

# Review of RBKC Basement Publication Policy, Operational Carbon emissions, July 2013

Prepared by Bespoke Builder Services Ltd on behalf of Cranbrook August 2013

ROPP6682 Issue 1

## Contents

- i. Executive summary
- ii. Foreword
- 1. Introduction
- 2. Document review
- 3. Assessment analysis
- 4. Amended calculation methodology
- 5. SAP 2009 Analysis
- 6. Conclusions

Appendix A. U values & SAP2009 worksheet outputs

## I. Executive Summary

This document reviews the planning consultation document, regarding Basements, published by The Royal Borough of Kensington and Chelsea July 2013 in relation to the Operations Carbon dioxide emissions. The keys conclusions are stated below.

- Operational Carbon dioxide emissions analysis used to support consultation document is flawed
- Calculation methodology is totally inappropriate
- Actual quoted assessed dwellings differ from the SAP calculations

This report details an appropriate calculation approach, assessing like for like extensions below & above ground level.

- Illustrates key thermal performance factors that will affect operational Carbon dioxide emissions within SAP2009 methodology.
- Completes analysis that demonstrates that there is no fundamental variation in emissions building below or above ground level.

About Bespoke Builder Services Ltd

Bespoke Builder Services Ltd is a construction consultancy specialising in sustainability, energy conservation and the application of renewable energy technologies. As a consultancy we do not sell products, so we are able to take an objective view of a development to assist developers in incorporating the most cost effective and practical solutions.

Our range of services includes specialist pre-planning reports, energy consumption calculations for Building Regulations purposes, and broader environmental and sustainability studies and reports and CSH, EcoHomes and Breeam assessments. Our team of consultants includes registered SAP Assessors, registered CSH, EcoHomes and Breeam Assessors, Planning Specialists, Chartered Engineers and Chartered Surveyors.

A sister consultancy is a Corporate Approved Inspector – approved to provide Building Control services in the residential sector, and where necessary we are able to draw on this additional expertise to ensure that all advice given in respect of energy conservation and sustainability will also meet all other constraints imposed by the Building regulations.

Established in 2001 by two directors with many years experience in the construction industry, and latterly, with the NHBC, the practice has grown steadily since, and to date has carried out hundreds of EcoHomes assessments, and many thousands of SAP assessments. By applying this expertise to assist developers to understand and meet the new obligations for sustainability, energy conservation and on-site renewable energy systems, we are able to help ensure that these vitally important issues are addressed in a transparent way, where the needs and responsibilities of all the stakeholders are fully respected.

Report prepared by:

Andrew Mitchell BEng

15th August 2013

Assessment type: Review of planning consultation document, regarding the Basement, published by The Royal Borough of Kensington and Chelsea July 2013

## 1. Introduction

This document reviews the planning consultation document, regarding Basements, published by The Royal Borough of Kensington and Chelsea July 2013.

It specifically looks at the statement detailed within paragraph 34.3.53,-

The carbon emissions of basements are greater than those of above ground development per square metre over the life cycle

The consultation document quotes the following document as part of the evidence to support this statement –

Life Cycle carbon Analysis of Extensions & Subterranean Development in RBK&C, Eight associates, August 2010

This review analysis's the operation carbon emissions as defined by building regulations and associated British and ISO standards and demonstrates that there is no fundament variation in the operational carbon dioxide emission of a construction built over or below ground.

## 2. Document review

The Eight associates' document reviews two contrasting improvements to existing properties -

- Case study 1, subterranean development of 75m<sup>2</sup>
- Case study 2, ground level development of 10.35m<sup>2</sup>

The report concludes that study 1 (basement) has an operation carbon emission of 1065  $kgCO_2/m^2$  compared to the ground level study 2 of 780  $kgCO_2/m^2$ .

Following a Freedom of information request we have obtained the SAP calculations used for the Eight Associate reports. These SAP results do not correspond with the quoted extensions stated with the report. The floor areas differ.

The key area of concern regarding this analysis is that the two assessed developments are totally different in size and style. This review will highlight a more robust assessment methodology.

## 3. Assessment analysis

Operational carbon emissions are calculated via the approved building regulations methodology, SAP2009 as defined within part L2010 of the building regulations.

SAP2009 calculates total carbon dioxide emission for a dwelling. The key data inputs are -

- Dwelling fabric performance U values, air tightness & thermal bridging
- Energy consumption heating systems, lighting & ventilation

The above details are defined and entering into the approved software. From this a dwelling emissions (carbon dioxide) rate is calculated.

In order for the Eight associates analysis to be robust I suggest that the two reviewed properties need to have be fundamental the same, but one being a basement & the second at ground level.

Published analysis does not indicate the heat loss envelope U values, heating system or lighting details. The large variation in floor area effects the floor to heat loss ratio.

In order to complete this analysis correctly the same extension needs to be reviewed above & below ground. All the following elements need to remain constant in order for the SAP analysis to assessment which is more operationally Carbon efficient

- Constant heat loss areas
- Constant construction thermal build up
- Same heating & lighting strategy

## 4. Amended calculation methodology

The keys SAP performance variation between the 'constant' subterranean extension to the ground level one will be the actual thermal performance of the element below ground, for the same 'constant' construction. The insulated floor and walls below ground will have an improved U value, compared to there above ground version. This is due to the additional insulating properties of the surrounding ground and increased surface resistances (as the elements below ground are protected from wind).

This is illustrated by the following analysis.

Ground floor construction- Wall construction-	Slab on ground, 100mm celotex (K=0.023) & screed 200mm masonry, 100mm battens with mineral wool (K = 0.038) & Plasterboard
At ground level U <sup>1,2</sup> values are	Floor = 0.16 W/m <sup>2</sup> K Wall = 0.32 W/m <sup>2</sup> K
1 metre below ground level	Floor = $0.15 \text{ W/m}^2\text{K}$ Wall = $0.32 \text{ W/m}^2\text{K}$
2 metres below ground level	$Floor = 0.14 \text{ W/m}^2\text{K}$ $Wall = 0.27 \text{ W/m}^2\text{K}$

If we assume that the extension has the following dimensions we can work out the area weighted U value at each depth –

Floor Area = 25 m2Perimeter = 10 mWall height = 2.6 m

2. U values calculation outputs in Appendix A

<sup>1.</sup> U values calculation methodology has been completed as defined within BS EN ISO 6946

At ground level area weighted U value =	0.242 W/m <sup>2</sup> K
1 metre below ground level area weighted U value =	$0.236 \text{ W/m}^2\text{K}$
2 metre below ground level area weighted U value =	$0.212 \text{ W/m}^2\text{K}$

From this thermal element performance analysis is it evident that for a given extension (constant size, construction and heating lighting details) there is a thermal improvement in constructing it below ground level. For a given construction the resulting U value will improve and this will be evident within the SAP2009 calculations.

## 5. SAP 2009 Analysis

Taking the same extension as detailed in section 4, SAP2009 analysis has been completed for the construction above ground and 2 metres below. The only variation being the improvement to floor & wall for the basement option as details in section 4.

#### **SAP** results

Extension at ground level <sup>3</sup> =	Dwelling Emissions Rate (DER) 29.89 kgCO <sub>2</sub> /m <sup>2</sup>
2 metres below ground level =	Dwelling Emissions Rate (DER) 29.13 kgCO <sub>2</sub> /m <sup>2</sup>

SAP improvement for basement extension = 2.54%

In order to complete the above analysis SAP2009 required the inclusion of windows. Within the approved calculation methodology windows have two key properties within the assessment. Firstly they result in an area of increased heat loss (due to there higher U values when compared to wall constructions) and secondly they offer solar gain which in turn reduces heating demand.

In the example above both reviewed extension have the same windows area and therefore this will not affect the comparative results.

SAP2009 calculates the solar gain via the window area, geographical location of the property and the orientation of the windows. Calculated solar gain reduced the heating demand, which therefore reduces demand on space heating fuel, improving the DER.

3. SAP2009 calculation worksheets in Appendix A

All the calculation analysis has been completed on the 'same' extension at ground level & two metre below. The only variation within the analysis to date has been the improved wall & floor U value as a result of basement construction. We also need to account for the likely variation in delivered solar gains, as the basement is very likely to have windows that are shaded, reducing the solar gain affect. SAP2009 allows for shading of windows to be included within the calculation.

#### SAP results (including over shading for basement window)

Extension at ground level <sup>2</sup> =	Dwelling Emissions Rate (DER) 29.89 kgCO <sub>2</sub> /m <sup>2</sup>							
2 metres below ground level =	Dwelling Emissions Rate (DER) 29.71 kgCO <sub>2</sub> /m <sup>2</sup>							
SAP improvement for basement extension = 0.6%								

The above illustrates that a subterranean development has no notable effect on the annual carbon dioxide emission for a give extension. The two key SAP2009 variables when constructing below ground, improved U values and lowering of solar gains, will offset each other.

## 6. Conclusion

The above analysis concludes that a subterranean extension has a neutral effect of the operational carbon dioxide emissions when compared to a ground level extension.

Analysis completed by Eight associates' used to support the argument within the planning consultation document, regarding operation  $CO_2$  emissions for Basements is flawed. The two examples reviewed are totally different in all terms of, size, form & construction therefore they do not offer a realistic assessment.

The above analysis concludes that only two key properties included within the SAP2009 calculation methodology are affected by building under ground.

- 1. Below ground construction elements have improved U values, reducing CO<sub>2</sub> emissions.
- 2. Solar gains are reduced, below ground, increasing CO<sub>2</sub> emissions

The net result is that there is no fundament variation in the operational carbon dioxide emission of a construction built over or below ground. The savings from improve thermal performance are off set be the reduced solar gains.

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:55

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\Basements U values.uva (File saved: 14 Aug 2013 18:29)

#### Element type: Heated basement

Calculation Method: BS EN ISO 6946, BS EN ISO 13370

#### Basements

Therma	l resistance	ofbaseme	ent floor coi	nstruction:					
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	<u>Density</u>	<u>Sp. heat</u>	<u>R layer</u> 0.170	<u>R bridge</u>	<u>Description</u> Rsi
1 2	75 100	1.200 0.023			1800 20	1000 1030	0.062 4.348		screed insulation board
	175 mm	<u>l</u>					4.580		

Total resistance: Upper limit: 4.580 Lower limit: 4.580 Ratio: 1.000 Average: 4.580 m<sup>2</sup>K/W

#### Thermal resistance of basement wall construction:

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	<u>Sp. heat</u>	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	100	0.038	0.130	0.118	20	1030	2.632	0.769	insulation between battens
4	200	1.210			2000	1000	0.165		masonry
	<u>313 mm</u>	L					2.986		

Total resistance: Upper limit: 2.498 Lower limit: 2.402 Ratio: 1.040 Average: 2.450 m<sup>2</sup>K/W

Ground param	elers'								
	10.00 m			Wall thickness:	300 mm				
	25.00 m <sup>2</sup>			Ground type:	Clay/silt ( $\lambda = 1.5 \text{ W/m} \cdot \text{K}$ )				
P/A:	0.400			Rse:	$0.04 \text{ m}^2\text{K/W}$				
Average basen	nent depth:		0.000 m	0.000 m					
Area of basem	ent walls:		$0.00 \text{ m}^2$	2					
U-value U <b>-value (rou</b> r	nded)	<u>Floor</u> 0.158 <b>0.16</b>	<u>Walls</u> 0.000 <b>0.00</b>	<u>Overall</u> (area- 0.158 <b>0.16 W/m²K</b>	weighted average)				
Heat capacity p	per m <sup>2</sup> (ĸ)	135.0	8.8	135.0 Btu/ft <sup>2,0</sup> I	?				
Calculated by:									

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:55

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\Basements U values.uva (File saved: 14 Aug 2013 18:29)

#### **Element type: Heated basement**

Calculation Method: BS EN ISO 6946, BS EN ISO 13370

#### Basements

Thermal	<u>l resistance</u>	ofbaseme	ent floor con	nstruction:					
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	<u>Fraction</u>	Density	<u>Sp. heat</u>	<u>R layer</u> 0.170	<u>R bridge</u>	<u>Description</u> Rsi
$\frac{1}{2}$	75 100	1.200 0.023			1800 20	1000 1030	0.062 4.348		screed insulation board
	<u>175 mm</u>	L					4.580		

Total resistance: Upper limit: 4.580 Lower limit: 4.580 Ratio: 1.000 Average: 4.580 m<sup>2</sup>K/W

#### Thermal resistance of basement wall construction:

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	<u>Sp. heat</u>	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	100	0.038	0.130	0.118	20	1030	2.632	0.769	insulation between battens
4	200	1.210			2000	1000	0.165		masonry
	313 mm	L					2.986		

Total resistance: Upper limit: 2.498 Lower limit: 2.402 Ratio: 1.040 Average: 2.450 m<sup>2</sup>K/W

Ground param	neters:								
Perimeter P:	10.00 m			Wall thickness:	300 mm				
Area A:	25.00 m <sup>2</sup>			Ground type:	Clay/silt ( $\lambda = 1.5 \text{ W/m} \cdot \text{K}$ )				
P/A:	0.400			Rse:	0.04 m <sup>2</sup> K/W				
Average baser	nent depth:		1.000 m	1.000 m					
Area of basem	ent walls:		10.00 m <sup>2</sup>						
<b>v</b> , <b>1</b>		Floor	Walls		weighted average)				
U-value		0.150	0.316	0.197					
U-value (roui	nded)	0.15	0.32	$0.20 \text{ W/m}^2\text{K}$					
Heat capacity j	per m <sup>2</sup> ( $\kappa$ )	135.0	8.8	98.9 Btu/ft <sup>2,0</sup> I	7				
Calculated by:									

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:56

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\Basements U values.uva (File saved: 14 Aug 2013 18:29)

#### **Element type: Heated basement**

Calculation Method: BS EN ISO 6946, BS EN ISO 13370

#### Basements

Thermal	l resistance	ofbaseme	ent floor con	nstruction:					
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	<u>Fraction</u>	<u>Density</u>	<u>Sp. heat</u>	<u>R layer</u> 0.170	<u>R bridge</u>	<u>Description</u> Rsi
1 2	75 100	1.200 0.023			1800 20	1000 1030	0.062 4.348		screed insulation board
	175 mm	-					4.580		

Total resistance: Upper limit: 4.580 Lower limit: 4.580 Ratio: 1.000 Average: 4.580 m<sup>2</sup>K/W

