1]x0.1 =	0	(10)
Structural infiltration: 0.2	5 for steel or timbe	er frame or	r 0.35 fo	r masoni	ry consti	ruction			0	(11)
if both types of wall are pre- deducting areas of opening	sent, use the value corr s); if equal user 0.35	esponding to	o the great	ter wall are	a (after					
If suspended wooden flo	oor, enter 0.2 (unse	aled) or 0	.1 (seale	ed), else	enter 0				0	(12)
If no draught lobby, ente	er 0.05, else enter ()							0	(13)
Percentage of windows	and doors draught	stripped							0	(14)
Window infiltration				0.25 - [0.2	2 x (14) ÷ 1	100] =			0	(15)
Infiltration rate				(8) + (10)	+ (11) + (′	12) + (13) +	- (15) =		0	(16)
Air permeability value, q	50, expressed in c	ubic metre	es per ho	our per s	quare m	etre of e	nvelope	area	3	(17)
If based on air permeability	y value, then (18) =	[(17) ÷ 20]+(8), otherw	ise (18) = ((16)				0.15	(18)
Air permeability value applies	if a pressurisation test l	nas been doi	ne or a deg	gree air pe	rmeability	is being us	sed			_
Number of sides sheltered									2	(19)
Shelter factor				(20) = 1 -	[0.075 x (′	19)] =			0.85	(20)
Infiltration rate incorporatir	ng shelter factor			(21) = (18) x (20) =				0.13	(21)
Infiltration rate modified for	monthly wind spe	ed	1	<u> </u>	-			1_	1	
Jan Feb N	/lar Apr Ma	y Jun	Jul	Aug	Sep	Oct	Nov	Dec	J	
Monthly average wind spe	ed from Table 7					,		i	1	
(22)m= 5.1 5 4	.9 4.4 4.3	3.8	3.8	3.7	4	4.3	4.5	4.7]	

Wind F	actor (2	22a)m =	(22)m ÷	4										
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18]	
Adjust	ed infiltr	ation rat	e (allow	ing for sl	nelter an	d wind s	peed) =	(21a) x	(22a)m	-			-	
	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15		
Calcul	ate effe	<i>ctive air</i>	change	rate for t	he appli	cable ca	se	-	-	-	-	-		(220)
lf exh	aust air h	eat pump	using App	endix N. (2	3b) = (23a	a) x Fmv (e	equation (I	N5)), othe	rwise (23ł	(23a) = (23a)			0.5	(238)
If bala	anced wit	h heat rec	overy: effic	ciency in %	allowing f	or in-use f	actor (fron	n Table 4h) =	., ()			75.65	(230)
a) If	balance	ed mech	, anical ve	entilation	with he	at recove	∙rv (MVI	HR) (24;	′ a)m = (2	2b)m + (23b) x [*	1 – (23c)	$1001 \div 1001$	(200)
(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27]	(24a)
b) If	balance	ed mech	anical ve	entilation	without	heat rec	ı overy (N	u MV) (24t	m = (2)	1 2b)m + (j	23b)		1	
, (24b)m=	0	0	0	0	0	0	0	0	0	0	0	0]	(24b)
c) If	whole h	iouse ex	tract ver	ntilation of	or positiv	ve input v	ventilatio	n from o	outside	1	1		1	
i	if (22b)r	n < 0.5 >	< (23b), 1	then (24	c) = (23b	o); otherv	wise (24	c) = (22l	o) m + 0	.5 × (23b	o)			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) If	natural if (22b)r	ventilati n = 1, th	on or wh en (24d)	ole hous m = (221	e positiv c)m othe	ve input v erwise (2	ventilatio 4d)m =	on from 0.5 + [(2	loft 2b)m² x	0.5]				
(24d) <mark>m=</mark>	0	0	0	0	0	0	0	0	0	0	0	0		(24d)
Effe	ctive air	change	rate - er	nter (24a) or (24t	o) or (24	c) or (24	d) in bo	(25)				,	
(25)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27		(25)
3 He	at losse	s and he	eat loss	naramet	ar.									
ELEN	/IENT	Gro	SS	Openin	gs	Net Ar	ea	U-val	ue	AXU		k-value	9	AXk
Doors		area	(1112)	II	ا ۲	A ,r				(V V /	N)	KJ/M2•I	n	KJ/K (26)
Windo		- 1				3.30		/[1/(1 5)+	- 0.041 -	4.720	4			(20)
Windo	ws Type	2 2				0.9		/[1/(1.5)+	0.041 _	1.27	\exists			(27)
Windo	ws Type	22				1.0		/[1/(1.5)+	0.041 _	2.12	\exists			(27)
Windo	ws Type	2 4				2.20		/[1/(1.5)+	0.041 -	5.23	\exists			(27)
Windo	ws Type	e 5				3.7	^	/[1/(1.5)+	0.04] =	5 24	\exists			(27)
Windo	ws Type	e 6				3.2	x1	- /[1/(1.5)+	0.04] =	4.53	=			(27)
Floor 7	Type 1					39.1	×	0.12		4.692	= r			(28)
Floor 7	Гуре 2					4.2	×	0.12	=	0.503999	99		\dashv	(28)
Walls		97.0	05	22.8	5	74.2	x	0.15	=	11.13	i F		\dashv	(29)
Roof		43.	3	0		43.3	×	0.12	=	5.2	i F		\dashv	(30)
Total a	area of e	elements	s, m²			183.6	5	•			L			(31)
* for win	dows and	l roof wind	lows, use e	effective wi	ndow U-va	alue calcul	ated using	g formula 1	/[(1/U-vali	ue)+0.04] a	as given in	paragraph	n 3.2	

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

Fabric heat loss, $W/K = S (A \times U)$	(26)(30) + (32) =	53.81	(33)
Heat capacity $Cm = S(A \times k)$	((28)(30) + (32) + (32a)(32e) =	5442.45	(34)
Thermal mass parameter (TMP = $Cm \div TFA$) in kJ/m ² K	Indicative Value: Medium	250	(35)
For design assessments where the details of the construction are not known r	precisely the indicative values of TMP in Table 1f	-	-

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

can be ι	used inste	ad of a de	tailed calc	ulation.										
Therm	al bridg	es : S (L	x Y) cal	culated u	using Ap	pendix l	K						9.28	(36)
if details	of therma	al bridging	are not kn	own (36) =	= 0.05 x (3	1)								_
Total fa	abric he	at loss							(33) +	(36) =			63.09	(37)
Ventila	ation hea	at loss ca	alculated	monthl	y				(38)m	= 0.33 × (25)m x (5)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	30.76	30.42	30.07	28.35	28	26.28	26.28	25.93	26.97	28	28.69	29.38		(38)
Heat tr	ransfer o	coefficie	nt, W/K						(39)m	= (37) + (3	38)m			
(39)m=	93.86	93.51	93.17	91.44	91.1	89.37	89.37	89.03	90.06	91.1	91.79	92.48		
Hoat k		motor (l		/m2k			•	-	(40)m	Average =	Sum(39) _{1.}	12 /12=	91.35	(39)
(40)m-	0.83			0.81	0.8	0.79	0.79	0.79	0.79	- (00)m .	0.81	0.82]	
(40)11-	0.05	0.02	0.02	0.01	0.0	0.79	0.79	0.75	0.75		Sum(40).	0.02 m /12-	0.81	(40)
Numbe	er of day	/s in mo	nth (Tab	le 1a)			-	-	,		Curr(40)1	12712-	0.01	()
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
4. Wa	ater hea	ting ene	rgy requ	irement:								kWh/ye	ear:	
4. Water heating energy requirement: kWh/year:													1	
Assum		upancy, I 9 N – 1	N + 1 76 x	[1 - exp	(-0.0003	249 x (TF	-13 q	(2)1 + 0)013 x (⁻	TFA -13	2.	83		(42)
if TF	A £ 13.	9, N = 1	1.1.0 /		(0.0000		71 10.0	/2/] • 0.0	,010 x (1171 10.	,			
Annua	l averag	e hot wa	ater usag	ge in litre	es per da	ay Vd,av	erage =	(25 x N)	+ 36		10	1.5		(43)
Reduce	the annua a that 125	al average	hot water	usage by : day (all w	5% if the a	welling is	designed : Id)	to achieve	a water us	se target o	f			
not more						iot und oo						_	1	
Hot wat	Jan	Feb	Mar day for e	Apr	May Vd m – fa	Jun	Jul Table 1c x	Aug	Sep	Oct	Nov	Dec		
(1.0)			400.50		va,m = 14				00.47	400.50	407.50	444.05		
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65	1010.00	
Energy	content of	^t hot water	used - cal	culated mo	onthly $= 4$.	190 x Vd,r	m x nm x D)))))))))))))))))))) kWh/mor	nth (see Ta	m(44) ₁₁₂ = ables 1b, 1	= c, 1d)	1218.02	(44)
(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35		
									-	Total = Su	m(45) ₁₁₂ =	-	1597.02	(45)
lf instan	taneous v	vater heati	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46,) to (61)					
(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05		(46)
vvater	storage	IOSS:	ingludir		olor or M		otorogo	within or	mayoa	ool			1	(47)
Slorag				ig any so		///IK3	slorage	within Se	ame ves	sei		150		(47)
II COM	nunity r viso if n	neating a	hot wate	INK IN OW ar (this in	/eiiing, e voludes i	nter 110 netantar		(47) mbi boil	ore) onte	ər '()' in (47)			
Water	storage	loss.	not wate		iciuues i	nstantai								
a) If m	nanufact	turer's de	eclared I	oss facto	or is kno	wn (kWł	n/day):				1.	91		(48)
Tempe	erature f	actor fro	m Table	2b			• •				0.	54		(49)
Enera	v lost fro	om water	storage	. kWh/ve	ear			(48) x (49)	=		1	03		(50)
b) If m	nanufact	turer's de	eclared of	ylinder l	oss fact	or is not	known:	. , . ,				00	l	()
Hot wa	ater stor	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ay)					0		(51)
If com	munity h	neating s	ee secti	on 4.3									1	
Volum	e tactor	Trom Ta	ble 2a m Toble	2h								0		(52)
rempe	siature l	actor Iro		20								U		(53)

Energy	y lost fro	m water	storage	e, kWh/ye	ear			(47) x (51)	x (52) x (53) =		0]	(54)
Enter	(50) or ((54) in (5	o5)					((50))			1.	.03	J	(55)
Water	storage	loss cal	culated 1	for each	month			((56)m = (55) x (41)ı	m		i	1	
(56)m=	31.97	28.88	31.97	30.94	31.97	30.94	31.97	31.97	30.94	31.97	30.94	31.97]	(56)
If cylinde	er contains	s dedicate	d solar sto	orage, (57)i	m = (56)m	x [(50) – (H11)] ÷ (5	0), else (5	7)m = (56)	m where (H11) is fro	m Append	lix H	
(57)m=	31.97	28.88	31.97	30.94	31.97	30.94	31.97	31.97	30.94	31.97	30.94	31.97		(57)
Primar	y circuit	loss (ar	nual) fro	om Table	e 3							0]	(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(mo	dified by	factor fi	rom Tab I	le H5 if t	here is s	solar wat	er heatii	ng and a	cylinde	r thermo	stat)	1	1	(50)
(59)m=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26		(59)
Combi	loss ca	culated	for each	month ((61)m =	(60) ÷ 36	65 × (41))m		-		-	_	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	neat requ	uired for	water h	eating ca	alculated	for eacl	h month	(62)m =	0.85 × ((45)m +	(46)m +	(57)m +	(59)m + (61)	m
(62)m=	220.81	194.71	204.67	183.74	180.24	138.81	131.93	146.68	147.02	190.51	201.12	215.59		(62)
Solar DI	HW input o	calculated	using App	endix G or	· Appendix	H (negativ	ve quantity	/) (enter '0	' if no sola	r contribut	on to wate	er heating)		
(add a	dditiona	l lines if	FGHRS	and/or V	WWHRS	applies	, see Ap	pendix (G)				1	
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	t from wa	ater hea	ter										,	
(64)m=	220.81	194.71	204.67	183.74	180.24	0	0	0	0	19 <mark>0.5</mark> 1	201.12	215.59		_
								Outp	out from wa	ater heate	(annual)₁	12	1591.38	(64)
Output	t immers	sion												
(64)m=	0	0	0	0	0	138.81	131.93	146.68	147.02	0	0	0		
								Outp	out from im	mersion (a	annual) ₁₁₂	2	564.44 <mark>440836</mark> 92	204 <mark>(64)</mark>
Heat g	ains froi	m water	heating,	, kWh/mo	onth 0.2	5 ´ [0.85	× (45)m	Outr + (61)m	but from im $1 + 0.8 \times$	mersion (a	annual) ₁₁₂ + (57)m	+ (59)m	564.4444083692]	204 <mark>(64)</mark>
Heat g (65)m=	ains from 99.24	m water 88.06	heating 93.88	, kWh/mo 86.08	onth 0.23 85.75	5 [0.85 60.62	× (45)m 58.82	Outr + (61)m 63.72	out from im n] + 0.8 > 63.35	mersion (a ([(46)m 89.17	annual) ₁₁₂ + (57)m 91.86	+ (59)m 97.51	564.44 <mark>440836</mark> 92]	(64) (65)
Heat g (65)m= inclu	ains from 99.24 Ide (57)r	m water 88.06 m in calo	heating, 93.88 culation	, kWh/mo 86.08 of (65)m	onth 0.29 85.75 only if c	5 ´ [0.85 60.62 sylinder is	× (45)m 58.82 s in the c	Outr + (61)m 63.72 dwelling	out from im a] + 0.8 × 63.35 or hot w	timersion (a ([(46)m 89.17 ater is fr	annual)₁12 + (57)m 91.86 om com	+ (59)m 97.51 munity h	564.4444083692]] neating	(64) (65)
Heat g (65)m= inclu 5. Int	ains from 99.24 ude (57)m ternal ga	m water 88.06 m in calo ains (see	heating, 93.88 culation of Table 5	, kWh/mo 86.08 of (65)m 5 and 5a)	onth 0.25 85.75 only if c	5 [*] [0.85 60.62 ylinder is	× (45)m 58.82 s in the c	Outp + (61)m 63.72 dwelling	out from im 1] + 0.8 × 63.35 or hot w	mersion (; ((46)m 89.17 ater is fr	annual) ₁₁₂ + (57)m 91.86 om com	+ (59)m 97.51 munity h	564.444408369;	(64) (65)
Heat g (65)m= inclu 5. Inf	ains from 99.24 Ide (57)r ternal ga olic gain	m water 88.06 m in calo ains (see s (Table	heating, 93.88 culation of Table 5 5), Wat	, kWh/mo 86.08 of (65)m 5 and 5a ts	onth 0.29 85.75 only if c	5 ⁻ [0.85 60.62 ylinder is	× (45)m 58.82 s in the c	Outp + (61)m 63.72 dwelling	out from im a] + 0.8 × 63.35 or hot w	(46)m 89.17 ater is fr	annual) ₁₁₂ + (57)m 91.86 om com	+ (59)m 97.51 munity h	564.4444083693	(64) (65)
Heat g (65)m= inclu 5. Int Metabo	ains from 99.24 ude (57)m ternal ga olic gain Jan	m water 88.06 m in calo ains (see s (Table Feb	heating, 93.88 culation of Table 5 5), Wat	kWh/mo 86.08 of (65)m 5 and 5a ts Apr	onth 0.29 85.75 only if c	5 ⁻ [0.85 60.62 ylinder is Jun	× (45)m 58.82 s in the c	Outp + (61)m 63.72 dwelling Aug	out from im 1] + 0.8 > 63.35 or hot w Sep	(46)m 89.17 ater is fr	annual) ₁₁₂ + (57)m 91.86 om com Nov	+ (59)m 97.51 munity h Dec	564.44408369;	(64) (65)
Heat g (65)m= inclu 5. Int Metabo (66)m=	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69	m water 88.06 m in calo ains (see s (Table Feb 141.69	heating 93.88 culation Table 5 5), Wat Mar 141.69	, kWh/ma 86.08 of (65)m 5 and 5a ts Apr 141.69	onth 0.29 85.75 only if c): May 141.69	5 ⁻ [0.85 60.62 ylinder is Jun 141.69	× (45)m 58.82 s in the c Jul 141.69	Outp + (61)m 63.72 dwelling Aug 141.69	vut from im 0] + 0.8 > 63.35 or hot w Sep 141.69	((46)m 89.17 ater is fr Oct 141.69	annual) ₁₁₂ + (57)m 91.86 om com om com Nov 141.69	+ (59)m 97.51 munity h Dec 141.69	564.444083693	(65) (66)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 g gains	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula	heating 93.88 culation of Table 5 5), Wat Mar 141.69 ted in Ap	, kWh/mo 86.08 of (65)m 5 and 5a ts Apr 141.69 opendix	onth 0.25 85.75 only if c): May 141.69 L, equat	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 o	× (45)m 58.82 s in the c Jul 141.69 r L9a), a	Outp + (61)m 63.72 dwelling Aug 141.69 Iso see	1] + 0.8 > 63.35 or hot w Sep 141.69 Table 5	((46)m 89.17 ater is fr Oct 141.69	annual) ₁₁₂ + (57)m 91.86 om com 0m com Nov 141.69	+ (59)m 97.51 munity h Dec 141.69	564.44408369	(66) (66)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m=	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 g gains 24.63	m water 88.06 m in cald ains (see s (Table Feb 141.69 (calcula 21.88	heating, 93.88 culation (Table 5 5), Wat 411.69 ted in Ap 17.79	, kWh/mo 86.08 of (65)m 5 and 5a ts Apr 141.69 opendix 13.47	onth 0.29 85.75 only if c : May 141.69 L, equat	5 [•] [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19	Outp + (61)m 63.72 dwelling Aug 141.69 Iso see 11.94	vut from im i] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03	(46)m 89.17 ater is fr Oct 141.69 20.35	annual) ₁₁₂ + (57)m 91.86 om com 0m com Nov 141.69 23.75	+ (59)m 97.51 munity h Dec 141.69	564.444083693	(64) (65) (66) (67)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 og gains 24.63 nces gai	m water 88.06 m in calo s (Table Feb 141.69 (calcula 21.88 ins (calc	heating 93.88 culation of Table 5 5), Wat Mar 141.69 ted in Ap 17.79 ulated ir	, kWh/ma 86.08 of (65)m 5 and 5a ts Apr 141.69 5 pendix 1 13.47	onth 0.29 85.75 only if c): May 141.69 L, equati 10.07 dix L, eq	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also	vut from im 0] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Table 5	(46)m 89.17 ater is fr Oct 141.69 20.35 ble 5	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75	+ (59)m 97.51 munity h Dec 141.69	564.44 <mark>40836</mark> 9	(64) (65) (66) (67)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m=	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 ug gains 24.63 nces gai 276.35	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula 21.88 ins (calc 279.22	heating, 93.88 culation (5), Wat 5), Wat 141.69 ted in Ap 17.79 ulated in 271.99	kWh/mo 86.08 of (65)m 5 and 5a 5 and 5a 141.69 5 pendix 13.47 6 Append 256.61	00000000000000000000000000000000000000	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L 218.94	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88	vut from im 0] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 > see Tal 211.1	Operation Contemporation Contemporatintemporatintematches Contemporation	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16	564.44408369;] heating	 (64) (65) (66) (67) (68)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m= Cookir	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 g gains 24.63 nces gai 276.35 ng gains	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula	heating, 93.88 culation (Table 5 5), Wat 141.69 ted in Ap 17.79 culated ir 271.99 tted in A	kWh/mo 86.08 of (65)m 5 and 5a ts Apr 141.69 opendix 13.47 n Append 256.61 ppendix	onth 0.29 85.75 only if c : 141.69 L, equati 10.07 dix L, eq 237.19 L, equat	5 [•] [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L 218.94 ion L15	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a)	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88), also se	vut from im 0] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 se Table	(46)m 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16	564.444083693	 (64) (65) (66) (67) (68)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m= Cookir (69)m=	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 g gains 24.63 nces gai 276.35 ng gains 37.17	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17	heating, 93.88 culation (Table 5), Wat 5), Wat 141.69 ted in Ap 17.79 ulated in 271.99 ated in A 37.17	, kWh/md 86.08 of (65)m 5 and 5a ts 141.69 5 pendix 13.47 1 Append 256.61 5 ppendix 37.17	onth 0.29 85.75 only if c): 141.69 L, equati 10.07 dix L, eq 237.19 L, equat 37.17	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L9 218.94 tion L15 37.17	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17	Outp + (61)m 63.72 dwelling dwelling 141.69 Iso see 11.94 3a), also 203.88), also se 37.17	vut from im i) + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 > see Tal 211.1 ee Table 37.17	Operation (a) ((46)m) 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91 37.17	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17	564.444083693	 (64) (65) (66) (67) (68) (69)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Appliat (68)m= Cookir (69)m= Pumps	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 ug gains 24.63 nces gai 276.35 ng gains 37.17 s and far	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains	heating, 93.88 culation of Table 5 5), Wat 141.69 ted in Ap 17.79 ulated in 271.99 uted in A 37.17 (Table 5	kWh/mo 86.08 of (65)m and 5a ts Apr 141.69 opendix 13.47 Append 256.61 ppendix 37.17 5a)	onth 0.29 85.75 only if c : 141.69 L, equat 10.07 dix L, equat 237.19 L, equat 37.17	5 [•] [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L 218.94 ion L15 37.17	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88), also se 37.17	vut from im i) + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 ee Table 37.17	Immersion (a ([(46)m] 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91 37.17	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17	564.444083693	 (64) (65) (66) (67) (68) (69)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applian (68)m= Cookir (69)m= Pumps (70)m=	ains from 99.24 ude (57)m ernal ga olic gain Jan 141.69 g gains 24.63 nces gai 276.35 ng gains 37.17 s and far 0	m water 88.06 m in calo ains (see 5 (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 ulated ir 271.99 tted in A 37.17 (Table \$ 0	kWh/mo 86.08 of (65)m 5 and 5a ts Apr 141.69 opendix 13.47 n Appendix 256.61 ppendix 37.17 5a) 0	onth 0.29 85.75 only if c): May 141.69 L, equati 10.07 dix L, eq 237.19 L, equat 37.17	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L9 218.94 ion L15 37.17	× (45)m 58.82 s in the o Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17 0	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88), also se 37.17	out from im [] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 > see Tal 211.1 >e Table 37.17 0	0 (46)m 89.17 ater is fr ater is fr 0 141.69 20.35 ble 5 226.49 5 37.17 0 0	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91 37.17	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17	564.444083693	 (64) (65) (65) (66) (67) (68) (69) (70)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m= Cookir (69)m= Pumps (70)m= Losses	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 og gains 24.63 nces gai 276.35 ng gains 37.17 s and far 0 s e.g. ev	m water 88.06 m in calo ains (see S (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0 raporatic	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 ulated in 271.99 uted in A 37.17 (Table \$ 0 on (nega	kWh/mo 86.08 of (65)m 5 and 5a 5 and 5a 5 and 5a 141.69 0 pendix 13.47 14.10 13.47 15.17 1	onth 0.29 85.75 only if c : 141.69 L, equati 10.07 dix L, eq 237.19 L, equat 37.17 0 es) (Tab	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L9 218.94 ion L15 37.17 0 le 5)	× (45)m 58.82 s in the o Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17	Outp + (61)m 63.72 dwelling dwelling 141.69 Iso see 11.94 3a), also 203.88), also se 37.17	vut from im 63.35 or hot w 63.35 or hot w 141.69 Table 5 16.03 o see Tal 211.1 ee Table 37.17 0	Operation (a) ((46)m) 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17 0	annual) ₁₁₂ + (57)m 91.86 om com 0m com 141.69 23.75 245.91 37.17	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17	564.444083693	 (64) (65) (65) (66) (67) (68) (69) (70)
Heat g (65)m= inclu 5. Int Metabu (66)m= Lightin (67)m= Appliat (68)m= Cookir (69)m= Pumps (70)m= Losses (71)m=	ains from 99.24 ude (57)m ternal ga olic gain 141.69 ug gains 24.63 nces gai 276.35 ng gains 37.17 s and far 0 s e.g. ev -113.35	m water 88.06 m in calo ains (see S (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0 aporatic -113.35	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 culated in 271.99 culated in A 37.17 (Table 5 0 on (nega -113.35	kWh/md 86.08 of (65)m and 5a ts Apr 141.69 opendix 13.47 n Append 256.61 ppendix 37.17 5a) 0 tive valu -113.35	onth 0.29 85.75 only if c : 141.69 L, equat 10.07 dix L, eq 237.19 L, equat 37.17 0 es) (Tab -113.35	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L 218.94 ion L15 37.17 0 le 5) -113.35	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17 0 -113.35	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88 0, also se 37.17 0	vut from im 0] + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 ce Table 37.17 0 -113.35	Immersion (a ([(46)m] 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17 0 -113.35	annual),12 + (57)m 91.86 om com 0 23.75 245.91 37.17 0 -113.35	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17 0	564.444083693	 (64) (65) (65) (66) (67) (68) (69) (70) (71)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m= Cookir (69)m= Pumps (70)m= Losses (71)m= Water	ains from 99.24 ude (57)m ternal ga olic gain Jan 141.69 g gains 24.63 nces gai 276.35 ng gains 37.17 s and far 0 s e.g. ev -113.35 heating	m water 88.06 m in calo ains (see S (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0 aporatio -113.35 gains (T	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 culated in A 37.17 (Table 5 0 n (nega -113.35 Table 5)	, kWh/md 86.08 of (65)m 5 and 5a ts 141.69 opendix 13.47 a Appendix 256.61 ppendix 37.17 5a) 0 tive valu -113.35	onth 0.29 85.75 only if c): 141.69 L, equati 10.07 dix L, equati 237.19 L, equati 37.17 0 es) (Tab -113.35	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L9 218.94 ion L15 37.17 0 le 5) -113.35	× (45)m 58.82 s in the o Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17 0 -113.35	Outp + (61)m 63.72 dwelling 141.69 Iso see 11.94 3a), also 203.88), also se 37.17 0	out from im i) + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 ce Table 37.17 0 -113.35	0 (46)m 89.17 (46)m ater is fr (141.69) 20.35 (141.69) 20.35 (141.69) 5 (141.69) 5 (141.69) 6 (141.69) 6 (141.69) 7 (141.69) 141.69 (141.69)	annual) ₁₁₂ + (57)m 91.86 om com 0 141.69 23.75 245.91 37.17 0 -113.35	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17 0	564.444083693	 (64) (65) (66) (67) (68) (69) (70) (71)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applia (68)m= Cookir (69)m= Pumps (70)m= Losses (71)m= Water (72)m=	ains from 99.24 ude (57)m ternal ga olic gain 141.69 ug gains 24.63 nces gai 276.35 ng gains 37.17 and far 0 s e.g. ev -113.35 heating 133.39	m water 88.06 m in calo ains (see S (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0 aporatic -113.35 gains (T 131.05	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 ulated in 271.99 uted in A 37.17 (Table 5 0 on (nega -113.35 able 5) 126.18	kWh/mo 86.08 of (65)m 5 and 5a 5 and 5a 5 and 5a 141.69 opendix 13.47 13.47 13.47 13.47 256.61 ppendix 37.17 5a) 0 tive valu -113.35	onth 0.29 85.75 only if c : May 141.69 L, equati 10.07 dix L, equati 237.19 L, equati 37.17 0 es) (Tab -113.35	5 [•] [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L 218.94 ion L15 37.17 0 le 5) -113.35	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17 0 -113.35	Outp + (61)m 63.72 dwelling dwelling 141.69 Iso see 11.94 3a), also 203.88 3, also se 37.17 0 -113.35	vut from im i) + 0.8 × 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 ce Table 37.17 0 -113.35 87.98	Immersion (a ([(46)m] 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17 0 -113.35 119.85	annual),12 + (57)m 91.86 om com 0 141.69 23.75 245.91 37.17 0 -113.35	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17 0 -113.35	564.444083693	 (64) (65) (65) (66) (67) (68) (69) (70) (71) (72)
Heat g (65)m= inclu 5. Int Metabo (66)m= Lightin (67)m= Applian (68)m= Cookir (69)m= Pumps (70)m= Losses (70)m= Uosses (71)m= Water (72)m=	ains from 99.24 ude (57)m ernal ga olic gain Jan 141.69 g gains 24.63 nces gai 276.35 ng gains 37.17 s and far 0 s e.g. ev -113.35 heating 133.39	m water 88.06 m in calo ains (see s (Table Feb 141.69 (calcula 21.88 ins (calc 279.22 (calcula 37.17 ns gains 0 aporatic -113.35 gains (T 131.05 gains =	heating, 93.88 culation (5), Wat 141.69 ted in Ap 17.79 tulated in 271.99 tited in A 37.17 (Table 5 0 on (nega -113.35 Table 5) 126.18	kWh/md 86.08 of (65)m 5 and 5a ts 141.69 opendix 13.47 n Append 256.61 ppendix 37.17 5a) 0 tive valu -113.35	onth 0.29 85.75 only if c : 141.69 L, equati 10.07 dix L, equati 237.19 L, equati 37.17 0 es) (Tab -113.35	5 [0.85 60.62 ylinder is Jun 141.69 ion L9 of 8.5 uation L9 218.94 ion L15 37.17 0 le 5) -113.35 84.2 (66)	× (45)m 58.82 s in the c Jul 141.69 r L9a), a 9.19 13 or L1 206.74 or L15a) 37.17 0 -113.35 79.05 m + (67)m	Outp + (61)m 63.72 dwelling dwelling 141.69 lso see 11.94 3a), also 203.88 0, also se 37.17 0 -113.35 85.64	out from im i) + 0.8 > 63.35 or hot w Sep 141.69 Table 5 16.03 o see Tal 211.1 ce Table 37.17 0 -113.35 87.98 (69)m + (Operation (a) ((46)m) 89.17 ater is fr Oct 141.69 20.35 ble 5 226.49 5 37.17 0 -113.35 119.85 (70)m + (7)	annual),12 + (57)m 91.86 om com 0 141.69 23.75 245.91 37.17 0 -113.35 127.58 1)m + (72)	+ (59)m 97.51 munity h Dec 141.69 25.32 264.16 37.17 0 -113.35 131.06	564.444083693	204 (64) (65) (66) (67) (68) (69) (70) (71) (72)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.77	x	0.9	×	36.79	×	0.63	x	0.8] =	11.57	(77)
Southeast 0.9x	0.77	x	1.5	×	36.79	x	0.63	x	0.8	j =	19.28	– (77)
Southeast 0.9x	0.77	x	2.28	×	36.79	x	0.63	x	0.8	i =	29.3	– (77)
Southeast 0.9x	0.77	x	4.2	×	36.79	x	0.63	x	0.8	i =	53.97	– (77)
Southeast 0.9x	0.77	x	0.9	×	62.67	x	0.63	x	0.8	i =	19.7	– (77)
Southeast 0.9x	0.77	x	1.5	×	62.67	x	0.63	x	0.8] =	32.84	(77)
Southeast 0.9x	0.77	x	2.28	×	62.67	x	0.63	x	0.8] =	49.91	– (77)
Southeast 0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.8	j =	91.94	– (77)
Southeast 0.9x	0.77	x	0.9	×	85.75	x	0.63	x	0.8	i =	26.96	– (77)
Southeast 0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.8	j =	44.93	– (77)
Southeast 0.9x	0.77	x	2.28	×	85.75	x	0.63	x	0.8	i =	68.29	– (77)
Southeast 0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.8] =	125.79	(77)
Southeast 0.9x	0.77	x	0.9	×	106.25	x	0.63	Х	0.8	1 =	33.4	(77)
Southeast 0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.8	j _	55.67	– (77)
Southeast 0.9x	0.77	x	2.28	x	106.25	İ 🖈	0.63	x	0.8	=	84.61	(77)
Southeast 0.9x	0.77	x	4.2	x	106.25	x	0.63	x	0.8	j =	155.87	– (77)
Southeast 0.9x	0.77	x	0.9	×	119.01	×	0.63	x	0.8	i =	37.41	– (77)
Southeast 0.9x	0.77	x	1.5	x	119.01	x	0.63	x	0.8	i =	62.35	– (77)
Southeast 0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.8	j =	94.77	– (77)
Southeast 0.9x	0.77	x	4.2	×	119.01	x	0.63	x	0.8	=	174.58	(77)
Southeast 0.9x	0.77	x	0.9	×	118.15	x	0.63	x	0.8] =	37.14	(77)
Southeast 0.9x	0.77	x	1.5	×	118.15	x	0.63	x	0.8] =	61.9	(77)
Southeast 0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.8] =	94.09	(77)
Southeast 0.9x	0.77	x	4.2	×	118.15	x	0.63	x	0.8] =	173.32	(77)
Southeast 0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.8] =	35.81	(77)
Southeast 0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.8] =	59.68	(77)
Southeast 0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.8] =	90.71	(77)
Southeast 0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.8] =	167.1	(77)
Southeast 0.9x	0.77	x	0.9	×	104.39	x	0.63	x	0.8] =	32.81	(77)
Southeast 0.9x	0.77	x	1.5	×	104.39	x	0.63	x	0.8] =	54.69	(77)
Southeast 0.9x	0.77	x	2.28	×	104.39	x	0.63	x	0.8	j =	83.13	– (77)
Southeast 0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.8	i =	153.13	(77)
Southeast 0.9x	0.77	x	0.9	×	92.85	×	0.63	×	0.8] =	29.19	(77)
Southeast 0.9x	0.77	x	1.5	×	92.85	×	0.63	×	0.8] =	48.65	(77)
Southeast 0.9x	0.77	x	2.28	×	92.85	×	0.63	×	0.8	=	73.94	(77)
Southeast 0.9x	0.77	x	4.2	×	92.85	x	0.63	×	0.8] =	136.21	(77)