#### Thermal resistance of basement wall construction:

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	<u>Sp. heat</u>	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	100	0.038	0.130	0.118	20	1030	2.632	0.769	insulation between battens
4	200	1.210			2000	1000	0.165		masonry
	313 mm	L					2.986		

Total resistance: Upper limit: 2.498 Lower limit: 2.402 Ratio: 1.040 Average: 2.450 m<sup>2</sup>K/W

Ground param	eters:				
Perimeter P:	10.00 m			Wall thickness	: 300 mm
Area A:	25.00 m <sup>2</sup>			Ground type:	Clay/silt ( $\lambda = 1.5 \text{ W/m} \cdot \text{K}$ )
P/A:	0.400			Rse:	$0.04 \text{ m}^2\text{K/W}$
Average baser	nent depth:		2.000 m		
Area of basem	ent walls:		20.00 m <sup>2</sup>		
U-value U <b>-value (rou</b> i	nded)	<u>Floor</u> 0.143 <b>0.14</b>	<u>Walls</u> 0.271 <b>0.2</b> 7	<u>Overall</u> (area 0.200 <b>0.20</b> W/m²K	-weighted average)
Heat capacity p	per m <sup>2</sup> ( $\kappa$ )	135.0	8.8	78.9 Btu/ft <sup>2.0</sup>	F
Calculated by:					

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:56

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\wall construction.uva (File saved: 14 Aug 2013 18:29)

#### Element type: Wall - Timber framed - insulation between studs

Calculation Method: BS EN ISO 6946

#### wall construction

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	Sp. heat	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	140	0.038	0.130	0.150	20	1030	3.684	1.077	insulation / timber frame
4	200	1.210			1700	800	0.165		Brick outer leaf
							0.040		Rse
	353 mm	ı (total wall	l thickness)				4.079		

Total resistance: Upper limit: 3.223 Lower limit: 3.098 Ratio: 1.040 Average: 3.160 m<sup>2</sup>K/W

U-value (uncorrected) 0.3164

U-value corrections

Air gaps in layer 3  $\Delta U = 0.0082$  (Level 1)

Total  $\Delta U$  0.0082

 U-value (corrected)
 0.325 (0.3246)

 U-value (rounded)
 0.32 W/m²K

Heat capacity per m<sup>2</sup> ( $\kappa$ ) 8.8 kJ/m<sup>2</sup>K

Calculated by: Andy Mitchell

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:57

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\Basements U values.uva (File saved: 14 Aug 2013 18:29)

#### **Element type: Heated basement**

Calculation Method: BS EN ISO 6946, BS EN ISO 13370

#### Basements

Thermal	<u>l resistance</u>	ofbaseme	ent floor con	nstruction:					
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	<u>Fraction</u>	Density	<u>Sp. heat</u>	<u>R layer</u> 0.170	<u>R bridge</u>	<u>Description</u> Rsi
$\frac{1}{2}$	75 100	1.200 0.023			1800 20	1000 1030	0.062 4.348		screed insulation board
	<u>175 mm</u>	L					4.580		

Total resistance: Upper limit: 4.580 Lower limit: 4.580 Ratio: 1.000 Average: 4.580 m<sup>2</sup>K/W

#### Thermal resistance of basement wall construction:

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	<u>Sp. heat</u>	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	100	0.038	0.130	0.118	20	1030	2.632	0.769	insulation between battens
4	200	1.210			2000	1000	0.165		masonry
	313 mm	L					2.986		

Total resistance: Upper limit: 2.498 Lower limit: 2.402 Ratio: 1.040 Average: 2.450 m<sup>2</sup>K/W

Ground param	alare				
	10.00 m			Wall thickness:	300 mm
	$25.00 \text{ m}^2$				
					Clay/silt ( $\lambda = 1.5 \text{ W/m} \cdot \text{K}$ )
P/A:	0.400			Rse:	$0.04 \text{ m}^2\text{K/W}$
Average baser	nent depth:		1.000 m		
Area of basem	ent walls:		10.00 m <sup>2</sup>		
		<u>Floor</u>	Walls	Overall (area-	weighted average)
U-value		$\overline{0.150}$	0.316	0.197	2 2 /
U-value (roui	nded)	0.15	0.32	0.20 W/m <sup>2</sup> K	
Heat capacity j	per m <sup>2</sup> ( $\kappa$ )	135.0	8.8	98.9 Btu/ft <sup>2,0</sup> I	ק
Calculated by:	<i>u</i>				

by BRE U-value Calculator version 2.02 Printed on 15 Aug 2013 at 09:57

Filename: M:\EcoHomes Jobs\Cranbrook Basements\BBS 6682 Review of K & C planning\Basements U values.uva (File saved: 14 Aug 2013 18:29)

#### **Element type: Heated basement**

Calculation Method: BS EN ISO 6946, BS EN ISO 13370

#### Basements

Thermal	l resistance	ofbaseme	ent floor con	nstruction:					
<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	<u>Fraction</u>	<u>Density</u>	<u>Sp. heat</u>	<u>R layer</u> 0.170	<u>R bridge</u>	<u>Description</u> Rsi
1 2	75 100	1.200 0.023			1800 20	1000 1030	0.062 4.348		screed insulation board
	175 mm	-					4.580		

Total resistance: Upper limit: 4.580 Lower limit: 4.580 Ratio: 1.000 Average: 4.580 m<sup>2</sup>K/W

#### Thermal resistance of basement wall construction:

Layer	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	Fraction	Density	<u>Sp. heat</u>	<u>R layer</u>	<u>R bridge</u>	Description
							0.130		Rsi
1	12.5	0.210			700	1000	0.060		Plasterboard
2									Vapour control layer
3	100	0.038	0.130	0.118	20	1030	2.632	0.769	insulation between battens
4	200	1.210			2000	1000	0.165		masonry
	313 mm	L					2.986		

Total resistance: Upper limit: 2.498 Lower limit: 2.402 Ratio: 1.040 Average: 2.450 m<sup>2</sup>K/W

Ground param	eters:				
Perimeter P:	10.00 m			Wall thickness	: 300 mm
Area A:	25.00 m <sup>2</sup>			Ground type:	Clay/silt ( $\lambda = 1.5 \text{ W/m} \cdot \text{K}$ )
P/A:	0.400			Rse:	$0.04 \text{ m}^2\text{K/W}$
Average baser	nent depth:		2.000 m		
Area of basem	ent walls:		20.00 m <sup>2</sup>		
U-value U <b>-value (rou</b> i	nded)	<u>Floor</u> 0.143 <b>0.14</b>	<u>Walls</u> 0.271 <b>0.2</b> 7	<u>Overall</u> (area 0.200 <b>0.20</b> W/m²K	-weighted average)
Heat capacity p	per m <sup>2</sup> ( $\kappa$ )	135.0	8.8	78.9 Btu/ft <sup>2.0</sup>	F
Calculated by:					

			User D	)etails:						
Assessor Name: Software Name:	Stroma FS			Strom Softwa	are Ver	rsion:		Versio	n: 1.5.0.49	
	<b>.</b>		Property	Address	: Base g	round le	vel			
Address :	Ţ	d level , TN3 8l	_A							
1. Overall dwelling dime	INSIONS.		Aro	a(m²)			eight(m)		Volume(m <sup>3</sup> )	
Ground floor					(1a) x	-	2.6	(2a) =	65	(3a)
Total floor area TFA = (1	a)+(1b)+(1c)+	(1d)+(1e)+(´	ln)	25	(4)					
Dwelling volume					(3a)+(3b)	<b>)+(</b> 3c)+(3d	)+(3e)+	.(3n) =	65	(5)
2. Ventilation rate:	<u> </u>									
	main heating	Second: heating		other		total			m <sup>3</sup> per hour	
Number of chimneys	0	+ 0	+	0	] = [	0	<b>x</b> 4	40 =	0	(6a)
Number of open flues	0	+ 0	<u> </u>	0	ī - Ē	0	x 2	20 =	0	(6b)
Number of intermittent fa	ns				Ī	1	<b>x</b> 1	10 =	10	(7a)
Number of passive vents						0	<b>x</b> 1	0 =	0	(7b)
Number of flueless gas fi	res				Ē	0	x 4	40 =	0	(7c)
								Air ch	anges per hou	ır
Infiltration due to chimne						10	1	+ (5) =	0.15	(8)
Number of storeys in th	1 at 1 at 1 at 1		ed to (17), (	Juliel Wise C	Jonande In	0111 (3) 10 (	10)	1	0	(9)
Additional infiltration	J.						[(9)-	-1]x0.1 =	0	(10)
Structural infiltration: 0	.25 for steel or	r timber frame o	or 0.35 fo	r masonr	y constr	uction	eksette:		0	(11)
if both types of wall are pl			to the great	er wall are	a (after					-
deducting areas of openir If suspended wooden f			0.1 (seale	ed). else	enter 0				0	(12)
If no draught lobby, en				, eice					0	(13)
Percentage of windows								-	0	(14)
Window infiltration				0.25 - [0.2	x (14) ÷ 1	= [00			0	(15)
Infiltration rate				(8) + (10)	+ <b>(1</b> 1) + (1	2) + (13) +	+ (15) =		0	(16)
Air permeability value,	• •		•	•	•	etre of e	nvelope	area	7	(17)
If based on air permeabil	-								0.5	(18)
Air permeability value applie Number of sides on whic		on test has been de	one or a deg	gree air pei	rmeability	is being us	sed		2	
Shelter factor	II SHellereu			(20) = 1 -	[ <b>0.07</b> 5 x (1	9)] =			0	(19) (20)
Infiltration rate incorporat	ing shelter fac	tor		(21) = (18	) x (20) =				0.5	(21)
Infiltration rate modified f	-								010	](==)
Jan Feb	Mar Apr	May Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp		e 7								
(22)m= 5.4 5.1	5.1 4.5	4.1 3.9	3.7	3.7	4.2	4.5	4.8	5.1		
Wind Factor (22a)m = (22	2)m ÷ 4									
(22a)m= 1.35 1.27	1.27 1.12	1.02 0.98	0.92	0.92	1.05	1.12	1.2	1.27		

Adjuste	ed infiltra	ation rat	e (allowi	ing for sl	nelter an	d wind s	speed) =	(21a) x	(22a)m			_	_	
	0.68	0.64	0.64	0.57	0.52	0.49	0 <u>.</u> 47	0 <u>.</u> 47	0.53	0.57	0 <u>.</u> 6	0.64		
		<i>ctive air (</i> al ventila	-	rate for t	he appli	cable ca	se	-	-	-		-		
				ondix N (2	(2h) = (23a	a) x Emv (d	aquation (I	N5)) , othe	nwien (23h	(23a)			0	(23a)
		• •			, ,	, .				<b>)</b> - ( <b>2</b> 5a)			0	(23b)
			-		-			n Table 4h		01	001	4 (00.)	0	(23c)
			1				<u> </u>	1	í .		<u>, -</u>	1 – (23c)	÷ 100]	(24a)
(24a)m=		0	0	0	0	0	0	0	0	0	0	0		(24 <b>a</b> )
-			1	1		· · · · · ·	<u> </u>	√V) (24b	ŕ – – –	r	<u> </u>	1	1	(2.11.)
(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24b)
,						•		on from c c) = (22t		.5 × (23t	<b>)</b> )			
(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0		(24c)
						•		on from I 0.5 + [(2		0.5]				
( <b>24d</b> )m=	0.73	0.71	0.71	0.66	0.63	0.62	0.61	0.61	0.64	0.66	0.68	0.71		(24d)
Effe	ctive air	change	rate - er	nter (24a	) or (24t	o) or (24	c) or (24	d) in boy	(25)					
(25)m=	0.73	0.71	0.71	0.66	0.63	0.62	0.61	0.61	0.64	0.66	0.68	0.71		(25)
3. He ELEN		s and he Gros area	ss	parameto Openin m	gs	Net Ar A ,r		U-valı W/m2		A X U (W/	K)	k-value kJ/m²·ł		A X k J/K
Windo	ws Type	e 1				1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Windov	ws Type	2				1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Floor						25		0.16	= [7	4				(28)
Walls		26		2.88		23.12	2 X	0.32	=	7.4	i F			(29)
Total a	rea of e	lements	, m²			51	=							(31)
				effective wi nternal wal			ated using	g formula 1.	/[(1/U-valu	ie)+0.04] a	as given in	paragraph	3.2	
Fabric	heat los	s, W/K :	= S (A x	U)				(26)(30)	) + (32) =				16.23	(33)
Heat c	apacity	Cm = S(	(A x k )						((28).	(30) + (32	2) + (32a).	(32e) =	2958.08	(34)
Therm	al mass	parame	eter (TMI	⊃ = Cm ÷	+ TFA) ir	ו kJ/m²K	,		Indica	tive Value	: Medium		250	(35)
	•		ere the de tailed calc		construct	ion are noi	t known pr	recisely the	e indicative	e values of	TMP in T	able 1f		
Therm	al bridge	es : S (L	x Y) cal	culated u	using Ap	pendix l	K						4.08	(36)
if details	of therma	al bridging	are not kn	own (36) =	= 0.15 x (3	1)								
Total fa	abric he	at loss							(33) +	(36) =			20.31	(37)
Ventila	tion hea	at loss ca	alculated	d monthly	y	-			(38)m	= 0.33 × (	25)m x (5	)		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	15.69	15.15	15.15	14 <b>.17</b>	13.59	13 <b>.31</b>	13.05	13.05	13.73	14.17	14.65	15.15		(38)
Heat tr	ansfer o	coefficier	nt, W/K						(39)m	= (37) + (	38)m			
(39) <b>m=</b>	36	35.47	35.47	34.49	33.9	33.63	33.37	33.37	34.04	34.49	34.96	35.47		
									,	Average =	Sum(39)	12 /12=	34.55	(39)
	· ·	meter (H	HLP), W	/m²K		1	1		(40)m	= (39)m ÷	· (4)			
(40)m=	1.44	1.42	1.42	1.38	1.36	1.35	1.33	1.33	1.36	1.38	1.4	1.42		
									,	Average =	Sum(40)1	12 /12=	1.38	(40)