Southeast 0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.8	=	21.77	(77)
Southeast 0.9x	0.77	x	1.5	x	69.27	x	0.63	x	0.8] =	36.29	(77)
Southeast 0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.8] =	55.16	(77)
Southeast 0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.8	=	101.61	(77)
Southeast 0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.8] =	13.85	(77)
Southeast 0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.8] =	23.09	(77)
Southeast 0.9x	0.77	x	2.28	x	44.07	×	0.63	x	0.8] =	35.1	(77)
Southeast 0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.8] =	64.65	(77)
Southeast 0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.8	=	9.9	(77)
Southeast 0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.8	=	16.5	(77)
Southeast 0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.8] =	25.08	(77)
Southeast 0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.8] =	46.19	(77)
Northwest 0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.8	=	29.16	(81)
Northwest 0.9x	0.77	x	3.2	x	11.28	×	0.63	x	0.8] =	12.61	(81)
Northwest 0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.8] =	59.36	(81)
Northwest 0.9x	0.77	x	3.2	x	22.97	×	0.63	x	0.8] =	25.67	(81)
Northwest 0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.8] =	106.95	(81)
Northwest 0.9x	0.77	x	3.2	×	41.38	x	0.63	x	0.8	=	46.25	(81)
Northwest 0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.8	-	175.64	(81)
Northwest 0.9x	0.77	x	3.2	x	67.96	×	0.63	x	0.8	=	75.95	(81)
Northwest 0.9x	0.7 <mark>7</mark>	x	3.7	x	91.35	x	0.63	x	0.8	=	236.09	(81)
Northwest 0.9x	0.77	x	3.2	x	91.3 <mark>5</mark>	x	0.63	x	0.8	=	102.09	(81)
Northwest 0.9x	0.77	x	3.7	x	97.38	x	0.63	x	0.8	=	251.7	(81)
Northwest 0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.8	=	108.84	(81)
Northwest 0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.8	=	235.46	(81)
Northwest 0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.8	=	101.82	(81)
Northwest 0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.8	=	187.71	(81)
Northwest 0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.8	=	81.17	(81)
Northwest 0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.8	=	130.32	(81)
Northwest 0.9x	0.77	x	3.2	×	50.42	×	0.63	x	0.8] =	56.35	(81)
Northwest 0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.8] =	72.54	(81)
Northwest 0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.8] =	31.37	(81)
Northwest 0.9x	0.77	×	3.7	×	14.2	×	0.63	x	0.8] =	36.69	(81)
Northwest 0.9x	0.77	x	3.2	×	14.2	×	0.63	x	0.8] =	15.87	(81)
Northwest 0.9x	0.77	x	3.7	×	9.21	×	0.63	x	0.8	=	23.82	(81)
Northwest 0.9x	0.77	x	3.2	x	9.21	×	0.63	x	0.8] =	10.3	(81)

Solar gains in watts, calculated for each month(83)m = Sum(74)m(82)m												_		
(83)m=	155.89	279.41	419.16	581.13	707.3	726.99	690.58	592.66	474.66	318.75	189.25	131.77		(83)
Total g	ains – ii	nternal a	ind solar	(84)m =	= (73)m -	⊦ (83)m	, watts							
(84)m=	(84)m= 655.77 777.07 900.63 1036.28 1135.33 1104.13 1051.07 959.62 855.27 750.94 652 617.8													(84)
7. Mean internal temperature (heating season)														
Temp	erature	during h	leating p	eriods ir	n the livir	ng area f	from Tab	ole 9, Th	1 (°C)				21	(85)
Utilisa	tilisation factor for gains for living area, h1,m (see Table 9a)													
Stroma FSAM 2012 VESDon 1.04.35 (SAM 9.52) - http://www.stuma.com/ul Aug Sep Oct Nov Dec												Dec	Pag	e 6 of 9

(86)m=	1	0.99	0.98	0.9	0.72	0.52	0.37	0.43	0.7	0.95	0.99	1		(86)
Mean	interna	l temper	ature in	living are	ea T1 (fo	ollow ste	ps 3 to 7	7 in Table	e 9c)					
(87)m=	20.2	20.35	20.59	20.84	20.97	21	21	21	20.98	20.79	20.44	20.18		(87)
Temp	erature	during h	eating p	eriods ir	n rest of	dwelling	from Ta	able 9, Tl	h2 (°C)					
(88)m=	20.23	20.23	20.23	20.25	20.25	20.26	20.26	20.27	20.26	20.25	20.25	20.24		(88)
Utilisa	ation fac	tor for g	ains for	rest of d	welling,	h2.m (se	e Table	9a)						
(89)m=	1	0.99	0.97	0.87	0.67	0.46	0.31	0.36	0.64	0.93	0.99	1		(89)
Mean	interna	l temper	ature in	the rest	of dwelli	ina T2 (fe	ollow ste	eps 3 to 7	7 in Tabl	e 9c)				
(90)m=	19.15	19.38	19.71	20.07	20.22	20.26	20.26	20.27	20.24	20.02	19.52	19.12		(90)
I									f	LA = Livin	g area ÷ (4	4) =	0.22	(91)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	llina) = fl	A 🗙 T1	+ (1 – fl	A) x T2			I		
(92)m=	19.38	19.6	19.91	20.25	20.39	20.43	20.43	20.43	20.41	20.19	19.73	19.36		(92)
Apply	adjustn	nent to t	he mear	internal	l temper	i ature fro	n Table	4e, whe	ere appro	priate				
(93)m=	19.38	19.6	19.91	20.25	20.39	20.43	20.43	20.43	20.41	20.19	19.73	19.36		(93)
8. Spa	ace hea	ting requ	uirement			-	-			-				
Set Ti	i to the r	mean int	ernal ter	mperatu	re obtain	ned at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	ilisation	factor fo	or gains	using Ta	able 9a	lur		A	0	Ort	Nierre	Dee		
Litilies	Jan tion fac	tor for a	ains hm	Apr	Iviay	Jun	Jui	Aug	Sep	Oct	INOV	Dec		
(94)m=	1	0.99	0.97	0.87	0.68	0.47	0.33	0.37	0.65	0.93	0.99	1		(94)
Usefu	I gains,	hmGm .	W = (9	4)m x (84	4)m	-								
(95)m=	653.56	769.19	8 <mark>69.36</mark>	902.94	769.47	519.17	342.05	358.55	556.08	69 <mark>6.09</mark>	645.95	616.36		(95)
Month	nly avera	age exte	rnal terr	perature	e from Ta	able 8								
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	1 <mark>0.6</mark>	7.1	4.2		(96)
Heat	oss rate	e for mea	an interr	al tempe	erature,	Lm , W =	=[(39)m	x [(93)m	– (96)m]	r		I	
(97)m=	1415.49	1374.24	1248.97	1037.48	791.76	520.74	342.15	358.81	568.26	873.56	1159.04	1401.65]	(97)
Space	e heatin	g require	ement fo	r each n	nonth, k	Wh/mont	th = 0.02	24 x [(97))m – (95)m] x (4 ⁻	1)m			
(98)m=	566.87	406.6	282.43	96.87	16.59	0	0	0	0	132.04	369.42	584.26		
								lota	l per year	(kWh/year	r) = Sum(9	8)15,912 =	2455.07	(98)
Space	e heatin	g require	ement in	kWh/m ²	²/year								21.65	(99)
9a. En	ergy rec	luiremer	nts – Ind	ividual h	eating s	ystems i	ncluding	micro-C	CHP)					
Space	e heatir	ng:	4 fra									ſ		
Fracti	on of sp	ace nea	it from s	econdar	y/supple	mentary	system	(202) 4	(204)				0	(201)
Fracti	on of sp	ace hea	it from m	nain syst	em(s)			(202) = 1 -	- (201) =				1	(202)
Fracti	on of to	tal heatii	ng from	main sys	stem 1			(204) = (2	02) × [1 –	(203)] =			1	(204)
Efficie	ency of r	main spa	ace heat	ing syste	em 1								190.24	(206)
Efficie	ency of s	seconda	ry/suppl	ementar	y heating	g system	ח, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/y	ear
Space	e heatin	g require	ement (c	alculate	d above))							1	
	566.87	406.6	282.43	96.87	16.59	0	0	0	0	132.04	369.42	584.26		
(211)m	ı = {[(98)m x (20	4)] } x 1	00 ÷ (20)6)			,					1	(211)
	297.97	213.72	148.45	50.92	8.72	0	0	0	0	69.4	194.18	307.11	<u> </u>	_
								Tota	I (kWh/yea	ar) = Sum(2)	2 11) _{15,1012}	-	1290.48	(211)

Space heating fuel (secondary), kWh/month

= {[(98	3)m x (20	01)] } x 1	00 ÷ (20)))										
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
		-	-				-	Tota	al (kWh/yea	ar) =Sum(2	215) _{15,101}	2	0	(215)
Water	heating	g												
Outpu	t from w	ater hea	$\frac{1}{204.67}$	ulated a	bove) 180.24	0	0	0	0	190.51	201.12	215.59		
Efficie	ncy of w	l ater hea	ater			Ů	Ů	Ů		100101			270.94	(216)
(217)m=	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94		(217)
Fuel fo	or water	heating	, kWh/m	onth		1		1					1	
(219)r	n = (64))m x 10	0 ÷ (217)m	00.50					70.04	74.00	70 57	1	
(219)m=	81.5	/1.86	75.54	67.81	66.53	0	0	U Tota	0 = Sum(2)	(70.31)	74.23	79.57	E97.26	
Water	heating	require	ment (im	mersion)			1010	u – Ouri(2	1000 ₁₁₂ –			567.30	(219)
valor				0	0	138.81	131.93	146.68	147.02	0	0	0		
Efficie	ncy of w	ater hea	ater (Imr	nersion)									100	(216)
(217)m=	0	0	0	0	0	100	100	100	100	0	0	0		(217)
Fuel fo	or water	heating	(Immers	sion), kW	h/month	I								
(219)r (219)m	n = [(64)m + (2 ⁻	$\frac{18}{0}$ m x	(2 <u>100</u> ÷ (2	<u>17)m</u>	138.81	131.93	146.68	147.02	0	0	0		
` '			1					Tota	I = Sum(2)	19a) ₁₁₂ =			564.44	(219)
Annua	al totals	;								k	Wh/yeai	r	kWh/year	
Space	e heating	g fuel u <mark>s</mark> e	ed, mair	system	1								1290.48	
Wat <mark>er</mark>	heating	fuel use	ed										587.36	7
Water	heating	fuel use	ed (Imme	ersion)									564.44	1
Electri	city for	oumps, f	ans and	electric	keep-ho	t								
mech	nanical v	ventilatio	n - balaı	nced, ext	ract or p	ositive i	nput fron	n outside	e			295.01		(230a)
Total e	electricit	y for the	above,	kWh/yea	r.			sum	of (230a).	(230g) =	:		295.01	(231)
Electri	city for I	ighting		-									435.02	(232)
12a.	CO2 err	nissions	– Indivic	lual heati	ing syste	ems inclu	uding mi	cro-CHF	þ					_
						En	orav			Emico	ion fac	tor	Emissions	
						k٧	/h/year			kg CO	2/kWh		kg CO2/yea	ar
Space	heating	g (main s	system 1)		(21	1) x			0.5	19	=	669.76	(261)
Space	heating	g (secon	dary)			(21	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.5	19	=	304.84	(264)
Water	heating	(Imme	rsion)			(219	9) x			0.5	19	=	292.95	(264)
Space	and wa	ater heat	ing			(26	1) + (262)	+ (263) + ((264) =				1267.54	(265)
Electri	city for p	oumps, f	ans and	electric	keep-ho	t (23 ⁻	1) x			0.5	19	=	153.11	(267)
Electri	city for I	ighting				(232	2) x			0.5	19	=	225.77	(268)
Energ Total (y saving CO2, kg	g/genera /year	tion tech	nologies					sum o	of (265)(2	271) =		1646.43	(272)