Numbe	er of day	/s in mo	nth (Tab	le 1a)	-	-	_	_	-	-	_			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
4. Wa	ater heat	ling ene	rgy requi	irement:								kWh/ye	ear:	
if TF			N + 1.76 x	[1 - exp	(-0.0003	349 x (TF	=A -13.9	)2)] + 0.(	)013 x (	TFA -13.		885		(42)
Reduce	the annua	al average	ater usag hot water berson per	usage by	5% if the a	lwelling is	designed			se target o		.052		(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	er usage il		day for ea			ctor from 1	Table 1c x	-						
(44)m=	66.06	63.66	61.25	58.85	56.45	54.05	54.05	56.45	58.85	61.25	63.66	66.06		
Energy	content of	hot water	used - cal	culated m	onthly = 4.	190 x Vd,r	m x nm x E	) )Tm / 3600		Total = Su oth (see Ta	( )		720.6243	(44)
(45)m=	98.2	85.88	88.62	77.26	74.14	63.97	59.28	68.03	68.84	80.22	87.57	95.1		
										Total = Su	m(45) <sub>1-12</sub> =		947.1126	(45)
lf ins <mark>tant</mark>	taneous w	ater heati	ng at point	of use (no	hot water	storage),	enter 0 in	boxes (46	) to (61)					
(46)m=	14.73	12.88	13.29	11.59	11.12	9.6	8.89	10.2	10.33	12.03	13.14	14.26		(46)
	storage anufactu		clared lo	oss facto	or is know	vn (kWh	/day):					0		(47)
Tempe	erature f	actor fro	m Table	2b								0		(48)
Energy	/ lost fro	m water	storage	, kWh/ye	ear			(47) x (48	) =		-	0		(49)
			red cylir ) includir	and the second			and the second se					0		(50)
	-	-	' no tank in t water (th	-			• •	enter '0' in	box (50)					
Hot wa	ater stor	age loss	factor fr	om Tabl	le 2 (kW	h/litre/da	ay)					0		(51)
Volum	e factor	from Ta	ble 2a									0		(52)
Tempe	erature f	actor fro	m Table	2b								0		(53)
Energy	y lost fro	m water	· storage	, kWh/y	ear			<b>((50)</b> x (51	l) x (52) x	(53) =		0		(54)
Enter (	(49) or (	54) in (5	5)									0		(55)
Water	storage	loss cal	culated f	fo <mark>r eac</mark> h	month			((56)m = (	55) × (41)	m				
(56)m=	0	0	0	0	0	0	0	0	0	0	0	0		(56)
If cylinde	er contains	s dedicate	d solar sto	rage, (57)	m = (56)m	x [(50) – (	H11)] ÷ (5	0), else (5	<b>7)</b> m = (56)	m where (	H11) is fro	m Append	ix H	
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primar	v circuit	loss (ar	nual) fro	om Table	e 3							0		(58)
	-	,	culated t			59)m = (	(58) ÷ 36	65 × (41)	m					
(mo	dified by	r factor f	rom Tab	le H5 if t	here is s	solar wa	ter heati	ng and a	ı cylinde	r thermo	stat)			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
Combi		culated	for each	month	(61 <b>)</b> m =	(60) ÷ 30	65 × (41	)m						
(61)m=	33.66	29.3	31.21	29.02	28.77	26.65	27.54	28.77	29.02	31.21	31.39	33.66		(61)
Total h	neat requ	uired for	water he	eating ca	alculated	l for eac	h month	(62)m =	0.85 × (	(45) <b>m +</b>	(46)m +	(57)m +	(59)m + (61)m	
(62)m=	131.86	1 <b>15.18</b>	1 <b>19.84</b>	106.29	102.9	90.63	86.82	96.79	97.86	<b>11</b> 1.44	118.96	128.76		(62)

Solar Di	HW input	calculated	using App	endix G or	Appendix	: H (negat	ive quantit	y) (ent	er '0'	if no solar	contribu	ution to wate	er heating)		
(add a	dditiona	I lines if	FGHRS	and/or \	WWHRS	applies	s, see Ap	penc	lix G	<b>6</b> )				_	
(63)m=	0	0	0	0	0	0	0	0		0	0	0	0		(63)
Outpu	t from w	ater hea	ter	-		-	-	-				-	-		
(64) <b>m=</b>	131.86	115.18	119.84	106.29	102.9	90.63	86.82	96.	79	97.86	<b>11</b> 1.44	118.96	128.76		
									Outp	ut from wa	ate <mark>r he</mark> at	er (annual)₁	12	1307.3261	(64)
Heat g	ains fro	m water	heating,	kWh/m	onth 0.2	5 ´ [0.85	5 × (45)m	n + (6	1)m	] + 0.8 x	[(46)m	า + (57)m	+ (59)m	]	
(6 <b>5)</b> m=	41.07	35.88	37.27	32.95	3 <b>1.</b> 84	27.93	26.6	29.	81	30.14	34.48	36.97	40.04		(65)
inclu	ude (57)	m in calo	culation	of (65)m	only if c	ylinder	is in the	dwell	ing o	or hot wa	ater is t	from com	munity h	eating	
5. In	ternal ga	ains (see	e Table 5	5 and 5a	):										
Metab	olic gair	ıs (Table	e 5). Wat	ts											
	Jan	Feb	Mar	Apr	May	Jun	Jul	A	ug	Sep	Oct	Nov	Dec		
(66)m=	54.43	54.43	54.43	54.43	54.43	54.43	54.43	54.	43	54.43	54.43	54.43	54.43		(66)
Lightin	ng gains	(calcula	ted in Ap	opendix	L, equat	ion L9 c	or L9a), a	lso s	ee T	Table 5					
(67)m=	8.62	7.65	6.22	4.71	3.52	2.97	3.21	4.1	8	5.61	7.12	8.31	8.86		(67)
Applia	nces ga	ins (calc	ulated ir	n Append	lix L, eq	uation L	13 or L1	3a), a	also	see Tal	ole 5				
(68)m=	86.3	87.2	84.94	80.14	74.07	68.37	64.56	63.	67	65.93	70.73	76.8	82.5		(68)
Cookir	ng gains	(calcula	ted in A	ppendix	L, equal	tion L15	or L15a	), als	o se	e Table	5				
(69) <b>m</b> =	28.44	28.44	28.44	28.44	28.44	28.44	28.44	28.	44	28.44	28.44	28.44	28.44	47 	(69)
Pumps	and fa	ns gains	(Table \$	5a)				7							
(70)m=	10	10	10	10	10	10	10	1(	<u> </u>	10	10	10	10		(70)
Losse	s e.g. ev	aporatio	n (nega	tive valu	es) (Tab	le 5)									
(71)m=	-43.54	-43.54	-43.54	-43.54	-43.54	-43.54	-43,54	-43.	54	-43.54	-43.54	-43.54	-43.54		(71)
Water	heating	gains (T	able 5)								_				
(72)m=	55.2	53.39	50.09	45.76	42.8	38.8	35.75	40.	07	<b>4</b> 1.87	46.34	51.34	53.81		(72)
Total	internal	gains =				(66	i)m + (67)n	n + (68	3)m +	(69)m + (	70)m + (	71)m + (72)	)m		
(7 <mark>3)</mark> m=	199.44	197.57	190.59	179 <u>.</u> 94	169.72	159 <u>.</u> 47	152.85	157	24	162.73	173.52	185.77	194.49		(73)
6. So	lar gain:	s:													
Solar (	gains are o	calculated	using sola	r flux from	⊺able 6a	and asso	ciated equa	ations	to co	nvert to th	e applica	able orientat	tion.		
Orient		Access F Table 6d		Area m²		Flı Ta	ux Ible 6a		Та	g_ able 6b	-	FF Table 6c		Gains (W)	
East	0.9x	1	x	1.4	4	x	19.87	x		0.63	<b>]</b> × [	0.7	=	8.75	(76)
East	0.9x	1	×	1.4	4		38.52	×		0.63	╡╷	0.7	=	16.95	(76)
East	0.9x	1	x	1.4			61.57	x		0.63	╡╷┟	0.7	_	27.09	(76)
East	0.9x	1	x	1.4			91 <b>.41</b>	x		0.63	=  _	0.7	_	40.23	(76)
East	0.9x	1	×	1.4			111.22	×		0.63	╡╷	0.7	=	48.95	(76)
												(76)			
East	0.9x	1	×	1.4			112.64	×		0.63	╡╷	0.7		49.57	(76)
East	0.9x	1	x	1.4			98.03	×		0.63	╡╷	0.7		43.14	(76)
East	0.9x	1	x	1.4		x	73.6	x		0.63	=  _	0.7		32.39	(76)
East	0.9×	1	×	1.4	4	x	46.91	×		0.63	=  × [	0.7	=	20.64	(76)

East 0.9	1	×	1.4	4	x	2	4.71	×	0.63		x	0.7	=	10.87	(76)
East 0.9	1	×	1.4	4	x	1	6.39	×	0.63		×	0.7	=	7 <b>.2</b> 1	(76)
West 0.9	0.77	×	1.4	4	x	1	9.87	x	0.63		×	0.7	-	8.75	(80)
West 0.9	0.77	۲× آ	1.4	4	x	3	8.52	×	0.63		×	0.7	=	16.95	(80)
West 0.9	0.77	×	1.4	4	x	6	1.57	x	0.63		×	0.7	-	27.09	(80)
West 0.9	0.77	- X	1.4	4	x	9	1 <b>.41</b>	×	0.63		×「	0.7	=	40.23	(80)
West 0.9	0.77	× ٦	1.4	4	x	1-	11.22	×	0.63		×	0.7	=	48.95	(80)
West 0.9	0.77	- X	1.4	4	x	1	16.05	x	0.63		×	0.7	=	51.07	(80)
West 0.9	0.77	×	1.4	4	x	11	12.64	x	0.63		×	0.7	=	49.57	(80)
West 0.9	0.77	×	1.4	4	x	9	8.03	x	0.63		×	0.7	=	43.14	(80)
West 0.9	0.77	×	1.4	4	x	7	73.6	x	0.63		×	0.7	=	32.39	(80)
West 0.9>	0.77	×	1.4	4	x	4	6.91	×	0.63		×	0.7	=	20.64	(80)
West 0.9>	0.77	x	1.4	4	x	2	4.71	x	0.63		×	0.7	=	10.87	(80)
West 0.9	0.77	۲ × آ	1.4	4	x	1	6.39	×	0.63		×	0.7	=	7.21	(80)
		-	-					•							
Solar gains i	n watts, calcu	lated	for each	month	ì			(83)m	= Sum(74)	)m (8	2)m				
(83)m= 17.49		4.19	80.46	97.89	-	02.14	99.14	86.			1.29	21.75	14.43	٦	(83)
	internal and							00.	29 04.7	0 4	1.29	21.75	14.43		(00)
(84)m= 216.9		4.78	260.39	267.61	1	61.62	252	243	53 227.5	51 2	14.81	207.52	208.92		(84)
						01.02	232	243	.55 221.3	51 2	14.01	201.52	200.92	1	
	ernal tempera												_	_	
Temperatur	e during heat	ing pe	eriods in	the livi	ing	area f	from Tab	ple 9.	Th1 (°C					21	(85)
				1000				7.00,		( ) · · · · · · · · · · · · · · · · · ·					A. 19. 19.
Utilisation fa	actor for gains	s for li	ving are	a, h1,n	n (s	ee Ta				, 	_				
Utilisation fa		s for li Mar	ving are Apr	a, h1,n May	T	ee Ta Jun			ug Se		Oct	Nov	Dec		
	Feb N	T		-	Ĺ		ble 9a)		ug Se	p	Oct 0.95	Nov 0.99	Dec 0.99		(86)
(86) <b>m</b> = 0.99	Feb         N           0.99         0	<b>Mar</b> .98	Apr 0.95	May 0.88		<b>Jun</b> 0.73	ble 9a) Jul 0.53	A1	ug Se 4 0.82	p		0000000	Sector Sector Sector	]	
(86)m= Jan 0.99 Mean interr	Feb     N       0.99     0       al temperature	Mar .98 re in I	Apr 0.95 iving are	May 0.88 ea T1 (f		Jun 0.73 w ste	ble 9a) Jul 0.53 ps 3 to 7	Au 0.5 7 in T	ug Se 4 0.82 able 9c)	2 (	0.95	0.99	0.99		(86)
(86) <b>m</b> = 0.99	Feb     N       0.99     0       al temperature	<b>Mar</b> .98	Apr 0.95	May 0.88		<b>Jun</b> 0.73	ble 9a) Jul 0.53	A1	ug Se 4 0.82 able 9c)	2 (		0000000	Sector Sector Sector		
(86)m= 0.99 Mean intern (87)m= 19.65	Feb     N       0.99     0       al temperature	Mar       .98       re in       0.05	Apr 0.95 iving are 20.36	May 0.88 ea T1 (f 20.71		Jun 0.73 ow ste 20.91	ble 9a) Jul 0.53 ps 3 to 7 20.98	Au 0.5 7 in T 20.1	ug Se 4 0.82 able 9c) 98 20.8	2 ( 5 2	0.95	0.99	0.99		(86)
(86)m= 0.99 Mean intern (87)m= 19.65	Feb0.99019.7920e during heat	Mar       .98       re in       0.05	Apr 0.95 iving are 20.36	May 0.88 ea T1 (f 20.71	íollo 2 f dw	Jun 0.73 ow ste 20.91	ble 9a) Jul 0.53 ps 3 to 7 20.98	Au 0.5 7 in T 20.1	ug Se 4 0.82 able 9c) 98 20.8 9, Th2 (°C	p 2 ( 5 2 C)	0.95	0.99	0.99		(86)
(86)m= Jan (86)m= 0.99 Mean interr (87)m= 19.65 Temperatur (88)m= 19.74	Feb0.99019.7920e during heat	Mar .98 re in I 0.05 iing pe 9.75	Apr 0.95 iving are 20.36 eriods in 19.78	May 0.88 20.71 rest of 19.8	follo 2 f dw	Jun 0.73 ww.ste 20.91 velling 9.81	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82	Au 0.5 7 in T 20.1 able 9 19.1	ug Se 4 0.82 able 9c) 98 20.8 9, Th2 (°C	p 2 ( 5 2 C)	0.95 20.47	0.99 19.98	0.99 19.7		(86) (87)
(86)m= Jan (86)m= 0.99 Mean interr (87)m= 19.65 Temperatur (88)m= 19.74	Feb0.99019.7920e during heat19.7519ector for gains	Mar .98 re in I 0.05 iing pe 9.75	Apr 0.95 iving are 20.36 eriods in 19.78	May 0.88 20.71 rest of 19.8	follo 2 f dw 1 h2,	Jun 0.73 ww.ste 20.91 velling 9.81	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82	Au 0.5 7 in T 20.1 able 9 19.1	ug Se 4 0.82 able 9c) 98 20.8 9, Th2 (°C 32 19.8	p 2 (0 25 2 C) 3 1	0.95 20.47	0.99 19.98	0.99 19.7		(86) (87)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99	Feb0.99019.7920e during heat19.7519ector for gains0.980	Mar .98 re in I 0.05 iing pe 9.75 s for r .97	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93	May 0.88 ea T1 (f 20.71 rest of 19.8 velling, 0.83	follo 2 7 4 1 h2,	Jun 0.73 ww_ste 20.91 yelling 9.81 ,m (se 0.63	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38	A 0.5 7 in T 20.1 able \$ 19.1 9a) 0.4	ug Se 4 0.82 able 9c) 98 20.8 9, Th2 (°C 32 19.8 4 0.73	p       2     (1       25     2       C)     3       3     (1	9.78 0.93	0.99 19.98 19.77	0.99 19.7 19.75		(86) (87) (88)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99	Feb0.990al temperature19.7920e during heat19.7519actor for gains0.980al temperature	Mar .98 re in I 0.05 iing pe 9.75 s for r .97	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93	May 0.88 ea T1 (f 20.71 rest of 19.8 velling, 0.83	follo z dw h2, ling	Jun 0.73 ww_ste 20.91 yelling 9.81 ,m (se 0.63	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38	A 0.5 7 in T 20.1 able \$ 19.1 9a) 0.4	Jg         Se           4         0.82           able 9c)         98           98         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73	p 2 ( 2 ( 2) 3 1 3 ( able 9	9.78 0.93	0.99 19.98 19.77	0.99 19.7 19.75		(86) (87) (88)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr	Feb0.990al temperature19.7920e during heat19.7519actor for gains0.980al temperature	Mar .98 re in I 0.05 iing pe 9.75 s for r .97 re in t	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of	May 0.88 20.71 (f 20.71 1 rest of 19.8 velling, 0.83 of dwell	follo z dw h2, ling	Jun 0.73 w ste 20.91 velling 9.81 ,m (se 0.63 T2 (fo	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38	Ai 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3	Jg         Se           4         0.82           able 9c)         98           98         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73	p       2     (       25     2       C)     3       33     (       able \$     9       '2     1	9.78 0.93 0.93 0.93 9.38	0.99 19.98 19.77 0.98 18.89	0.99 19.7 19.75 0.99 18.61		(86) (87) (88) (89) (90)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54	Feb         N           0.99         0           aal temperature         19.79         20           e during heat         19.75         19           actor for gains         0.98         0           aal temperature         19.75         19           actor for gains         19.8         0           18.69         18	Mar .98 re in I 0.05 iing pe 9.75 s for r .97 re in t 3.95	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 he rest of 19.28	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61	follo z dw h2, ling	Jun 0.73 wwwste 20.91 /elling 9.81 ,m (se 0.63 T2 (fo 9.77	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1	Jg         Se           4         0.82           6able         9c)           98         20.8           9, Th2 (°C           32         19.8           4         0.73           to 7 in T           31         19.7	p       2     (       25     2       20)     3       3     (       3able \$     9       2     1       fLA	9.78 0.93 0.93 0.93 9.38	0.99 19.98 19.77 0.98	0.99 19.7 19.75 0.99 18.61		(86) (87) (88) (89)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54	Feb0.990al temperature19.7920e during heat19.7519actor for gains0.980al temperature	Mar .98 re in I 0.05 iing pe 9.75 s for r .97 re in t 3.95	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 he rest of 19.28	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61	follo z dw h2, ling	Jun 0.73 wwwste 20.91 /elling 9.81 ,m (se 0.63 T2 (fo 9.77	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1	Jg         Se           4         0.82           6able         9c)           98         20.8           9, Th2 (°C           32         19.8           4         0.73           to 7 in T           31         19.7	p       2     (       25     2       20)     3       3     (       3able \$     9       2     1       fLA	9.78 0.93 0.93 0.93 9.38	0.99 19.98 19.77 0.98 18.89	0.99 19.7 19.75 0.99 18.61		(86) (87) (88) (89) (90)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54	Feb       N         0.99       0         aal temperature       19.79       20         ae during heat       19.75       19         actor for gains       0.98       0         aal temperature       18.69       18         aal temperature       18.69       18	Mar .98 re in I 0.05 iing pe 9.75 s for r .97 re in t 3.95	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 he rest of 19.28	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61	iollo 2 dw 1 h2, 1 ling	Jun 0.73 wwwste 20.91 /elling 9.81 ,m (se 0.63 T2 (fo 9.77	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1	Jg         Se           4         0.82           able 9c)         98           98         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         19.7           51         19.7           - fLA) ×	p       2     (       2     (       2     (       3     1       3     (       able S     2       2     1       fLA     T2	9.78 0.93 0.93 0.93 9.38	0.99 19.98 19.77 0.98 18.89	0.99 19.7 19.75 0.99 18.61		(86) (87) (88) (89) (90)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54           Mean interr           (92)m=         18.99	Feb       N         0.99       0         aal temperature       19.79       20         ae during heat       19.75       19         actor for gains       0.98       0         aal temperature       18.69       18         aal temperature       18.69       18	Mar .98 re in I 0.05 iing po 9.75 s for r .97 re in t 3.95 re (for 9.39	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 he rest of 19.28 r the who 19.71	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61 19.61	follo 2 7 dw 1 h2, 1 1 h2, 2	Jun 0.73 w ste 20.91 /elling 9.81 .m (se 0.63 T2 (fo 9.77 g) = fl 20.23	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1 + (1 20.1	Jg     Se       4     0.82       able     9c)       98     20.8       9, Th2 (°C       32     19.8       4     0.73       to 7 in T       31     19.7       - fLA) × 1       28     20.1	p       2     (1       25     2       20     1       3     (1       3     (1       3     (1       3     (1       4     1       7     1	0.95 0.47 9.78 0.93 0C) 9.38 = Livii	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4	0.99 19.75 0.99 18.61		(86) (87) (88) (89) (90) (91)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54           Mean interr           (92)m=         18.99	Feb       I         0.99       0         aal temperature       19.79       20         ae during heat       19.75       19         actor for gains       0.98       0         aal temperature       18.69       18         aal temperature       19.73       18         aal temperature       19.13       18         aal temperature       19.13       19	Mar .98 re in I 0.05 iing po 9.75 s for r .97 re in t 3.95 re (for 9.39	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 he rest of 19.28 r the who 19.71	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61 19.61	follo 2 4 h2, 1 h2, 0 1 1 2 1 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1	Jun 0.73 wwwste 20.91 /elling 9.81 ,m (se 0.63 T2 (fo 9.77 g) = fl 20.23	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1 + (1 20.1	Jg         Se           4         0.82           able 9c)         20.8           98         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         0.73           51         19.7           - fLA) ×         28           20.1         where ap	p       2     (       2     (       2     (       3     1       3     (       able S     2       2     1       fLA       T2       7     1       ppropr	0.95 0.47 9.78 0.93 0C) 9.38 = Livii	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4	0.99 19.75 0.99 18.61		(86) (87) (88) (89) (90) (91)
Jan           (86)m=         0.99           Mean interr           (87)m=         19.65           Temperatur           (88)m=         19.74           Utilisation fa           (89)m=         0.99           Mean interr           (90)m=         18.54           Mean interr           (92)m=         18.99           Apply adjus           (93)m=         18.84	Feb       I         0.99       0         aal temperature       19.79       20         ae during heat       19.75       19         actor for gains       0.98       0         aal temperature       18.69       18         aal temperature       19.73       18         aal temperature       19.13       18         aal temperature       19.13       19	Mar           .98           re in I           0.05           ing pe           0.75           s for r           .97           re in t           3.95           re (for           0.39           mean           0.24	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of 19.28 r the who 19.71 internal	May 0.88 20.71 (f 20.71 19.8 velling, 0.83 of dwell 19.61 19.61 20.05 temper	follo 2 4 h2, 1 h2, 0 1 1 2 1 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1	Jun 0.73 w ste 20.91 /elling 9.81 ,m (se 0.63 T2 (fc 9.77 g) = fl 20.23 ire fro	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28 m Table	An 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1 + (1 20.2 + (1 20.2 + (1 20.2)	Jg         Se           4         0.82           able 9c)         20.8           98         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         0.73           51         19.7           - fLA) ×         28           20.1         where ap	p       2     (       2     (       2     (       3     1       3     (       able S     2       2     1       fLA       T2       7     1       ppropr	9.95 9.78 9.78 0.93 9.38 = Livin 9.82 iate	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4 19.33	0.99 19.75 0.99 18.61 1) = 19.04		(86) (87) (88) (89) (90) (91) (92)
Jan         (86)m=       0.99         Mean interr         (87)m=       19.65         Temperatur         (88)m=       19.74         Utilisation fa         (89)m=       0.99         Mean interr         (90)m=       18.54         Mean interr         (92)m=       18.99         Apply adjus         (93)m=       18.84         8, Space her	Feb0.99019.7920e19.7920e19.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7519.7518.6918.6918.6919.1319.1319.1319.9819.9819.9819.9819.9819.9819.9819.9819.98	Mar           .98           re in I           0.05           iing pe           0.75           s for r           .97           re in t           3.95           re (for           0.39           mean           0.24           ment	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of 19.28 r the who 19.71 internal 19.56	May 0.88 20.71 1 rest of 19.8 velling, 0.83 of dwell 19.61 20.05 temper 19.9	iollo iollo i 2 i dw ing ing ing ing ing ing ing ing i 1 2 i ing i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2	Jun 0.73 w ste 20.91 /elling 9.81 m (se 0.63 T2 (fc 9.77 g) = fl 20.23 ire fro 20.08	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28 m Table 20.13	A 0.5 7 in T 20.1 able 9 19.3 9a) 0.4 eps 3 19.3 + (1 20.1 + (1 20.1 20.1 	Jg         Se           4         0.82           able 9c)         38           38         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         0.73           5         19.7           4         0.73           5         20.1           where ap         13           13         20.0	p       2       (1         2       (2       (2         2       (2       1         3       (3       (3         33       (3       (3         34       (1       (2         7       1       (1         12       1       (1	9.95 9.78 9.78 0.93 9.38 = Livii 9.82 iate 9.67	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4 19.33 19.18	0.99 19.75 0.99 18.61 1) = 19.04 18.89		(86) (87) (88) (89) (90) (91) (92)
$\begin{array}{c} Jan \\ (86)n= 0.99 \\ Mean interr \\ (87)m= 19.65 \\ Temperatur \\ (88)m= 19.74 \\ Utilisation fa \\ (89)m= 0.99 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (92)m= 18.95 \\ Apply adjus \\ (93)m= 18.84 \\ 8. Space he \\ Set Ti to the \\ \end{array}$	Feb         I           0.99         0           aal temperature         19.79         20           e during heat         19.75         19           actor for gains         0.98         0           actor for gains         0.98         0           actor for gains         18.69         18           al temperature         18.69         18           actor tor gains         18.69         18	Mar	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of 19.28 r the who 19.71 internal 19.56	May 0.88 ea T1 (f 20.71 19.8 velling, 0.83 of dwell 19.61 19.61 cole dwe 20.05 temper 19.9	iollo iollo i 2 i dw ing ing ing ing ing ing ing ing i 1 2 i ing i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2 i 2	Jun 0.73 w ste 20.91 /elling 9.81 m (se 0.63 T2 (fc 9.77 g) = fl 20.23 ire fro 20.08	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28 m Table 20.13	A 0.5 7 in T 20.1 able 9 19.3 9a) 0.4 eps 3 19.3 + (1 20.1 + (1 20.1 20.1 	Jg         Se           4         0.82           able 9c)         38           38         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         0.73           5         19.7           4         0.73           5         20.1           where ap         13           13         20.0	p       2       (1         2       (2       (2         2       (2       1         3       (3       (3         33       (3       (3         34       (1       (2         7       1       (1         12       1       (1	9.95 9.78 9.78 0.93 9.38 = Livii 9.82 iate 9.67	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4 19.33 19.18	0.99 19.75 0.99 18.61 1) = 19.04 18.89		(86) (87) (88) (89) (90) (91) (92)
$\begin{array}{c} Jan \\ (86)n= 0.99 \\ Mean interr \\ (87)m= 19.65 \\ Temperatur \\ (88)m= 19.74 \\ Utilisation fa \\ (89)m= 0.99 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (92)m= 18.95 \\ Apply adjus \\ (93)m= 18.84 \\ 8. Space he \\ Set Ti to the \\ \end{array}$	Feb       I         0.99       0         aal temperature       19.79       20         aa tor for gains       19.75       19         aactor for gains       0.98       0         aal temperature       18.69       18         aal temperature       18.69       18         aal temperature       19.13       19         aating require       18.98       19         aating require       18.98       19	Mar	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of 19.28 r the who 19.71 internal 19.56 nperatur using Ta	May 0.88 2a T1 (f 20.71 19.8 velling, 0.83 of dwell 19.61 20.05 temper 19.9 e obtain ble 9a	follo follo follo f dw h2, f dw h2, f dw h2, f dw f ling f ling f ling f ling f ling f ling f ling	Jun 0.73 w ste 20.91 /elling 9.81 m (se 0.63 T2 (fc 9.77 g) = fl 20.23 ire fro 20.08	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28 m Table 20.13	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1 4e, 1 20.1 4e, 1 20.1 Tabl	Jg       Se         4       0.82         able 9c)       20.8         9, Th2 (°C       22         32       19.8         4       0.73         4       0.73         4       0.73         5       20.8         4       0.73         4       0.73         5       20.1         where ap       13         13       20.0         e 9b, so f	p       2       (1)         2       (2)       (2)         3       (1)       (2)         3       (2)       1         3       (2)       1         6       (2)       1         7       1       (2)         7       1       (2)         9       (2)       1         10       (2)       1         11       (2)       1         12       1       (2)         13       (2)       1         14       (2)       (2)         15       (2)       (2)         16       (2)       (2)         17       (2)       (2)         16       (2)       (2)         17       (2)       (2)         18       (2)       (2)         19       (3)       (2)         10       (3)       (2)         11       (3)       (2)         11       (3)       (2)         12       (3)       (3)         13       (3)       (3)         14       (3)       (3)         15       (3)	9.95 9.78 9.78 0.93 9.38 = Livii 9.82 iate 9.67	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4 19.33 19.18	0.99 19.75 0.99 18.61 1) = 19.04 18.89		(86) (87) (88) (89) (90) (91) (92)
$\begin{array}{c} Jan \\ (86)n= 0.99 \\ Mean interr \\ (87)m= 19.65 \\ Temperatur \\ (88)m= 19.74 \\ Utilisation fa \\ (89)m= 0.99 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (90)m= 18.54 \\ Mean interr \\ (92)m= 18.95 \\ Apply adjus \\ (93)m= 18.84 \\ 8. Space he \\ Set Ti to the the utilisation \\ Jan \\ \end{array}$	Feb       I         0.99       0         aal temperature       19.79       20         aa tor for gains       19.75       19         aactor for gains       0.98       0         aal temperature       18.69       18         aal temperature       18.69       18         aal temperature       19.13       19         aating require       18.98       19         aating require       18.98       19	Mar .98 re in I 0.05 iing po 0.75 s for r .97 re in t 3.95 re (for 9.39 mean 9.24 ment al ten ains t Var	Apr 0.95 iving are 20.36 eriods in 19.78 est of dv 0.93 the rest of 19.28 r the who 19.71 internal 19.56 nperatur using Ta Apr	May 0.88 ea T1 (f 20.71 19.8 velling, 0.83 of dwell 19.61 19.61 cole dwe 20.05 temper 19.9	follo follo follo f dw h2, f dw h2, f dw h2, f dw f ling f ling f ling f ling f ling f ling f ling	Jun 0.73 w ste 0.91 /elling 9.81 .m (se 0.63 T2 (fc 9.77 g) = fl 20.23 ire fro 20.08 1 at ste	ble 9a) Jul 0.53 ps 3 to 7 20.98 from Ta 19.82 ee Table 0.38 ollow ste 19.81 _A × T1 20.28 m Table 20.13	A 0.5 7 in T 20.1 able 9 19.1 9a) 0.4 eps 3 19.1 4e, 1 20.1 4e, 1 20.1 Tabl	Jg         Se           4         0.82           able 9c)         38           38         20.8           9, Th2 (°C           32         19.8           4         0.73           4         0.73           4         0.73           4         0.73           4         0.73           5         19.7           4         0.73           5         20.1           where ap         13           13         20.0	p       2       (1)         2       (2)       (2)         3       (1)       (2)         3       (2)       1         3       (2)       1         6       (2)       1         7       1       (2)         9       (2)       1         10       (2)       1         11       (2)       1         12       1       (2)         14       (2)       1         15       (2)       1         16       (2)       (2)         17       (2)       (2)         18       (2)       (2)         19       (3)       (2)         10       (3)       (2)         11       (3)       (2)         12       (3)       (2)         14       (4)       (4)	9.95 0.47 9.78 0.93 9.38 9.82 iate 9.67 i,m=1	0.99 19.98 19.77 0.98 18.89 ng area ÷ (4 19.33 19.18 76)m and	0.99 19.75 0.99 18.61 19.04 18.89 18.89 d re-cal		(86) (87) (88) (89) (90) (91) (92)