Dwelling CO2 Emission Rate

El rating (section 14)

(272)	÷	(4)	=	
(212)		(7)	_	

14.52	(273)
86	(274)



				User D	etails:						
Assessor Name: Software Name:	Stroma FS	AP 201	2		Strom Softwa	a Num are Vei	ber: rsion:		Versio	n: 1.0.4.25	
			Р	roperty	Address	: House	1 (ASHF	P) S2A			
Address :											
1. Overall dwelling dime	ensions:										
				Are	a(m²)	I	Av. Hei	ight(m)	-	Volume(m ³)	-
Ground floor					39.1	(1a) x	2	2.7	(2a) =	105.57	(3a)
First floor					43.3	(1b) x	2	2.7	(2b) =	116.91	(3b)
Second floor					31	(1c) x	3	3.4	(2c) =	105.4	(3c)
Total floor area TFA = (1	a)+(1b)+(1c)+	(1d)+(1e)+(1r	I) 1	13.4	(4)			-		_
Dwelling volume						(3a)+(3b)+(3c)+(3d	l)+(3e)+	.(3n) =	327.88	(5)
2. Ventilation rate:											-
	main heating	se h	econdar eating	У	other		total			m ³ per hour	
Number of chimneys	0	+	0	+	0] = [0	X 4	40 =	0	(6a)
Number of open flues	0	+	0] + [0] = [0	× 2	20 =	0	(6b)
Number of intermittent fa	ans					- Ē	4	x *	10 =	40	(7a)
Number of passive vents	5						0	x ′	10 =	0	(7b)
Number of flueless gas f	ires					Ē	0	X 4	40 =	0	(7c)
									Air ch	anges per hou	ır
Infiltration due to chimne	evs flues and f	ans = (68	a)+(6b)+(7	a)+(7b)+(7c) =	Г	40	<u> </u>	÷ (5) −		1 (8)
If a pressurisation test has l	been carried out of	is intende	d. procee	d to (17).	otherwise o	continue fr	rom (9) to (16)	. (0) –	0.12	
Number of storeys in t	he dwelling (na	3)	.,,				- (-) - (-/		0	(9)
Additional infiltration	0.	,						[(9)·	-1]x0.1 =	0	(10)
Structural infiltration: 0	.25 for steel or	timber f	rame or	0.35 fo	r masoni	ry constr	ruction			0	(11)
if both types of wall are p	resent, use the va	lue corres	conding to	the great	ter wall are	a (after					4
deducting areas of openi	ngs); if equal user floor, optor 0,2	0.35 (uppool	ad) or 0	1 (000)	ad) alaa	optor 0					
If suspended wooden				r (Seale	eu), eise					0	(12)
Porcontago of window	and doors dr	aught et	rinnod							0	$ \begin{bmatrix} (13) \\ (14) \end{bmatrix} $
Window infiltration	5 anu uoors ur	augiit st	nppeu		0 25 - [0 2	' x (14) ∸ 1	001 =			0	$\int_{(14)}^{(14)}$
Infiltration rate					(8) + (10)	+(11)+(1)	12) + (13) +	+ (15) =		0	$\int_{(16)}^{(15)}$
	a50 evoress	d in cub	ic motro	s nor ha			etre of e		area	0	(10)
If based on air permeabi	lity value then	(18) = [(1)]	$7) \div 20]+(8)$	3), otherw	ise (18) = ((16)		invelope	area	5	(17)
Air permeability value applie	es if a pressurisation	on test has	been don	e or a de	aree air pe	rmeabilitv	is beina us	sed		0.37	
Number of sides sheltere	ed					, in the second s	5			2	(19)
Shelter factor					(20) = 1 -	[0.075 x (1	19)] =			0.85	(20)
Infiltration rate incorpora	ting shelter fac	tor			(21) = (18) x (20) =				0.32	(21)
Infiltration rate modified	for monthly wir	d speed									-
Jan Feb	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp	beed from Tabl	e 7									
(22)m= 5.1 5	4.9 4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7		

Wind F	actor (2	22a)m =	(22)m ÷	4										
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18		
Adjuste	ed infiltr	ation rat	e (allowi	ing for sł	nelter an	nd wind s	peed) =	(21a) x	(22a)m					
	0.4	0.4	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.36	0.37		
Calcula	ate effe	ctive air	change	rate for t	he appli	cable ca	se	•		•			_	
II ME	echanica			ondiv N (2	(26) - (22)		austion (I	NE)) otho	nuico (22)	(222)		l	0	(23a)
lf bala	aust all II	beat reco	worv: offic	$\frac{1}{2}$	(200) = (200)	for in-use f	ector (fron	n Table 4b	1 WISE (231	5) = (25a)		l	0	(23b)
)-)	2h)m (226) [·	1 (22a)	0	(23c)
a) II								чк) (24a 	$\frac{1}{2}$	$\frac{20}{1}$ $\frac{1}{0}$	230) × [1 - (230)	÷ 100]	(24a)
(24a)III-	bolonor				without	hoot roo			$\int \frac{1}{\sqrt{2}}$	$\frac{1}{2}$	22h)	0		(244)
(24b)m-								VIV) (241.	D = (2	$\frac{20}{1}$ $\frac{1}{0}$	230)			(24b)
(240)III-			tractiver				untilatio			0	0	0		(210)
c) ii	f (22b)r	$0.5 \times 0.5 $	(23b), 1	then (24)	c) = (23t)): otherv	vise (24	c) = (22b)	b) m + 0	.5 x (23b))			
(24c)m=	0	0	0		0		0			0	0	0		(24c)
) If	natural	L ventilatio	l on or wh	L Iole hous	L	L I	ventilatio	I on from l	L loft	I	1			
u) II i	f (22b)r	n = 1, the	en (24d)	m = (22)	o)m othe	erwise (2	4d)m =	0.5 + [(2	2b)m² x	0.5]				
(24d) <mark>m=</mark>	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57		(24d)
Effec	ctive air	change	rate - er	nter (24a) or (24k	o) or (240	c) or (24	d) in box	x (25)					
(25)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57		(25)
3 He	at losse	s and he	at loss i	naramet	or.									
ELEN	IENT	Gros	SS (m2)	Openin	gs	Net Are	ea	U-val	ue	AXU		k-value		A X k
Doors		area	(112)	11	14	A , I				(\ \ \ \		KJ/III-•r		KJ/K (26)
Windo		1				3.38		1.2 /[1/(1.4.)_	- 0.041	4.05	4			(20)
Windo	wa Type					0.9		/[1/(1.4)+	0.04] =	1.19	\dashv			(27)
	ws type	÷ Z				1.5		/[1/(1.4)+	0.04] =	1.99				(27)
VVINGO	ws type	3				2.28	X1	/[1/(1.4)+	0.04] =	3.02				(27)
vvindo\	ws type —	e 4 -				4.2	x1	/[1/(1.4)+	• 0.04] =	5.57				(27)
Window	ws Type	95				3.7	x1	/[1/(1.4)+	0.04] =	4.91				(27)
Window	ws Type	e 6				3.2	x1	/[1/(1.4)+	0.04] =	4.24				(27)
Floor T	ype 1					39.1	x	0.13	=	5.083				(28)
Floor T	ype 2					4.2	x	0.13	=	0.545999	99			(28)
Walls		97.0)5	22.8	5	74.2	x	0.18	=	13.36				(29)
Roof		43.	3	0		43.3	x	0.13	=	5.63				(30)
Total a	rea of e	elements	, m²		-	183.65	5				-			(31)
* for win	dows and	l roof wind	ows, use e	effective wi	ndow U-va	alue calcula	ated using	formula 1	1/[(1/U-val	ue)+0.04] a	as given in	paragraph	3.2	

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

Fabric heat loss, $W/K = S (A \times U)$	(26)(30) + (32) =	54.49	(33)
Heat capacity Cm = S(A x k)	((28)(30) + (32) + (32a)(32e) =	5442.45	(34)
Thermal mass parameter (TMP = $Cm \div TFA$) in kJ/m ² K	Indicative Value: Medium	250	(35)
For design assessments where the details of the construction are not known r	precisely the indicative values of TMP in Table 1f		-

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

can be u	ised inste	ad of a de	tailed calc	ulation.										
Therma	nermal bridges : S (L x Y) calculated using Appendix K [details of thermal bridging are not known (36) = $0.05 \times (31)$											4.64	(36)	
if details of thermal bridging are not known (36) = $0.05 \times (31)$ (33) + (36) =59.13Total fabric heat loss $(33) + (36) =$ (59.13)														
Total fa	abric he	at loss							(33) +	(36) =			59.13	(37)
Ventila	tion hea	at loss ca	alculated	I monthly	/				(38)m	= 0.33 × (25)m x (5)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	62.89	62.55	62.22	60.65	60.35	58.98	58.98	58.73	59.51	60.35	60.95	61.57		(38)
Heat tr	ansfer o	coefficier	nt, W/K						(39)m	= (37) + (3	38)m			
(39)m=	122.02	121.68	121.35	119.77	119.48	118.11	118.11	117.86	118.64	119.48	120.07	120.7		
				(m. 217					(10)	Average =	Sum(39)1	.12 /12=	119.77	(39)
Heat IC	ss para		1LP), VV/		4.05				(40)m	= (39)m ÷	(4)	1.00	I	
(40)m=	1.08	1.07	1.07	1.06	1.05	1.04	1.04	1.04	1.05	1.05	1.06	1.06		
Numbe	er of day	/s in moi	nth (Tab	le 1a)					/	Average =	Sum(40)1	.12 /12=	1.06	(40)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
													_	
1 \//2	itor hoot	ting one	av roqui	romont.								k\Mb/v	oor:	
4. VVa	lier nea	ing ener	gy requ	rement.								KVVII/ye	.	
Assumed occupancy, N													(42)	
if TFA > 13.9, N = 1 + 1.76 x [1 - $exp(-0.000349 x (TFA - 13.9)2)$] + 0.0013 x (TFA -13.9) if TFA \$ 13.9, N = 1														
	A L IS.	9, IN = 1	ator usa	no in litro	s per da	w Vd av	erade -	(25 x NI)	+ 36		10	4 5		(42)
Reduce	the annua	al average	hot water	usage by a	5% if the a	welling is	designed t	to achieve	a water us	e target o	r 10	1.5		(43)
not more	e that 125	litres per j	person per	[•] day (all w	ater use, l	hot and co	ld)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage i	n litres per	day for ea	ach m <mark>onth</mark>	Vd,m = fa	ctor from T	able 1c x	(43)						
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65		
		I						I		Fotal = Su	m(44) ₁₁₂ =		1218.02	(44)
Energy o	content of	hot water	used - cal	culated mo	onthly $= 4$.	190 x Vd,r	n x nm x D)Tm / 3600	kWh/mon	th (see Ta	bles 1b, 1	c, 1d)		
(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35		
									-	Fotal = Su	m(45) ₁₁₂ =	:	1597.02	(45)
lf instant	aneous w	ater heatii	ng at point	of use (no	hot water	r storage),	enter 0 in	boxes (46)	to (61)					
(46)m= Water	24.84 storage	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05		(46)
Storag	e volum	e (litres)	includir	a anv so	olar or W	/WHRS	storage	within sa	me ves	sel	· ·	150		(47)
If comr	nunity h	eating a	nd no ta	nk in dw	ellina e	nter 110	litres in	(47)						
Otherw	/ise if no	o stored	hot wate	er (this in	icludes i	nstantar	neous co	mbi boil	ers) ente	er '0' in (47)			
Water	storage	loss:		,					,	,	,			
a) If m	anufact	urer's de	eclared I	oss facto	or is kno	wn (kWł	n/day):				1.:	39		(48)
Tempe	rature f	actor fro	m Table	2b							0.	54		(49)
Energy	v lost fro	m water	storage	, kWh/ye	ear			(48) x (49)	=		0.	75		(50)
b) If manufacturer's declared cylinder loss factor is not known:														
Hot wa	ter stor	age loss	factor fr	om Tabl	e 2 (kW	h/litre/da	ıy)				()		(51)
If comr	nunity h	eating s	ee secti	on 4.3									L	
Volume	e factor	from Ta	ble 2a	0							()		(52)
Tempe	rature f	actor fro	m Table	2b							()		(53)