0.93

0.83

0.65

0.42

0.44

0.75

0.92

0.98

0.99

0.96

(94)m=

0.98

0.98

(94)

Useful	gains, l	nmGm .	W = (94	4)m x (8	4)m									
	213.64	226.59	235.53	241.4	, 222.19	170.69	106.44	106.22	<b>169.</b> 81	198.65	202.61	205.86		(95)
Monthly	y avera	ge exte	rnal tem	perature	e from Ta	able 8								
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9		(96)
Heat lo	ss rate	for mea	an intern	al temp	erature,	Lm , W =	=[(39)m :	x [(93)m	– (96)m	]				
(97)m= 5	516.08	495.81	441.32	374.59	277.85	184.14	107.85	107.81	194.69	305.8	425.71	496.23		(97)
· -	ī					Wh/mont	th = 0.02	24 x [(97	)m – (95					
(98)m= 2	225.02	180.92	1 <b>5</b> 3 <b>.1</b> 1	95.9	41.41	0	0	0	0	79.72	160.63	216.03		_
Space	haating	roquire	mont in	kWh/m <sup>2</sup>	2Woor			Tota	l per year	(kWh/year	') = Sum(9	8)=	46.11	(98) (99)
	-	•			-								40.11	(55)
9a. Ener			its – Indi	ividual h	eating s	ystems i	ncluding	micro-C	CHP)					
Space Eraction		-	t from s	econdar	vleunnle	mentary	evetem					Г	0	(201)
	•					mentary	-	(202) = 1 -	_ (201) =			l		
	-			nain syst	• /					(000)]			1	(202)
			-	main sys				(204) = (20	02) × [1 —	(203)] =		ļ	1	(204)
Efficien	icy of m	nain spa	ice heat	ing syste	em 1								84.8	(206)
Efficien	cy of s	econda	ry/suppl	ementar	y heatin	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Sp <mark>ace</mark> I	heating	require	ement (c	alculate	d above	)								
2	225.02	180.92	153.11	95.9	41.41	0	0	0	0	79.72	160.63	216.03		
(211)m =	= {[(98)	m x (20	4)] + (21	0)m } x	100 ÷ (2	.06)								(211)
2	265.35	213.35	180.55	113.08	48.83	0	0	0	0	94.01	189.43	254.75		
								Tota	l (kWh/yea	ar) =Sum(2	211) <sub>15,1012</sub>	=	1359.36	(211)
Space I	heating	fuel (se	econdar	y), kWh/	month									
= {[(98)n	n x (20	1)] + (21	14) m } x	( 100 ÷ (	208)									
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		_
								Tota	l (kWh/yea	ar) = <b>Sum(</b> 2	21 <b>5)</b> <sub>15,1012</sub>	=	0	(215)
Water h	-													
Output fr							00.00		07.00		440.00	100 70		
	131.86	115.18	119.84	106.29	102.9	90.63	86.82	96.79	97.86	<b>11</b> 1 <b>.4</b> 4	118.96	128.76		
Efficienc	·												80.5	(216)
	86.12	85.94	85.46	84.66	82.97	80.5	80.5	80.5	80.5	84.13	85.59	86.09		(217)
Fuel for v (219)m =														
	153.1	134.03	140.22	125.55	124.03	112.58	107.85	120.24	<b>121.5</b> 7	132.45	138.99	149.57		
								Tota	I = Sum(2	19a), <sub>12</sub> =			1560.17	(219)
Annual	totals									k\	Wh/year	. L	kWh/yea	
Space h	eating	fuel use	d, main	system	1								1359.36	
Water he	eating f	uel use	d									ĺ	1560.17	j
Electricit	y for pu	umps, fa	ans and	electric	keep-ho	t						-		
central	heating	g pump:										130		(230c)

boiler with a fan-assisted flue			45 (230e)
Total electricity for the above, kWh/year	sum of	(230a)(230g) =	175 (231)
Electricity for lighting			152.19 (232)
12a. CO2 emissions – Individual heating systems	including micro-CHP		
	<b>Energy</b> kWh/year	Emission factor kg CO2/kWh	<b>Emissions</b> kg CO2/year
Space heating (main system 1)	<b>(2</b> 11) x	0.198 =	269.15 (261)
Space heating (secondary)	(215) x	0 =	0 (263)
Water heating	(219) x	0.198 =	308.91 (264)
Space and water heating	(261) + (262) + (263) + (264	4) =	578.07 (265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517 =	90.48 (267)
Electricity for lighting	(232) x	0.517 =	78.68 (268)
Total CO2, kg/year		sum of (265)(271) =	747.22 (272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =	29.89 (273)
El rating (section 14)			86 (274)

				User D	)etails:						
Assessor Name:					Strom	a Num	ber:				
Software Name:	Stroma FS	AP 200			Softwa				Versio	n: 1.5.0.49	
	<b>A 1 1</b>				Address:	2 metre	es below	ground			
Address : 1. Overall dwelling dimen	2 metres be	elow grou	ind, IN3	8 8LA							
T. Overall dwelling dimer	ISIONS.			۸ro	a(m²)			eight(m)		Volume(m <sup>3</sup>	<b>`</b>
Ground floor						(1a) x	r	2.6	(2a) =	65	(3a)
Total floor area TFA = (1a	)+(1b)+(1c)+	(1d)+ <b>(1e</b>	)+(1r	ו)	25	(4)					
Dwelling volume						(3a) <b>+</b> (3b)	<b>+(</b> 3c)+(3d	)+(3e)+	.(3n) =	65	(5)
2. Ventilation rate:									-		-
	main heating		econdar eating	ý	other		total			m <sup>3</sup> per hou	r
Number of chimneys	0	] + [	0	] + [	0	] = [	0	<b>x</b> 4	= 0	0	(6a)
Number of open flues	0	_ + _	0	] + [	0	] = [	0	x 2	20 =	0	(6b)
Number of intermittent fan	s					- E	1	<b>x</b> 1	0 =	10	(7a)
Number of passive vents						Г	0	x 1	0 =	0	(7b)
Number of flueless gas fire	es						0	× 4	40 =	0	(7c)
									Air ch	anges per ho	our
Infiltration due to chimney	s. flues and f	ans = (6)	a)+(6b)+(7	a)+(7b)+(	7c) =	Г	10		⊧ (5) =	0.15	(8)
If a pressurisation test has be						continue fro	a state of	1	<u>,-</u> /	0.10	
Number of storeys in the	e dwelling (n	s)								0	(9)
Additional infiltration								[(9)-	1]x0.1 =	0	(10)
Structural infiltration: 0.2						-	uction			0	(1 <b>1</b> )
if both types of wall are pre deducting areas of opening			ponaing to	ine great	er wall are	a (aner					
If suspended wooden flo	por, enter 0.2	! (unseal	ed) or 0.	1 (seale	ed), else	enter 0				0	(12)
If no draught lobby, ente	er 0.05, else	enter 0								0	(13)
Percentage of windows	and doors dr	raught st	ripped							0	(14)
Window infiltration					0.25 - [0.2					0	(15)
Infiltration rate					(8) + (10)					0	(16)
Air permeability value, c	•			•	•	•	etre of e	nvelope	area	7	(17)
If based on air permeabilit	•							1		0.5	(18)
Air permeability value applies Number of sides on which		on test has	s been don	e or a de	gree air pei	meability	s being us	sed	Í	0	(19)
Shelter factor	Shekerea				(20) = 1 -	<b>0.07</b> 5 x (1	9)] =			0	(10)
Infiltration rate incorporation	ng shelter fac	tor			(21) = (18)	) x (20) =				0.5	(21)
Infiltration rate modified fo	r monthly wir	nd speed	l								
Jan Feb I	/lar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind spe	ed from Tab	e 7			-						
<u> </u>	5.1 4.5	4.1	3.9	3.7	3.7	4.2	<b>4.</b> 5	4.8	5.1		
Wind Factor (22a)m = (22	)m ÷ 4										
	.27 1.12	1.02	0.98	0.92	0.92	1.05	1 <b>.1</b> 2	1.2	1.27		

Adjust	ed infiltr	ation rat	e (allowi	ng for sl	nelter an	d wind s	speed) =	(21a) x	(22a)m	-				
	0.68	0.64	0.64	0.57	0.52	0.49	0 <u>.</u> 47	0 <u>.</u> 47	0.53	0.57	0.6	0.64		
		<i>tive air -</i> al ventila	-	rate for t	he appli	cable ca	se						0	(23a)
				endix N (2	(23a) = (23a	a) x Emv (e	auation ( <b>1</b>	N5)) , othe	wise (23h	) = (23a)			0	
		• •			, ,	, .		n Table 4h		) (200)		·	0	(23b)
			-		-			HR) (24a		$\frac{1}{2}$	23h) y [1	(23a)	0 ÷ 1001	(23c)
(24a)m=	-				0			0	0	0	200) ^ [	0	- 100]	(24 <b>a</b> )
		-	_	_		_		//√) (24b	_		Ŭ	Ū		(_ · - )
(24b)m=	· · · · · · · · · · · · · · · · · · ·							0	$0 = \frac{22}{2}$	0	230)	0		(24b)
			_						-	0	Ŭ	v		(=)
								on from c c) = (22t		.5 × (23b	))			
(24c)m=	· · ·	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) lf	natural	ventilatio	on or wh	ole hous	se positiv	ve input	ventilatio	on from I	oft					
								0.5 + [(2		0.5]	-	_		
( <b>24d</b> )m=	0.73	0.71	0.71	0.66	0.63	0.62	0.61	0 <u>.</u> 61	0.64	0.66	0.68	0.71		(24 <b>d</b> )
Effe	ctive air	change	rate - er	nter (24a	) or (24t	o) or (24	c) or (24	d) in boy	(25)	_				
(25)m=	0.73	0.71	<mark>0.71</mark>	0.66	0.63	0.62	<mark>0.61</mark>	0.61	0.64	0.66	0.68	0.71		(25)
3 He	at losse	s and he	at loss	paramet	er.						-			_
ELEN		Gros		Openin		Net Ar	ea	U-valu	Je	AXU		k-value	,	AXk
		area	and the second se	m	-	A ,r		W/m2		(W/I	K)	kJ/m²·k		kJ/K
Windo	ws Type	1		-		1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Windo	ws Type	2				1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Floor						25		0.14	] = [	3.5	F r			(28)
Walls <sup>·</sup>	Type1	6		2.88		3.12	×	0.32	   =	1	٦ ř			(29)
Walls <sup>·</sup>	Type2	20	,	0		20	x	0.27	= - i	5.4	<b>-</b>		╡ ├─	(29)
Total a	area of e	lements	, m²			51	=		'					(31)
* for win	dows and	roof winde	ows, use e	effective wi	ndow U-va		ated using	j formula 1,	/[(1/U-valu	re)+0.04] a	is given in	paragraph	3.2	
** inclua	le the area	as on both	sides of ir	nternal wal	ls and part	titions								
Fabric	heat los	s, W/K	= S (A x	U)				(26)(30)	) + (32) =				14.73	(33)
Heat c	apacity	Cm = S(	(A x k )						((28)	(30) + (32	2) + (32a).	(32e) =	2958.08	(34)
Therm	al mass	parame	eter (TMI	⊃ = Cm +	+ TFA) ir	ו kJ/m²K			Indica	tive Value	: Medium		250	(35)
	•		ere the de tailed calc		construct	ion are no	t known pr	recisely the	e indicative	values of	TMP in Te	able 1f		
				culated	usina Ar	nnendix l	к						4.08	(36)
	Ū	•	•	own (36) =	• •	•							4.00	(00)
	abric he			1 /	(	,			<b>(</b> 33) +	(36) =			18.81	(37)
Ventila	ation hea	at loss ca	alculated	d monthly	y				(38)m	= 0.33 × (	25)m x (5)		-	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	15.69	15.15	15.15	14 <b>.1</b> 7	13.59	13.31	13.05	13.05	13.73	<b>14</b> .17	14.65	15.15		(38)
Heat tr	ansfer o	coefficier	nt, W/K						(39)m	= (37) + (3	38)m			
( <b>39)</b> m=	34.5	33.97	33.97	32.99	32.4	32.13	31.87	31.87	32.54	32.99	33.46	33.97		
			-	-		-	-		,	Average =	Sum(39)1	.12 /12=	33.05	(39)