Energy Enter	/ lost fro (50) or (om water (54) in (5	storage 55)	e, kWh/ye	ear			(47) x (51)) x (52) x (53) =	0.	0 75		(54) (55)
Water	storage	loss cal	culated	for each	month			((56)m = (55) × (41)ı	m	L			
(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(56)
If cylinde	er contain	s dedicate	l d solar sto	l rage, (57)i	n = (56)m	x [(50) – (I H11)] ÷ (5	0), else (5	1 7)m = (56)	n where (H11) is fro	m Append	l lix H	
(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33		(57)
Primar	y circuit	loss (an	nual) fro	om Table	e 3							0		(58)
Primar	y circuit	loss cal	culated	for each	month (59)m = ((58) ÷ 36	65 × (41)	m					
(moo	dified by	factor fi	rom Tab	le H5 if t	here is s	solar wat	ter heatir	ng and a	cylinde	r thermo	stat)		1	
(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
Combi	loss ca	lculated	for each	month ((61)m =	(60) ÷ 36	65 × (41))m					_	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0		(61)
Total h	eat req	uired for	water h	eating ca	alculated	l for eac	h month	(62)m =	0.85 × ((45)m +	(46)m +	(57)m +	(59)m + (61)	m
(62)m=	212.17	186.9	196.03	175.37	171.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95		(62)
Solar DH	HW input	calculated	using App	endix G oı	Appendix	H (negati	ve quantity	v) (enter '0	' if no sola	r contribut	ion to wate	er heating)		
(add a	dditiona	l lines if	FGHRS	and/or \	WWHRS	applies	, see Ap	pendix (<u>3)</u>					
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0		(63)
Output	from w	ater hea	ter				-							
(64)m=	212.17	186.9	196.03	175.37	171.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95		
								Outp	out from wa	ater heate	r (annual)₁	12	2145.64	(64)
Hea <mark>t g</mark>	ains fro	m wat <mark>e</mark> r	heating,	kWh/m	onth 0.2	5 ′ [0.85	× (45)m	+ (61)m	n] + 0.8 x	(<mark>46)m</mark> (+ (57)m	+ (59)m]	
(65)m=	92.33	81.82	86.96	79.39	78.84	71.94	70.51	75.42	74.67	82.25	85.17	90.59		(65)
in <mark>clu</mark>	lde (57)	m in calo	culation	of (65)m	only if c	ylinder i	s in the o	dwelling	or hot w	ate <mark>r is f</mark> r	om com	munity h	eating	
5. Int	ernal ga	ains (see	Table 5	5 and 5a):									
Metab	olic gair	s (Table	5), Wat	ts										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69		(66)
Lightin	g gains	(calcula	ted in Ap	opendix	L, equat	ion L9 o	r L9a), a	lso see	Table 5					
(67)m=	24.79	22.02	17.91	13.56	10.13	8.56	9.24	12.02	16.13	20.48	23.9	25.48		(67)
Applia	nces ga	ins (calc	ulated ir	Append	dix L, eq	uation L	13 or L1	3a), also	see Ta	ble 5			-	
(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16		(68)
Cookir	ng gains	(calcula	ited in A	ppendix	L, equat	tion L15	or L15a)	, also se	e Table	5				
(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17		(69)
Pumps	and fai	ns gains	(Table &	5a)										
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3		(70)
Losses	s e.g. ev	vaporatio	n (nega	tive valu	es) (Tab	le 5)						•		
(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35		(71)
Water	heating	gains (T	able 5)										I	
(72)m=	124.1	121.76	, 116.89	110.27	105.97	99.92	94.78	101.36	103.71	110.56	118.29	121.76		(72)
Total i	nternal	gains =				(66)	m + (67)m	ı + (68)m +	• ⊦ (69)m + ((70)m + (7	1)m + (72)	m	I	
(73)m=	493.75	491.5	475.29	448.94	421.8	395.92	379.27	385.77	399.44	426.03	456.61	479.91		(73)
6. So	lar gains	5:		1		1	1		1					

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

Orientation:	Access Factor Table 6d	r	Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast 0.9x	0.77	x	0.9	x	36.79) x	0.63	x	0.7] =	10.12	(77)
Southeast 0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.7	i =	16.87	(77)
Southeast 0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.7	=	25.64	(77)
Southeast 0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.7	=	47.23	(77)
Southeast 0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.7] =	17.24	(77)
Southeast 0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.7	=	28.73	(77)
Southeast 0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.7] =	43.67	(77)
Southeast 0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.7	=	80.45	(77)
Southeast 0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.7] =	23.59	(77)
Southeast 0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.7] =	39.31	(77)
Southeast 0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.7] =	59.75	(77)
Southeast 0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.7] =	110.07	(77)
Southeast 0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.7] =	29.22	(77)
Southeast 0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.7] =	48.71	(77)
Southeast 0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.7] =	74.04	(77)
Southeast 0.9x	0.77	x	4.2	×	106.25	x	0.63	Х	0.7	=	136.38	(77)
Southeast 0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.7] =	32.73	(77)
Southeast 0.9x	0.77	x	1.5	х	119.01] ×	0.63	x	0.7] =	54.56	(77)
Southeast 0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.7] =	82.93	(77)
Southeast 0.9x	0.77	x	4.2	×	119.01	x	0.63	x	0.7] =	152.76	(77)
Southeast 0.9x	0.77	x	0.9	x	118.15	×	0.63	x	0.7] =	32.5	(77)
Southeast 0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.7] =	54.16	(77)
Southeast 0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.7] =	82.33	(77)
Southeast 0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.7] =	151.65	(77)
Southeast 0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.7	=	31.33	(77)
Southeast 0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.7	=	52.22	(77)
Southeast 0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.7	=	79.37	(77)
Southeast 0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.7	=	146.21	(77)
Southeast 0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.7	=	28.71	(77)
Southeast 0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.7	=	47.85	(77)
Southeast 0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.7	=	72.74	(77)
Southeast 0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.7	=	133.99	(77)
Southeast 0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.7	=	25.54	(77)
Southeast 0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.7	=	42.57	(77)
Southeast 0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.7	=	64.7	(77)
Southeast 0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.7	=	119.18	(77)
Southeast 0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.7	=	19.05	(77)
Southeast 0.9x	0.77	x	1.5	×	69.27	x	0.63	x	0.7] =	31.75	(77)
Southeast 0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.7] =	48.27	(77)

Southeast 0.9x	0.77	x	4.2	×	69.27	×	0.63	x	0.7] =	88.91	(77)
Southeast 0.9x	0.77	x	0.9	x	44.07	×	0.63	x	0.7	i =	12.12	– (77)
Southeast 0.9x	0.77	x	1.5	x	44.07	×	0.63	x	0.7	i =	20.2	(77)
Southeast 0.9x	0.77	x	2.28	x	44.07	×	0.63	x	0.7	i =	30.71	(77)
Southeast 0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.7	i =	56.57	– (77)
Southeast 0.9x	0.77	x	0.9	×	31.49	×	0.63	x	0.7	=	8.66	(77)
Southeast 0.9x	0.77	x	1.5	x	31.49	×	0.63	x	0.7	=	14.43	– (77)
Southeast 0.9x	0.77	x	2.28	×	31.49	×	0.63	x	0.7	=	21.94	(77)
Southeast 0.9x	0.77	x	4.2	×	31.49	×	0.63	x	0.7] =	40.42	(77)
Northwest 0.9x	0.77	x	3.7	×	11.28	×	0.63	x	0.7] =	25.52	(81)
Northwest 0.9x	0.77	x	3.2	×	11.28	×	0.63	x	0.7] =	11.03	(81)
Northwest 0.9x	0.77	x	3.7	x	22.97	×	0.63	x	0.7] =	51.94	(81)
Northwest 0.9x	0.77	x	3.2	x	22.97	×	0.63	x	0.7] =	22.46	(81)
Northwest 0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.7	=	93.58	(81)
Northwest 0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.7	=	40.47	(81)
Northwest 0.9x	0.77	x	3.7	x	67.96	×	0.63	x	0.7] =	153.68	(81)
Northwest 0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.7	=	66.46	(81)
Northwest 0.9x	0.77	x	3.7	X	91.35	x	0.63	х	0.7	=	206.58	(81)
Northwest 0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.7	=	89.33	(81)
Northwest 0.9x	0.77	x	3.7	x	97.38	×	0.63	x	0.7	=	2 <mark>20.24</mark>	(81)
Northwest 0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.7	=	95.24	(81)
Northwest 0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.7] =	206.03	(81)
Northwest 0.9x	0.77	x	3.2	x	91.1	×	0.63	x	0.7	=	89.09	(81)
Northwest 0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.7	=	164.25	(81)
Northwest 0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.7] =	71.03	(81)
Northwest 0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.7	=	114.03	(81)
Northwest 0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.7	=	49.31	(81)
Northwest 0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.7	=	63.47	(81)
Northwest 0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.7] =	27.45	(81)
Northwest 0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.7	=	32.11	(81)
Northwest 0.9x	0.77	x	3.2	x	14.2	×	0.63	x	0.7] =	13.88	(81)
Northwest 0.9x	0.77	x	3.7	×	9.21	×	0.63	x	0.7] =	20.84	(81)
Northwest 0.9x	0.77	×	3.2	x	9.21	×	0.63	x	0.7] =	9.01	(81)
Solar gains in	watts, calcul	ated	for each mon	th		(83)m	n = Sum(74)m(82)m	1 1		L	

(83)m=	136.4	244.49	366.77	508.49	618.89	636.12	604.25	518.57	415.32	278.9	165.59	115.3		(83)
Total g	ains – ir	nternal a	nd solar	(84)m =	= (73)m -	+ (83)m	, watts							
(84)m=	630.15	735.99	842.06	957.43	1040.69	1032.04	983.52	904.34	814.77	704.94	622.2	595.21		(84)
7. Mean internal temperature (heating season)														
Temperature during heating periods in the living area from Table 9, Th1 (°C)										21	(85)			
Utilisation factor for gains for living area, h1,m (see Table 9a)											_			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		