Heat lo	ss para	ımeter (I	HLP), W/	/m²K					(40)m	= (39)m ÷	(4)			
(40)m=	1.38	1.36	1.36	1.32	1.3	1.29	1 <u>.</u> 27	1 <u>.</u> 27	1.3	1.32	1.34	1.36		
Numbe	r of day	rs in mo	nth (Tab	le 1a)		-		-	,	Average =	Sum(40)₁	.12 /12=	1.32	(40)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
•				•										
4. Wa	ter hea	ting ene	rgy requi	irement:								kWh/ye	ear:	
if TF	A > 13.9	upancy, 9, N = 1 9, N = 1		[1 - exp	0(-0.0003	349 x (TI	=A -13.9	)2)] + 0.(	0013 x (	TFA -13.		1885		(42)
Reduce t	the annua	al average		usage by	5% if the c	welling is	designed	(25 x N) to achieve		se target o		.052		(43)
[	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	r usage i	n litres pei	r day for ea	•	Vd,m = fa	ctor from	Table 1c x	-						
(44)m=	66.06	63.66	61.25	58.85	56.45	54.05	54.05	56 <b>.4</b> 5	58.85	61.25	63.66	66.06		_
Energy c	ontent of	hot water	used - cal	culated mi	onthly = 4	190 x Vd i	т х пт х Г	0 Tm / 3600		Total = Su			720.6243	(44)
(45)m=	98.2	85.88	88.62	77.26	74.14	63.97	59.28	68.03	68.84	80.22	87.57	95.1		
(-0)	00.2	00.00	00.02	11.20		00.01	00.20			Total = Su	85687.0500	NO ADDRESS 11	947.1126	(45)
lf ins <mark>tanta</mark>	aneous w	ater heati	ng at point	of use (no	o hot water	storage),	enter 0 in	boxes (46						
(46)m=	14.73	12.88	13.29	11.59	11.12	9.6	8.89	10.2	10.33	12.03	13.14	14.26		(46)
Water a		and the second second	clared lo	oss facto	or is know	vn (kWh	(day):				<b></b>	0		(47)
		1	m Table				, day j.				_	0		(48)
			r storage		ear			(47) × (48)	) =			0		(49)
			ared cylir											
-		•	) includir / no tank in	<b>G</b> ,		U		<b>;</b>				0		(50)
	-	-		-				enter '0' in	box (50)					
Hot wa	ter stor	age loss	s factor fr	om Tab	le 2 (kW	h/litre/da	ay)					0		(51)
Volume	e factor	from Ta	ble 2a									0		(52)
			om Table									0		(53)
			r storage	, kWh/y	ear			<b>((50)</b> x (51	) <b>x (5</b> 2) x	(53) =		0		(54)
		54) in (5 Joss cal	culated f	for each	month			((56)m = (	55) × (41)	m		0		(55)
(56)m=	0				0	0	0		0	0	0	0		( <b>5</b> 6)
	•	Ť	ŗ	÷	-	-	•	Ŷ	•	÷	-	m Appendi	ix H	(/
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primary	y circuit	loss (ar	nual) fro	om Table	e 3	-	-	-		-		0		(58)
Primary	y circuit	loss cal	culated t	fo <mark>r</mark> each	month (	,	. ,	65 × (41)						
ŗ	-	1	i	i	i	i	î	ng and a	-	i	· · · · · ·			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
r		1	for each	Ī		<u> </u>	<u> </u>	í	00.00	04.54	01.00	00.00		104
(61)m=	33.66	29.3	31.21	29.02	28.77	26.65	27.54	28.77	29.02	31 <u>.</u> 21	31.39	33.66		(61)

1920m       1918.86       115.18       115.48       119.44       108.29       102.0       0.03       88.82       68.70       97.86       111.44       118.66       128.76       (62)         Solar DHW input ziculated using Appencix G w Appencix H (regitive quantity) (ever 'U if ice setar continuon to water heating)       (62)       (63)         (64) additional lines if FCHRS and/or WHRES applies, see Appencix H       (76)       0	Total h	neat req	uired for	water he	eating ca	alculated	d fo	r eac	h month	(62)	m =	0.85 × (	45)m -	+ (46)m +	(57)m +	(59)m + (61)n	n
(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)       (63)         (63)m <sup>-1</sup> 0       0	(62)m=	<b>1</b> 31.86	1 <b>15.1</b> 8	119.84	106.29	102.9	g	0.63	86.82	96.	79	97.86	<b>11</b> 1.44	118.96	<b>12</b> 8.76		(62)
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Solar Di	HW input	calculated	using App	endix G o	r Appendix	(H)	negati	ve quantity	/) (ent	er '0'	if no solar	r contrib	ution to wate	er heating)		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	(add a	dditiona	al lines if	FGHRS	and/or \	NWHRS	3 ap	plies	, <mark>s</mark> ee Ap	penc	lix C	<del>3</del> )		-			
	(63) <b>m=</b>	0	0	0	0	0		0	0	C	)	0	0	0	0		(63)
Output from water heating, kWh/month 0.25 '[0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]         (86)m - (61)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]           (86)m = 41.07 35.8 37.27 32.85 31.44 27.93 26.6 29.81 30.14 34.48 36.97 40.04 (65)         (65)           include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating         (5)           5. Internel gains (see Table 5 and 59).         Metabolic gains (Table 5). Warts         (66)           (69)m = 54.43 54.44 28.44	Outpu	t from w	ater hea	ter	-	-			_	_					-	_	
Heat gains from water heating, kWh/month 0.25 ' [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] (85)m = $\frac{41.07}{35.88}$ 37.27 32.85 31.84 27.93 28.6 29.81 30.14 34.48 36.97 40.04 (95) include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating <b>5.</b> Internal gains (caeculated 5). Watts Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec (86)m = $\frac{54.43}{54.43}$ 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 (94.4) 5.61 7.12 6.31 6.86 (97) Lighting gains (calculated in Appendix L, equation L13 or L[3a), also see Table 5 (67)m = $\frac{64.2}{7.65}$ 6.22 4.71 3.62 2.97 3.21 4.16 5.61 7.12 6.31 6.86 (97) Applances gains (calculated in Appendix L, equation L13 or L[3a), also see Table 5 (68)m = $\frac{94.4}{24.4}$ 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (98) Pumps and fans gains (Table 5a) (70)m = 10 10 10 10 10 10 10 10 10 10 10 10 (70) Losses e.g. evaporation (negative values) (Table 5 (71)m = 44.354 43.54 43.54 43.54 43.54 43.54 43.54 43.54 43.54 43.54 43.54 43.54 (71) Water heating gains (Table 5) (72)m = $\frac{55.2}{55.2}$ 53.38 0.09 45.76 42.6 36.8 35.75 40.07 41.87 46.34 51.34 63.81 (72) Total internal gains (Table 5) (72)m = $\frac{65.2}{170m}$ 10.0 10 10.0 10 10 10 10 10 (72) Losses e.g. evaporation (negative values) (Table 5 (72)m = $\frac{65.2}{170m}$ 10.0.59 47.6 42.6 36.8 35.75 40.07 41.87 46.34 51.34 63.81 (72) Total internal gains = (65)m + (67)m + (69)m + (70)m + (71)m + (72)m (73)m = $\frac{193.44}{197.57}$ 190.59 172.04 168.77 152.65 157.24 162.73 173.52 185.77 194.49 (73) <b>6.</b> Solar gains Solar gains are calculated using solar 1xx from Table 6a and associated equations to convert to the applicable eformation. Orientation: Access Factor Area m <sup>2</sup> Table 6a $\frac{9}{120.44}$ 28.44 28.44 28.44 28.44 (71) East 0.0x 1 x 1.44 x 19.87 x 0.63 x 0.7 = 48.75 (76) East 0.0x 1 x 1.44 x 19.87 x 0.63 x 0.7 = 48.95 (76) East 0.0x 1 x 1.44 x 114.27 x 0.63 x 0.7 = 48.95 (76) East 0.0x 1 x 1.44 x 114.27 x	(64) <b>m=</b>	131.86	115.18	1 <b>19.84</b>	106.29	102.9	ç	0.63	86.82	96.	79	97.86	111.44	118.96	128.76		_
(85)m=       41.07       35.88       37.27       32.95       31.84       27.93       26.6       29.81       30.14       34.48       36.97       40.04       (95)         include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating       5.       Internal gains (calculated in Appendix L, equation L3 or L9a), also see Table 5       (67)m=       54.43       56.66       660       77.8											Outp	out from wa	ate <mark>r he</mark> ai	te <b>r (annual)</b> ₁	12	1307.3261	(64)
include (57)m in calculation of (65)m only if cylinder is in the cwelling or hot water is from community heating <b>5.</b> Internal gains (see Table 5 and 5a) Metabolic gains (Table 5), Watts $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Heat g	ains fro	m water	heating,	kWh/m	onth 0.2	5 ′	[0.85	× (45)m	+ (6	51)m	] + 0.8 x	(46)r	n + (57)m	+ (59)m	]	
5. Internal gains (see Table 5 and 5a).         Metabolic gains (Table 5), Watts         (66))= $54.43$ $56.1$ $7.12$ $8.31$ $8.86$ (67)         Appliances gains (calculated in Appendix L, equation L13 or L13a) also see Table 5       (68)       Cocking gains (calculated in Appendix L, equation L15 or L15a) also see Table 5       (69)       (60)       (70)	(65) <b>m=</b>	41.07	35.88	37.27	32.95	31.84	2	7.93	26.6	29.	81	30.14	34.48	36.97	40.04		(65)
	inclu	ude (57)	m in calc	culation	of (65)m	only if c	ylir	nder i	s in the o	dwell	ing	or hot w	ater is	from com	munity h	neating	
$ \begin{array}{ c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	5. In	ternal g	ains (see	e Table 5	5 and 5a	):											
$ \begin{array}{ c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Metab	olic gair	ns (Table	e 5), Wat	ts												
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 (67)me 6.62 r.65 6.22 4.71 3.92 2.97 3.21 4.14 5.61 7.12 6.31 6.66 (67) Applances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 (68)me 8.5 87.2 44.94 80.14 74.07 68.37 64.56 63.67 65.93 70.73 76.8 82.5 (68) Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 (69)me 28.44						May		Jun	Jul	Α	ug	Sep	Oct	Nov	Dec		
	(66)m=	54.43	54.43	54.43	54.43	54.43	5	4.43	54.43	54.	43	54.43	54.43	54.43	54.43		(66)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 (6a)m b6.3 87.2 84.94 80.14 74.07 66.37 64.56 63.67 65.93 70.73 76.8 82.5 (6b)m 28.44 2	Lightin	ig gains	(calculat	ted in Ap	opendix	L, equat	ion	L9 o	r L9a), a	so s	ee	Table 5		-		•	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	(67) <b>m=</b>	8.62	7.65	6.22	4.71	3.52		2.97	3.21	4.1	8	5.61	7.12	8.31	8.86		(67)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 (69)m 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (69) Pumps and fans gains (Table 5a) (70)m 10 10 10 10 10 10 10 10 10 10 10 10 10	Applia	nces ga	ins (calc	ulated in	Append	dix L, eq	uat	ion L	13 or L1	3a),	also	see Tal	ole 5				
$ \begin{array}{c} (69) \\ (69) \\ (69) \\ (70) \\ (73) \\ (71) \\ (73) \\ (72) \\ (73) \\ (73) \\ (72) \\ (73) \\ ($	(68) <b>m</b> =	86.3	87.2	84.94	80.14	74.07	6	8.37	64.56	63.	67	65.93	70.73	76.8	82.5		(68)
Pumps and fans gains (Table 5a) (70)m= 10 10 10 10 10 10 10 10 10 10 10 10 10	Cookir	ng gains	s (calcula	ted in A	ppendix	L, equa	tior	L15	or L15a)	, als	o se	e Table	5			,	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	(69)m=	28.44	28.44	28.44	28.44	28.44	2	8.44	28.44	28.	44	28.44	28.44	28.44	28.44		(69)
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Pumps	s and fa	ns gains	(Table §	ōa)						*		1)				
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	1.20	-				10	Γ	10	10	1	0	10	10	10	10	1	(70)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Losse	se.g. e	vaporatio	n (nega	tive valu	es) (Tat	ble	5)			12						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	(71)m=	-43.54	-43.54	-43.54	-43.54	-43.54	-4	13.54	-43.54	-43	.54	-43.54	-43.54	-43.54	-43.54		(71)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Water	heating	gains (T	able 5)												4	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	(7 <b>2</b> )m=	55.2	53.39	50.09	45.76	42.8		38.8	35.75	40.	07	41.87	46.34	51.34	53.81		(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 m <sup>2</sup> Flux Table 6a       Table 6b       FF Table 6c       Gains (W)         East       0.9x       1       ×       1.44       ×       19.87       ×       0.63       ×       0.7       =       8.75       (76)         East       0.9x       1       ×       1.44       ×       38.52       ×       0.63       ×       0.7       =       8.75       (76)         East       0.9x       1       ×       1.44       ×       38.52       ×       0.63       ×       0.7       =       16.95       (76)         East       0.9x       1       ×       1.44       ×       61.57       ×       0.63       ×       0.7       =       27.09       (76)         East       0.9x       1       ×       1.44       91.41       ×       0.63       ×       0.7       =       40.23       (76)         East       0.9x       1       ×       1.44       111.22       ×       0.63       ×       0.7 <td>Total</td> <td>internal</td> <td>l gains =</td> <td></td> <td></td> <td></td> <td>•</td> <td><b>(6</b>6)</td> <td>im + (67)m</td> <td>1 + (68</td> <td>3)m +</td> <td>- (69)m + (</td> <td>70)m +</td> <td>(71)m + (72)</td> <td>)m</td> <td></td> <td></td>	Total	internal	l gains =				•	<b>(6</b> 6)	im + (67)m	1 + (68	3)m +	- (69)m + (	70)m +	(71)m + (72)	)m		
Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.Orientation:Access Factor Table 6dArea m²Flux Table 6a $g_{-}$ Table 6bFF Table 6cGains (W)East $0.9x$ 1× $1.44$ × $19.87$ × $0.63$ × $0.7$ = $8.75$ (76)East $0.9x$ 1× $1.44$ × $38.52$ × $0.63$ × $0.7$ = $16.95$ (76)East $0.9x$ 1× $1.44$ × $61.57$ × $0.63$ × $0.7$ = $27.09$ (76)East $0.9x$ 1× $1.44$ × $91.41$ × $0.63$ × $0.7$ = $40.23$ (76)East $0.9x$ 1× $1.44$ × $111.22$ × $0.63$ × $0.7$ = $40.23$ (76)East $0.9x$ 1× $1.44$ × $111.22$ × $0.63$ × $0.7$ = $48.95$ (76)East $0.9x$ 1× $1.44$ × $111.22$ × $0.63$ × $0.7$ = $48.95$ (76)East $0.9x$ 1× $1.44$ × $111.05$ × $0.63$ × $0.7$ = $51.07$ (76)	(73)m=	199.44	197.57	190.59	179.94	169.72	1:	59.47	152.85	157	.24	162.73	173.52	2 185.77	194.49		(73)
Orientation:Access Factor Table 6dArea m²Flux Table 6a $g_{-}$ Table 6bFF Table 6cGains (W)East $0.9x$ 1 $x$ $1.44$ $x$ $19.87$ $x$ $0.63$ $x$ $0.7$ $=$ $8.75$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $38.52$ $x$ $0.63$ $x$ $0.7$ $=$ $16.95$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $61.57$ $x$ $0.63$ $x$ $0.7$ $=$ $27.09$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $91.41$ $x$ $0.63$ $x$ $0.7$ $=$ $40.23$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $111.22$ $x$ $0.63$ $x$ $0.7$ $=$ $48.95$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $111.22$ $x$ $0.63$ $x$ $0.7$ $=$ $48.95$ $(76)$ East $0.9x$ 1 $x$ $1.44$ $x$ $116.05$ $x$ $0.63$ $x$ $0.7$ $=$ $51.07$ $(76)$	6. So	lar gain	s:				•										
Table 6d $m^2$ Table 6aTable 6bTable 6bTable 6c(W)East $0.9x$ 1x $1.44$ x $19.87$ x $0.63$ x $0.7$ = $8.75$ (76)East $0.9x$ 1x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $16.95$ (76)East $0.9x$ 1x $1.44$ x $61.57$ x $0.63$ x $0.7$ = $27.09$ (76)East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $40.23$ (76)East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $48.95$ (76)East $0.9x$ 1x $1.44$ x $111.22$ x $0.63$ x $0.7$ = $48.95$ (76)East $0.9x$ 1x $1.44$ x $116.05$ x $0.63$ x $0.7$ = $51.07$ (76)	Solar (	gains are	calculated	using sola	r flux from	⊺ab <b>l</b> e 6a	and	assoc	iated equa	tions	to co	nvert to th	e applica	able orientat	ion.		
East $0.9x$ 1x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $16.95$ $(76)$ East $0.9x$ 1x $1.44$ x $61.57$ x $0.63$ x $0.7$ = $27.09$ $(76)$ East $0.9x$ 1x $1.44$ x $61.57$ x $0.63$ x $0.7$ = $27.09$ $(76)$ East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $40.23$ $(76)$ East $0.9x$ 1x $1.44$ x $111.22$ x $0.63$ x $0.7$ = $48.95$ $(76)$ East $0.9x$ 1x $1.44$ x $116.05$ x $0.63$ x $0.7$ = $51.07$ $(76)$	Orient			actor							т						
East $0.9x$ 1x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $16.95$ $(76)$ East $0.9x$ 1x $1.44$ x $61.57$ x $0.63$ x $0.7$ = $27.09$ $(76)$ East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $40.23$ $(76)$ East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $40.23$ $(76)$ East $0.9x$ 1x $1.44$ x $111.22$ x $0.63$ x $0.7$ = $48.95$ $(76)$ East $0.9x$ 1x $1.44$ x $116.05$ x $0.63$ x $0.7$ = $51.07$ $(76)$	East	0.9x	1	x	1.4	14	x	1	9.87	x		0.63	x	0.7	=	8,75	(76)
East $0.9x$ 1x $1.44$ x $61.57$ x $0.63$ x $0.7$ = $27.09$ $(76)$ East $0.9x$ 1x $1.44$ x $91.41$ x $0.63$ x $0.7$ = $40.23$ $(76)$ East $0.9x$ 1x $1.44$ x $111.22$ x $0.63$ x $0.7$ = $48.95$ $(76)$ East $0.9x$ 1x $1.44$ x $116.05$ x $0.63$ x $0.7$ = $51.07$ $(76)$	East	0.9x											= 1		=		
East       0.9x       1       x       1.44       x       91.41       x       0.63       x       0.7       =       40.23       (76)         East       0.9x       1       x       1.44       x       111.22       x       0.63       x       0.7       =       48.95       (76)         East       0.9x       1       x       1.44       x       116.05       x       0.63       x       0.7       =       51.07       (76)	East	0.9x	1	×			x			x					=		
East       0.9x       1       x       1.44       x       111.22       x       0.63       x       0.7       =       48.95       (76)         East       0.9x       1       x       1.44       x       116.05       x       0.63       x       0.7       =       48.95       (76)	East	<u> </u>		×			x			x			ا × آ		=		
East $0.9x$ 1 x 1.44 x 116.05 x 0.63 x 0.7 = 51.07 (76)	East	Ļ	1	×			x			×			T x		=		
	East	0.9x	1	×			x			x			ا × آ		=		(76)
East 0.9x 1 x 1.44 x 112.64 x 0.63 x 0.7 = 49.57 (76)	East	0.9x	1	x			x			x			ا × آ		=		
East 0.9x 1 × 1.44 × 98.03 × 0.63 × 0.7 = 43.14 (76)	East	0.9×	1	×	1.4	14	x			×		0.63	×	0.7	=		