(86)m=	1	1	0.99	0.96	0.87	0.69	0.52	0.58	0.85	0.98	1	1		(86)
Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)														
(87)m=	19.82	19.97	20.22	20.55	20.83	20.96	20.99	20.99	20.89	20.53	20.12	19.79		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)														
(88)m=	20.02	20.02	20.03	20.04	20.04	20.05	20.05	20.05	20.05	20.04	20.03	20.03		(88)
Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)														
(89)m=	1	1	0.99	0.95	0.82	0.6	0.41	0.47	0.78	0.97	1	1		(89)
Mean	interna	l temper	ature in	the rest	of dwelli	ing T2 (f	ollow ste	eps 3 to 7	7 in Tabl	e 9c)				
(90)m=	18.44	18.66	19.03	19.51	19.87	20.02	20.05	20.05	19.96	19.49	18.88	18.41		(90)
			_		_			-	f	LA = Livin	g area ÷ (4	4) =	0.22	(91)
Mean	interna	l temper	ature (fo	or the wh	ole dwe	lling) = fl	LA × T1	+ (1 – fL	.A) × T2					
(92)m=	18.74	18.95	19.29	19.74	20.08	20.24	20.26	20.26	20.17	19.72	19.16	18.72		(92)
Apply	adjustn	nent to tl	ne mear	internal	temper	ature fro	m Table	4e, whe	ere appro	opriate				
(93)m=	18.74	18.95	19.29	19.74	20.08	20.24	20.26	20.26	20.17	19.72	19.16	18.72		(93)
8. Spa	ace hea	ting requ	uirement	t										
Set Ti	i to the r	mean int	ernal ter	mperatur	re obtair	ed at ste	ep 11 of	Table 9	o, so tha	t Ti,m=(76)m an	d re-calc	ulate	
the ut	lisation		or gains		ible 9a	l	1.1	A	Can	Oct	Nevi	Dee		
Litilies	Jan tion fac	tor for a	ains br	Apr	iviay	Jun	Jui	Aug	Sep	Oct	INOV	Dec		
(94)m=	1	0.99	0.98	0.94	0.83	0.62	0.44	0.5	0.79	0.96	0.99	1		(94)
Usefu	ll gains	hmGm	W = (9	4)m x (84	4)m	0.02		0.0	0.10		0.00			
(95)m=	628.42	731.22	826.93	900.56	860.66	642.51	429.35	449.2	641.69	679.66	618.39	593.99		(95)
Month	nly avera	age exte	rnal terr	perature	e from Ta	able 8								
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2		(96)
Heat	loss rate	e for mea	an interr	al tempe	erature,	Lm , W =	=[(39)m	x [(93)m	– (96)m]				
(97)m=	1762.59	1710.07	1552.57	1298.67	1001.59	665.57	432.11	454.57	719.63	1090.09	1448.02	1752.36		(97)
Space	e heatin	g require	ement fo	r each m	nonth, k	Wh/mon	th = 0.02	24 x [(97)m – (95)m] x (4′	1)m			
(98)m=	843.82	657.79	539.87	286.64	104.85	0	0	0	0	305.36	597.33	861.82		
								Tota	l per year	(kWh/year) = Sum(9	8)15,912 =	4197.5	(98)
Space	e heatin	g require	ement in	kWh/m ²	/year								37.01	(99)
9a. En	erav rec	auiremer	nts – Ind	ividual h	eating s	vstems i	ncludina	ı micro-C	CHP)					
Space	e heatir	ng:			<u> </u>				/					
Fracti	on of sp	ace hea	t from s	econdar	y/supple	mentary	system						0	(201)
Fracti	on of sp	ace hea	it from m	nain syst	em(s)			(202) = 1 -	- (201) =			İ	1	(202)
Fracti	on of to	tal heatii	ng from	main sys	stem 1			(204) = (2	02) × [1 –	(203)] =			1	(204)
Efficiency of main space heating system 1										93.5	(206)			
Efficiency of secondary/supplementary heating system %									0	(208)				
		Tab	Mor	Apr	May		., , .	Aug	Son	Oct	Nov			
Space	Jan		iviai		d above		Jui	Aug	Sep	Uci	INOV	Dec	KVV1/y	ear
Opact	843.82	657.79	539.87	286.64	104.85	0	0	0	0	305.36	597.33	861.82		
(211)~)m v (20	/)] \ v 4		16)				-					(211)
رد ۱۱/۱۱	902.49	703.52	→/] } X 577 4	306.57	112.14	0	0	0	0	326.59	638.86	921.73		(211)
						Ĺ	Ĺ	L Tota	l (kWh/yea	L ar) =Sum(2	211), <u></u>	=	4489 3	(211)
									-		1			L` '

Space heating fuel (secondary), kWh/month

= {[(98)m x (20′	1)]}x 1	00 ÷ (20	8)									_	
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
						-	-	Tota	al (kWh/yea	ar) =Sum(215) _{15,101}	2=	0	(215)
Water	heating													
Output	from wa	ter hea	ter (calc	ulated a	bove)								1	
	212.17	186.9	196.03	1/5.3/	1/1.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95		
Efficier	ncy of wa	iter nea		00.40	00.55	70.0	70.0	70.0	70.0	00.40	07.00	00.04	79.8	(216)
(217)m=	88.13	87.89	87.38	86.12	83.55	79.8	79.8	79.8	79.8	86.19	87.63	88.21		(217)
Fuel to (219)m	or water n n = (64)n	ieating, n x 100	. KVVN/m() ÷ (217)	m										
(219)m=	240.76	212.65	224.35	203.65	205.4	191.68	183.65	202.13	201.96	211.02	219.96	234.61		
								Tota	al = Sum(2	19a) ₁₁₂ =			2531.81	(219)
Annua	I totals									k	Wh/yea	r	kWh/yea	 r
Space	heating f	fuel use	ed, main	system	1								4489.3	
Water	heating f	uel use	ed										2531.81]
Electric	city for pu	umps, fa	ans and	electric	keep-ho	t								_
centra	al heating	g pump	:									30		(230c)
boi <mark>ler</mark>	with a fa	in-assis	sted flue									45		(230e)
Tota <mark>l e</mark>	electricity	for the	above, l	<mark><wh <="" mark="">yea</wh></mark>	r			sum	of (230a).	<mark>(2</mark> 30g) =			75	(231)
Electric	city for lig	phting											4 <mark>37.82</mark>	(232)
12a. (CO2 emis	ssions -	– Individ	ual heat	ing syste	ems inclu	uding mi	icro-CHF						
						_				_				
						En kW	ergy /h/year			Emiss kg CO	ion fac 2/kWh	tor	Emissions kg CO2/ye	s ar
Space	heating	(main s	ystem 1)		(211	1) x			0.2	16	=	969.69	(261)
Space	heating	(second	dary)			(21	5) x			0.5	19	=	0	(263)
Water	heating					(219	9) x			0.2	16	=	546.87	(264)
Space and water heating (261) + (262) + (263) + (264) =								1516.56	(265)					
Electric	city for pu	umps, f	ans and	electric	keep-ho	t (23 ⁻	1) x			0.5	19	=	38.93	(267)
Electric	city for lig	phting				(232	2) x			0.5	19	=	227.23	(268)
Total C	CO2, kg/y	vear							sum o	of (265)(271) =		1782.71	(272)

TER =

23.08 (273)

A3. RENEWABLE ENERGY FEASIBILITY ASSESSMENT

A3.1 In line with GLA London Plan requirements, a feasibility assessment of potential renewable energy technologies has been undertaken, and the results from this are presented below.

Technology	Appraisal	Included in
		Development?
Biomass	This technology is not considered a practical solution to	
	reducing CO ₂ emissions, in the view of limited storage	X
	space for the combustible material, accessibility of the site	
	for regular deliveries of the material, associated carbon	
	emissions of this technology which are not normally	
	accounted for within energy modelling, and local air	
	material.	
Air course boot	This technology is deemed appropriate to provide both	
	space and water heating to the proposed dwellings. Full	
le a le	details of the proposed system efficiencies and	V
	associated carbon dioxide savings are provided in	
	Section 4.	
Ground source	This technology is not deemed appropriate as heat is	
neat pump	aiready due to be provided to the scheme by air source heat nump systems	×
Photovoltaics (PV)	The orientation of the site and roofs means that only 50%	
	of the roof space faces south-west. Roofs facing north-	X
	east will receive less solar gain. In addition, a significant	•
	portion of the site is overshadowed by a large tree to the	
	PV panels considerably and it is therefore considered	
	that rooftop PV is unsuitable for this development.	

Solar thermal hot water (STHW)	As stated above, the development roofs are not considered suitable for solar technology due to orientation and overshading issues. This technology is therefore rejected.	×
Wind turbines	This technology is rejected on the basis of its potential impact on visual amenity and relatively low efficiency from unpredictable, turbulent wind conditions in urban locations.	×

A4. DOMESTIC OVERHEATING ASSESSMENT

Introduction

- A4.1 Policies 5.9 of the London Plan and CC2 of the Camden Local Plan seek 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.
- A4.2 In order to reduce overheating and reliance on air conditioning, the design of the proposed scheme at Godwin and Crowndale Estate has followed the Cooling Hierarchy detailed in Policy 5.9:
 - 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 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.

Cooling Hierarchy

A4.3 The methods used to minimise overheating and excessive heat generation in line with the cooling hierarchy are outlined below.

Minimisation of internal heat generation through energy efficient design

- Heat gain from lighting is kept to a minimum as a result of an energy-efficient lighting design solution.
- The availability of natural light is maximised by optimising the light transmittance of the glass elements of the façade.
- Heat gains from equipment will be minimised through the specification of low energy systems.
- Heat distribution pipework will be fully insulated to prevent unwanted heat loss.
- The scheme will use individual air source heat pumps, which is a low temperature distribution system, leading to lower internal heat gains from distribution pipework.

Reduction of the amount of heat entering the building in summer

- The building's façades have a limited amount of glazing to mitigate direct solar heat gain while optimising daylight penetration.
- The use of blinds will provide solar shading and glare protection to houses.

Management of the heat within the building through exposed thermal mass and high ceilings

- Generous floor to ceiling heights of 2.7m (ground and first floors) and up to 3.4m (second floor) will allow internal heat to rise and stratify above occupied areas.
- The habitable rooms are distributed across three storeys allowing heat to rise and exit the building due to the stack effect.

Passive ventilation

- Openable windows on multiple aspects will provide a passive ventilation strategy that utilises crossflow ventilation to maximise the potential for natural ventilation within the scheme.
- Trickle ventilation will be provided for ground floor spaces.

Mechanical and active cooling

• Cooling is not proposed.

Overheating Criteria

- A4.4 TM59:2017 is a design methodology for the assessment of overheating risk in homes, published by the Chartered Institution of Building Services Engineers (CIBSE), in April 2017.
- A4.5 This is a standardised approach to predict overheating risk for residential building designs using dynamic thermal analysis. It provides a baseline which includes specific weather files, defined internal gains and a set of profiles that represent reasonable usage patterns for a home suitable for evaluating overheating risk. In addition, defined thresholds to provide a pass / fail result are clearly provided as detailed below.
- A4.6 Compliance is based on passing both of the following two criteria:
 - For living rooms, kitchen and bedrooms: the number of hours during which the temperature difference between the inside and outside is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours.
 - For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 22:00 to 07:00 shall not exceed 26°C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, therefore 33 or more hours above 26°C will be recorded as a fail).
A4.7 Both criteria (1) and (2) above should be met for all relevant rooms.