East	0.9x	4	x	1.4		x	-	3.6	×Г	0.63	٦ × ۱	0.7			32.39	(76)
East	0.9×	1	╡,	1.4		x		5.0 6.91		0.63		0.7	=		20.64	(76)
East	0.9x	1	╡ <sup>ˆ</sup>	1.4		x		4.71		0.63		0.7	$\dashv$		10.87	(76)
East	0.9×	1	<b>−</b> <sup>^</sup> x	1.4		×		6.39		0.63		0.7	=		7.21	(76)
West	0.9×												$\dashv$			(80)
West	0.9×	0.77	x x	1.4		x x		9.87 8.52		0.63	^     x	0.7	=		8.75	(80)
West	0.9×		╡ ^	1.4		×		0.52 1.57		0.63		0.7	=		27.09	(80)
West	0.9×	0.77									4 1	0.7	=			(80)
West	0.9X	0.77	<u> </u>	1.4		X		1.41		0.63		0.7	$\dashv$		40.23	
West		0.77	×	1.4		X		1.22		0.63		0.7			48.95	(80)
West	0.9x	0.77		1.4		X		6.05		0.63		0.7			51.07	(80)
West	0.9x	0.77	×	1.4		X		2.64		0.63		0.7			49.57	(80)
West	0.9×	0.77	×	1.4		x		8.03		0.63		0.7	=		43.14	(80)
	0.9x	0.77	×	1.4		×		'3.6		0.63		0.7	=		32.39	(80)
West	0.9x	0.77	×	1.4		×	46	6.91		0.63		0.7	_  ⁻		20.64	(80)
West	0.9×	0.77	×	1.4		x		4.71		0.63		0.7			10.87	(80)
West	0.9x	0.77	X	1.4	4	x	16	6.39	x	0.63	X	0.7			7.21	(80)
<b>A</b> 1 <b>B</b>																
Solar ( (83)m=	17.49	watts, ca 33.9	54.19	tor eacl 80.46	97.89	1	02.14	99.14	(83)m = 86.29	Sum(74)m 64.78	(82)m 41.29	21.75	14.43	-1		(83)
· · ·	100	nternal a							00.29	04.70	41.25	-21.75	14.45			(00)
(84)m=	216.93	231.48	244.78	260.39	267.61	-	61.62	252	243.5	227.51	214.81	207.52	208.92	5		(84)
											and the second se					1.0000000
<b>7.</b> Me		nal temp	and a second					T		14 (80)				 		
7. Me Temp	erature	during h	eating p	eriods ir	n the liv	ring		1	ole 9, T	'h1 (°C)					21	(85)
7. Me Temp	erature ation fac	during h tor for ga	eating p ains for l	eriods ir iving are	n the liv ea, h1,r	ring m (s	ee Tal	ble 9a)			Oat	Nev	Daa		21	(85)
7. Me Temp Utilisa	erature ation fac Jan	during h tor for ga Feb	eating p ains for I Mar	eriods ir iving are Apr	n the liv ea, h1,r May	ring m (s	ee Tal Jun	ble 9a) Jul	Aug	Sep	Oct	Nov	Dec		21	
7. Me Temp Utilisa (86)m=	ation fac Jan 0.99	during h tor for ga Feb 0.99	eating p ains for I Mar 0.97	eriods ir iving are Apr 0.95	n the liv ea, h1,r May 0.87	ring m (se	ee Tal Jun 0.71	ble 9a) Jul 0.51	Aug 0.52	Sep 0.8	Oct 0.95	Nov 0.99	Dec 0.99		21	(85)
7. Me Temp Utilisa (86)m= Mean	erature ation fac Jan 0.99 interna	during h tor for ga Feb 0.99	eating p ains for I Mar 0.97 ature in	eriods ir iving are Apr 0.95 living are	n the liv ea, h1,r May 0.87 ea T1 (	ring n (se	ee Tat Jun 0.71 ow step	ble 9a) Jul 0.51 os 3 to 7	Aug 0.52 in Tal	Sep 0.8 Dile 9c)	0.95	0.99	0.99		21	(86)
7. Me Temp Utilisa (86)m=	ation fac Jan 0.99	during h tor for ga Feb 0.99	eating p ains for I Mar 0.97	eriods ir iving are Apr 0.95	n the liv ea, h1,r May 0.87	ring n (se	ee Tal Jun 0.71	ble 9a) Jul 0.51	Aug 0.52	Sep 0.8 Dile 9c)					21	
7. Me Temp Utilisa (86)m= Mean (87)m= Temp	erature ation fac Jan 0.99 internal 19.72 perature	during h tor for ga Feb 0.99	eating p ains for I Mar 0.97 ature in 20.12	eriods ir iving are Apr 0.95 living are 20.42	n the liv ea, h1,r May 0.87 ea T1 ( 20.74	ring n (se follo	ee Tal Jun 0.71 ow step 20.93	ble 9a) Jul 0.51 os 3 to 7 20.99	Aug 0.52 7 in Tal 20.99	Sep 0.8 Dle 9c) 20.87	0.95	0.99	0.99		21	(86)
7. Me Temp Utilisa (86)m= Mean (87)m=	ation fac Jan 0.99 internal 19.72	during h tor for ga Feb 0.99 I tempera 19.86	eating p ains for I Mar 0.97 ature in 20.12	eriods ir iving are Apr 0.95 living are 20.42	n the liv ea, h1,r May 0.87 ea T1 ( 20.74	follo follo	ee Tal Jun 0.71 ow step 20.93	ble 9a) Jul 0.51 os 3 to 7 20.99	Aug 0.52 7 in Tal 20.99	Sep 0.8 0le 9c) 20.87 Th2 (°C)	0.95	0.99	0.99		21	(86)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m=	erature Jan 0.99 internal 19.72 erature 19.78	during h tor for ga Feb 0.99 I tempera 19.86 during h	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83	n the liv ea, h1,r May 0.87 ea T1 ( 20,74 n rest o 19.85	ring n (se follo 2 f dw 1	ee Tal Jun 0.71 ww.step 20.93 /elling 19.86	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86	Sep 0.8 0le 9c) 20.87 Th2 (°C)	0.95 20.52	0.99 20.04	0.99 19.77		21	(86)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m=	erature Jan 0.99 internal 19.72 erature 19.78	during h tor for ga Feb 0.99 I tempera 19.86 during h 19.8	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83	n the liv ea, h1,r May 0.87 ea T1 ( 20,74 n rest o 19.85	ring m (se follo 2 f dw 1 , h2,	ee Tal Jun 0.71 ww.step 20.93 /elling 19.86	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86	Sep 0.8 0le 9c) 20.87 Th2 (°C)	0.95 20.52	0.99 20.04	0.99 19.77		21	(86)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m=	ation fac Jan 0.99 internal 19.72 perature 19.78 ation fac 0.99	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93	n the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81	ring n (sr follo 2 f dw 1 , h2,	ee Tab Jun 0.71 w step 20.93 velling 19.86 ,m (se 0.61	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38	Sep         0.8         Dle 9c)         20.87         Th2 (°C)         19.84         0.71	0.95 20.52 19.83 0.92	0.99 20.04 19.81	0.99 19.77 19.8		21	(86) (87) (88)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m=	ation fac Jan 0.99 internal 19.72 perature 19.78 ation fac 0.99	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93	n the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81	ring n (s follo 2 f dw 1 , h2, 0 ( lling	ee Tab Jun 0.71 w step 20.93 velling 19.86 ,m (se 0.61	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38	Sep           0.8           ble 9c)           20.87           Th2 (°C)           19.84	0.95 20.52 19.83 0.92	0.99 20.04 19.81	0.99 19.77 19.8		21	(86) (87) (88)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean	erature Jan 0.99 interna 19.72 eerature 19.78 ation fac 0.99	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in t	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest	n the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 of dwel	ring n (s follo 2 f dw 1 , h2, 0 ( lling	ee Tab Jun 0.71 ww step 20.93 /elling 19.86 ,m (se 0.61 T2 (fo	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste	Aug 0,52 7 in Tal 20,99 able 9, 19,86 9a) 0,38 eps 3 to	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0.71 0.71 19.78	0.95 20.52 19.83 0.92 e 9c) 19.47	0.99 20.04 19.81 0.98	0.99 19.77 19.8 0.99 18.71		0.4	(86) (87) (88) (89)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m=	ation fac Jan 0.99 internal 19.72 Derature 19.78 ation fac 0.99 internal 18.65	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in 1 19.06	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 0.68	ring n (se follo 2 f dw 1 , h2, 0 1 1 1	ee Tal Jun 0.71 w step 20.93 /elling 9.86 ,m (se 0.61 T2 (fc 19.82	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86	Sep           0.8           0le 9c)           20.87           Th2 (°C)           19.84           0.71           07 in Table           19.78	0.95 20.52 19.83 0.92 e 9c) 19.47	0.99 20.04 19.81 0.98 18.99	0.99 19.77 19.8 0.99 18.71			(86) (87) (88) (89) (90)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m=	erature ation fac Jan 0.99 internal 19.72 eerature 19.78 ation fac 0.99 internal 18.65	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in 1 19.06	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37	a the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 of dwel 19.68	ring n (sr follo 2 f dw 1 1 , h2, 0 1 1 1 elling	ee Tal Jun 0.71 ww step 20.93 /elling 9.86 0.61 T2 (fc 19.82 g) = fL	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 –	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0 7 in Table 19.78 fl	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv	0.99 20.04 19.81 0.98 18.99 ing area ÷ (4	0.99 19.77 19.8 0.99 18.71 4) =			(86) (87) (88) (89) (90)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m=	ation fac Jan 0.99 internal 19.72 Derature 19.78 ation fac 0.99 internal 18.65	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in t 19.06 ature (fo 19.48	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37 r the wh 19.79	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 0.81 19.68 ole dwe 20.11	ring n (se follo 2 f dw 1 1 , h2, 0 1 1 elling 2	ee Tal           Jun           0.71           ow step           20.93           /elling           /9.86           ,m (se           0.61           T2 (for           /9.82           g) = fL           20.27	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86 .A × T1 20.31	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 – 20.31	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0.71 0.71 19.78 ft fLA) × T2 20.21	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv 19.89	0.99 20.04 19.81 0.98 18.99	0.99 19.77 19.8 0.99 18.71			(86) (87) (88) (89) (90) (91)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m=	ation fac Jan 0.99 internal 19.72 Derature 19.78 ation fac 0.99 internal 18.65	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in t 19.06 ature (fo 19.48	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37 r the wh 19.79	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 0.81 19.68 ole dwe 20.11	ring n (s follo 2 f dw 1 1 , h2, 0 1 1 1 elling 2 2 ratu	ee Tal           Jun           0.71           ow step           20.93           /elling           /9.86           ,m (se           0.61           T2 (for           /9.82           g) = fL           20.27	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86 .A × T1 20.31	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 – 20.31	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0 7 in Table 19.78 fl	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv 19.89	0.99 20.04 19.81 0.98 18.99 ing area ÷ (4	0.99 19.77 19.8 0.99 18.71 4) =			(86) (87) (88) (89) (90) (91)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m= Mean (92)m=	ation fac Jan 0.99 internal 19.72 Derature 19.78 ation fac 0.99 internal 18.65 internal 19.08 v adjustn 18.93	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8 I tempera 19.23 nent to th	eating p ains for I Mar 0.97 ature in 20.12 eating p 19.8 ains for r 0.97 ature in 1 19.06 ature (fo 19.48 ne mean 19.33	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37 r the wh 19.79 internal 19.64	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 of dwel 19.68 ole dw 20.11	ring n (s follo 2 f dw 1 1 , h2, 0 1 1 1 elling 2 2 ratu	ee Tal Jun 0.71 ww step 20.93 /elling 9.86 0.61 T2 (for 9.82 (9.82) (9.8	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86 A × T1 20.31 m Table	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 – 20.31	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0.71 19.78 fLA) × T2 20.21 here approx	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv 19.89 opriate	0.99 20.04 19.81 0.98 18.99 ing area ÷ (4 19.41	0.99 19.77 19.8 0.99 18.71 4) = 19.14			(86) (87) (88) (89) (90) (91) (92)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (92)m= Apply (93)m= 8. Sp Set T	ation fac Jan 0.99 internal 19.72 perature 19.78 ation fac 0.99 internal 18.65 internal 19.08 r adjustn 18.93 ace hea i to the r	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8 I tempera 19.23 nent to tr 19.08 ting requi	eating p ains for I Mar 0.97 ature in 1 20.12 eating p 19.8 ains for r 0.97 ature in 1 19.06 ature (fo 19.48 ne mean 19.33 tirement ernal ter	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37 r the wh 19.79 internal 19.64	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 0.81 19.68 ole dwe 20.11 tempe 19.96	ring n (s follo 2 f dw 1 1 1 1 1 1 1 2 1 2 1 2 1 2 1 2 1 1 2 1 1 2 1 1 2 1 1 2 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1	ee Tal           Jun           0.71           ow step           20.93           /elling           9.86           ,m (se           0.61           T2 (fc           9.82           g) = fL           20.27           ire from           20.12	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 – 20.31 4e, wi 20.16	Sep 0.8 0le 9c) 20.87 Th2 (°C) 19.84 0.71 0 7 in Table 19.78 fLA) × T2 20.21 here approx	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv 19.89 opriate 19.74	0.99 20.04 19.81 0.98 18.99 ing area ÷ (4 19.41	0.99 19.77 19.8 0.99 18.71 1) = 19.14 18.99		0.4	(86) (87) (88) (89) (90) (91) (92)
7. Me Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (92)m= Apply (93)m= 8. Sp Set T	ation fac Jan 0.99 internal 19.72 perature 19.78 ation fac 0.99 internal 18.65 internal 19.08 r adjustn 18.93 ace hea i to the r	during h tor for ga 0.99 I tempera 19.86 during h 19.8 tor for ga 0.98 I tempera 18.8 I tempera 19.23 nent to tr 19.08 ting requ	eating p ains for I Mar 0.97 ature in 1 20.12 eating p 19.8 ains for r 0.97 ature in 1 19.06 ature (fo 19.48 ne mean 19.33 tirement ernal ter	eriods ir iving are Apr 0.95 living are 20.42 eriods ir 19.83 rest of dv 0.93 the rest 19.37 r the wh 19.79 internal 19.64	the liv ea, h1,r May 0.87 ea T1 ( 20.74 n rest o 19.85 welling 0.81 0.81 19.68 ole dwe 20.11 tempe 19.96	ring n (se follo 2 f dw 1 1 1 elling 2 ratu 2 ratu 2 ratu	ee Tal           Jun           0.71           ow step           20.93           /elling           9.86           ,m (se           0.61           T2 (fc           9.82           g) = fL           20.27           ire from           20.12	ble 9a) Jul 0.51 0s 3 to 7 20.99 from Ta 19.86 e Table 0.37 bllow ste 19.86	Aug 0.52 7 in Tal 20.99 able 9, 19.86 9a) 0.38 eps 3 to 19.86 + (1 – 20.31 4e, wi 20.16	Sep           0.8           0le 9c)           20.87           Th2 (°C)           19.84           0.71           7 in Table           19.78           fLA) × T2           20.21           nere appro           20.06           9b, so that	0.95 20.52 19.83 0.92 e 9c) 19.47 _A = Liv 19.89 opriate 19.74	0.99 20.04 19.81 0.98 18.99 ing area ÷ (4 19.41	0.99 19.77 19.8 0.99 18.71 1) = 19.14 18.99		0.4	(86) (87) (88) (89) (90) (91) (92)