Methodology

- A4.8 The TM59 methodology provides a baseline and guidance for a domestic overheating risk assessment. In line with this methodology, this section includes model inputs used to assess overheating risks to the proposed sample dwellings of the proposed development at Godwin and Crowndale Estate.
- A4.9 Three dwellings were selected for this overheating risk assessment, due to the differences in internal layouts, with some dwellings having bedrooms on the ground floor.
- A4.10 The images below show the locations of the tested dwellings.



Figure A4.1 Locations of tested dwellings

A4.11 The model was created in EDSL TAS to simulate the internal conditions in each of the occupied spaces highlighted in the above images. The geometry was modelled based on planning submission issue drawings from Surface To Air Architects.

- A4.12 The weather files used for simulation have been based on the guidance contained within CIBSE TM49:2014 (Design Summer Years for London) as follows:
 - Design summer year weather file for the London Weather Centre, based on an urban location for 1989 (DSY1), has been used on the simulations as required by TM49 methodology. The CIBSE DSY1 represents a moderately warm summer.
 - Design summer year weather file for the London Weather Centre, based on an urban location for 1976 (DSY2), has been used on the simulations as required by TM49 methodology. The CIBSE DSY2 represents summer with a long period of persistent warmth.
 - Design summer year weather file for the London Weather Centre, based on an urban location for 2003 (DSY3), has been used on the simulations as required by TM49 methodology. The CIBSE DSY3 represents a summer with a single intense warm spell.
- A4.13 The building fabric parameters have been based on the same level of performance as that detailed in the energy strategy. A summary of the thermal envelope values used in the assessment is shown in Table A4.1.
- A4.14 In line with the TM59 methodology, the following internal gains and time periods have been employed for this analysis.

Room	Sensible heat gain (W/person)	Latent heat gain (W/person)	Occupancy period
Kitchen/Living Room	75	55	Full gains from 9am-10pm
Bedroom	52.5	38.5	70% gains from 11pm to 8am; 100% gains from 8am to 9am and from 10pm to 11pm; 50% gains from 9am to 10pm.

Table A4.1 Occupancy heat gains

Room	Heat gain (W)	Occupancy period
Kitchen/Living Room	450 W 200 W 110 W 85 W	6pm to 8pm 8pm to 10pm 9am to 6pm and 10pm to 12pm All other times
Bedroom	80 W 10 W	9am to 11pm All other times

Table A4.2 Equipment heat gains

- A4.15 A lighting gain of 2 W/m² has been applied from 7pm to 11pm to all occupiable rooms.
- A4.16 Passive ventilation was modelled based on information provided by Surface To Air as part of the planning submission documentation. The openable window proportions for each dwelling are shown below.

Figure A4.2 Window open areas (front elevation)





Figure A4.3 Window open areas (rear elevation)

- A4.17 Due to the height of the floors tested, it was assumed that windows on the first and second floors could be opened throughout the day without any security concerns. Ground floor spaces were assumed to be ventilated through trickle ventilation only.
- A4.18 The TM59 methodology states that internal blinds can be included for the analysis only if specifically included in the design, provided in the base build and explained within associated home user guide. In addition, blinds should not be used if they clash with the opening of windows. The proposed overheating mitigation strategy includes the use of internal blinds with full details to be provided by Surface To Air Architects.
- A4.19 An infiltration rate of 0.15 air changes per hour has been used for all dwellings, and has been derived from CIBSE Guide A (2015) for a dwelling with an air permeability of 3m³/hr per m² @ 50Pa for low rise and high-rise dwellings.
- A4.20 Background mechanical ventilation will be provided by MVHR units as required by Part F of the Building Regulations. The ventilation rate included in the model is 1.5 air changes per hour for all rooms.
- A4.21 As stated above mechanical cooling is not proposed for the residential elements of the scheme.

Results

A4.22 The table below shows the results of the simulation incorporating the inputs described above.

Room	Criterion 1	Criterion 1		Criterion 2	
	Max.	Hours	Max.	Night Hours	Pass/Fail
	Exceedable	Exceeded	Exceedable	Exceeded	
	Hours		Night Hours		
Dwelling 1	, 110	2	32	3	Pass
Bedroom 1					
Dwelling 1	, 110	0	32	5	Pass
Bedroom 2					
Dwelling 1	, 110	1	32	3	Pass
Bedroom 3					
Dwelling 1	, 110	0	32	4	Pass
Bedroom 4					
Dwelling 2	2, 110	12	32	3	Pass
Bedroom 1					
Dwelling 2	2, 110	7	32	5	Pass
Bedroom 2					
Dwelling 2	2, 110	11	32	5	Pass
Bedroom 3					
Dwelling 2	2, 110	12	32	5	Pass
Bedroom 4					
Dwelling 3	, 110	12	32	8	Pass
Bedroom 1					

Table A4.3 DSY1 Results

Dwelling 3, Bedroom 2	110	19	32	6	Pass
Dwelling 3, Bedroom 3	110	24	32	7	Pass
Dwelling 3, Bedroom 4	110	13	32	6	Pass
Dwelling 1, Kitchen	59	1	N/A	N/A	Pass
Dwelling 2, Kitchen	59	12	N/A	N/A	Pass
Dwelling 3, Kitchen	59	17	N/A	N/A	Pass
Dwelling 1, Living Room	59	2	N/A	N/A	Pass
Dwelling 2, Living Room	59	16	N/A	N/A	Pass
Dwelling 3, Living Room	59	17	N/A	N/A	Pass

Table A4.4 DSY2 Results

Room	Criterion 1		Criterion 2		Result
	Max. Exceedable Hours	Hours Exceeded	Max. Exceedable Night Hours	Night Hours Exceeded	Pass/Fail
Dwelling 1, Bedroom 1	110	20	32	22	Pass

Dwelling '	1, 110	29	32	31	Pass
Bedroom 2					
Dwelling [·] Bedroom 3	1, 110	17	32	23	Pass
Dwelling Bedroom 4	1, 110	29	32	28	Pass
Dwelling 2 Bedroom 1	2, 110	33	32	27	Pass
Dwelling 2 Bedroom 2	2, 110	37	32	25	Pass
Dwelling 2 Bedroom 3	2, 110	33	32	27	Pass
Dwelling 2 Bedroom 4	2, 110	38	32	22	Pass
Dwelling 3 Bedroom 1	3, 110	38	32	33	Fail
Dwelling 3 Bedroom 2	3, 110	60	32	23	Pass
Dwelling 3 Bedroom 3	3, 110	69	32	28	Pass
Dwelling 3 Bedroom 4	3, 110	41	32	23	Pass
Dwelling ² Kitchen	1, 59	24	N/A	N/A	Pass
Dwelling 2 Kitchen	2, 59	35	N/A	N/A	Pass

Dwelling 3, Kitchen	59	45	N/A	N/A	Pass
Dwelling 1, Living Room	59	29	N/A	N/A	Pass
Dwelling 2, Living Room	59	39	N/A	N/A	Pass
Dwelling 3, Living Room	59	48	N/A	N/A	Pass

Table A4.5 DSY3 Results

Room	Criterion 1		Criterion 2		Result
	Max. Exceedable Hours	Hours Exceeded	Max. Exceedable Night Hours	Night Hours Exceeded	Pass/Fail
Dwelling 1 Bedroom 1	110	22	32	19	Pass
Dwelling 1 Bedroom 2	110	26	32	22	Pass
Dwelling 1 Bedroom 3	110	17	32	20	Pass
Dwelling 1 Bedroom 4	110	24	32	19	Pass
Dwelling 2 Bedroom 1	110	43	32	18	Pass
Dwelling2Bedroom 2	110	39	32	19	Pass

Dwelling 2, Bedroom 3	110	44	32	24	Pass
Bedroom 4	110	46	32	19	Pass
Dwelling 3, Bedroom 1	110	49	32	30	Pass
Dwelling 3, Bedroom 2	110	74	32	20	Pass
Dwelling3,Bedroom 3	110	76	32	24	Pass
Dwelling 3, Bedroom 4	110	51	32	21	Pass
Dwelling 1, Kitchen	59	20	N/A	N/A	Pass
Dwelling 2, Kitchen	59	36	N/A	N/A	Pass
Dwelling 3, Kitchen	59	57	N/A	N/A	Pass
Dwelling 1, Living Room	59	31	N/A	N/A	Pass
Dwelling 2, Living Room	59	52	N/A	N/A	Pass
Dwelling 3, Living Room	59	63	N/A	N/A	Fail

5.11 It can be concluded that all dwellings pass the TM59 overheating criteria for the DSY1 weather file. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.

A4.1 The building design and building services design have maximised all available measures to minimise heat generation within the dwellings, to reduce the amount of heat entering the building, and to passively and mechanically ventilate the dwellings in line with the cooling hierarchy in Policy 5.9 of the London Plan.

Conclusion

- A4.2 This study has shown how the proposed development at Godwin and Crowndale Estate has been designed to minimise the risk of overheating. The strategy has followed the cooling hierarchy in Policy 5.9 of the London Plan and Camden Local Plan Policy CC2.
- A4.3 TM59:2017 has been adopted for this overheating study as it is the recommended methodology for the assessment of overheating risk in dwellings.
- A4.4 The new methodology aims to produce a test that encourages good design that is comfortable within sensible limits, without being so stringent that it over-promotes the use of mechanical cooling.
- A4.5 Three dwellings were chosen for this overheating assessment, to represent the range of different layouts present in the development.
- A4.6 A dynamic thermal model was created in EDSL TAS to simulate the internal conditions in each of the occupied spaces within the selected sample dwellings.
- A4.7 The modelling incorporated inputs provided within the TM59 methodology guidance and information provided by Surface To Air Architects.
- A4.8 The building design and building services design have maximised all available measures to minimise heat generation within the dwellings, to reduce the amount of heat entering the building, and to passively and mechanically ventilate the dwellings in line with the cooling hierarchy in Policy 5.9 of the London Plan.
- A4.9 The results were then compared to the CIBSE TM59 overheating criteria for the three weather files specified in CIBSE TM49. It can be concluded that all dwellings pass the TM59 overheating criteria for the DSY1 weather files. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.

- A4.10 If overheating was found to be an issue in future for these dwellings, the following mitigation measures should be explored:
 - Retrofitted solar control film to minimise solar gain
 - Additional external shading to limit solar gain
 - Improved blinds to reduce solar gain
 - Increased MVHR flow rates for additional purge ventilation
 - Use of free-standing fans in extreme cases

A5. GENERAL NOTES

- A5.1 The report is based on information available at the time of the writing and discussions with the client during any project meetings. Where any data supplied by the client or from other sources have been used it has been assumed that the information is correct. No responsibility can be accepted by Iceni Projects Ltd for inaccuracies in the data supplied by any other party.
- A5.2 The review of planning policy and other requirements does not constitute a detailed review. Its purpose is as a guide to provide the context for the development and to determine the likely requirements of the Local Authority.
- A5.3 No site visits have been carried out, unless otherwise specified.
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