Utilisa	ation fac	ctor for a	ains, hm	n:										
(94)m=	0.98	0.98	0.96	0.92	0.82	0.64	0.41	0.42	0.73	0.92	0.98	0.99		(94)
	l gains,	hmGm	, W = (94	4)m x (8 <sup>,</sup>	4)m									
(95)m=	213.61	226.49	235.21	240.44	, 219 <b>.5</b> 3	166.47	102.94	102.77	<b>166.8</b> 1	197.85	202.49	205.83		(95)
Month	nly aver	age exte	ernal tem	perature	e from Ta	able 8								
(96)m=	<b>4.</b> 5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9		(96)
Heat	oss rate	e for me	an intern	al temp	erature,	Lm , W =	=[(39)m	x [(93)m	– (96)m	]				
(97)m=	497.88	478.06	425.6	360.87	267.47	177.19	103.96	103.93	187.57	294.76	410.33	478.45		(97)
Space	e heatin	g requir	ement fo	r each n	nonth, k	Wh/mon	th = 0.02	24 x [(97	)m – (95	)m] x (4	1)m			
(98)m=	211.5	169.05	14 <b>1.6</b> 5	86.71	35.67	0	0	0	0	72.1	149.64	202.83		_
								Tota	l per year	(kWh/year	r) = Sum(9	8) =	1069.15	(98)
Space	e heatin	ig requir	ement in	kWh/m²	/year								42.77	(99)
9a. En	ergy rea	quiremer	nts – Indi	ividual h	eating s	ystems i	ncluding	<mark>i micro-</mark> C	CHP)					
-	e heatiı	-										1		-
Fracti	on of sp	bace hea	at from s	econdar	y/supple	mentary	system						0	(201)
Fracti	on of sp	bace hea	at from m	nain syst	em(s)			(202) = 1	– (201) =				1	(202)
Fracti	on of to	tal heati	ng from	main sys	stem 1			(204) = (2	02) × [ <b>1 –</b>	(203)] =			1	(204)
Efficie	ency of	main spa	ace heat	ing syste	em 1								84.8	(206)
Efficie	ency of s	seconda	ry/supple	ementar	y heating	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/yea	ar
Space	e heatin	g require	ement (c	alculate	d above	)								
	2 <mark>11.5</mark>	169.05	141.65	86.71	35.67	0	0	0	0	72.1	149.64	202.83		
(211)m	i = {[(98	)m x (20	4)] + (21	10)m } x	100 ÷ (2	.06)								(211)
	249.41	199.35	167.04	102.25	42.06	0	0	0	0	85.02	176.47	239.18		
								Tota	l (kWh/yea	ar) =Sum(2	21 <b>1)<sub>15,1012</sub></b>		1260.79	(211)
Space	e heatin	g fuel (s	econdar	y), kWh/	month							ľ		-
= {[(98	)m x (20	01)] + (2	14) m } x	( 100 ÷ (	208)								1	
( <b>21</b> 5)m=	0	0	0	0	0	0	0	0	0	0	0	0		_
								Tota	ll (kWh/yea	ar) =Sum(2	21 <b>5)<sub>15,10 12</sub></b>	Ē	0	(215)
	heating	-												
Output	from w 131.86		ter (calc 119.84	ulated a 106.29		00.63	86.82	96.79	07.86	<b>11</b> 1.44	119.00	128.76	l	
Efficier				106.29	102.9	90.63	80.82	96.79	97.86	111.44	118.96	128.76	00 <b>F</b>	
	-	ater hea		04.40	00.7	00 F	00 F	<b>0</b> 0 5	00 F	00.01	05.40	05.04	80.5	(216)
( <b>21</b> 7)m=	85.99	85.78	85.28	84.43	82.7	80.5	80.5	80.5	80.5	83.91	85.43	85.94		(217)
		-	. kWh/mo ) ÷ (217)											
• •	153.35	134.27	140.51	125.89	124.42	112.58	107.85	120.24	121.57	132.8	139.25	149.82		
		<u>.</u>	<u>.</u>				<u>.</u>	Tota	l = Sum(2	19a)=	<u>.</u>		1562.55	(219)
Annua	l totals									k	Wh/year	•	kWh/year	<b>_</b>
Space	heating	fuel use	ed, main	system	1						•		1260.79	1
Water	heating	fuel use	ed										1562.55	ĩ
	J													4

Electricity for pumps, fans and electric keep-hot

central heating pump:		Γ	130		(230c)
boiler with a fan-assisted flue		ſ	45		(230e)
Total electricity for the above, kWh/year	sum o	f (230a)(230g) =	[	175	(231)
Electricity for lighting			Ē	152.19	(23 <mark>2</mark> )
12a. CO2 emissions – Individual heating systems i	including micro-CHP				
	<b>Energy</b> kWh/year	Emission fact kg CO2/kWh	or	<b>Emissions</b> kg CO2/yea	r
Space heating (main system 1)	(211) x	0.198	-	249.64	(261)
Space heating (secondary)	(215) x	0	-	0	(263)
Water heating	(219) ×	0.198	= [	309.39	(264)
Space and water heating	(261) + (262) + (263) + (26	64) =	Γ	559.02	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	= [	90.48	(267)
Electricity for lighting	(232) ×	0.517	= [	78.68	(268)
Total CO2, kg/year		sum of (265)(271) =	Γ	728.18	(272)
Dwelling CO2 Emission Rate	_	(272) ÷ (4) =		29.13	(273)
El rating (section 14)				86	(274)

				User D	etails:						
Assessor Name:					Strom	a Numl	ber:				
Software Name:	Stroma FS	AP 200	9		Softwa	ıre Ver	sion:		Versio	n: 1.5.0.49	
			P	roperty A	Address:	2 metre	s below	ground	shaded		
Address :	2 metres be	low grou	ind shac	led, TN3	3 8LA						
1. Overall dwelling dime	nsions:				( 2)						
Ground floor				Area	<b>a(m²)</b> 25	(1a) x		ight(m) 6	(2a) =	Volume(m <sup>3</sup>	<b>')</b> (3a)
Total floor area TFA = (1a	a)+(1b)+(1c)+	(1d)+(1e	)+(1r	ı)	25	(4)					
Dwelling volume						(3a)+(3b)	<b>+(</b> 3c)+(3d	)+(3e)+	.(3n) =	65	(5)
2. Ventilation rate:											
	main heating		econdar eating	У	other		total			m <sup>3</sup> per hou	I <b>r</b>
Number of chimneys	0	] + [	0	+	0	] = [	0	x 4	= 0	0	(6a)
Number of open flues	0	<u> </u>	0	Ī+Ē	0	1 - Г	0	x 2	20 =	0	(6b)
Number of intermittent fai	ns					- T	1	<b>x</b> 1	0 =	10	(7a)
Number of passive vents						Г	0	x 1	0 =	0	(7b)
Number of flueless gas fi	res					Γ	0	×4	= 04	0	(7c)
						_			Air ch	anges per ho	bur
Infiltration due to chimney				1			10	1	⊦ (5 <mark>) =</mark>	0.15	(8)
If a pressurisation test has be Number of storeys in th	100 C 100	100	a, proceed	10 (17), 0	unerwise c	onunue no	)111 (9) 10 (	10)	Ĩ	0	(9)
Additional infiltration		· \						[(9)-	1]x0.1 =	0	(10)
Structural infiltration: 0.	25 for steel o	r timber f	rame or	0.35 for	r masonr	y constru	uction			0	(11)
if both types of wall are pr			oonding to	the greate	er wall area	a (after			-		
deducting areas of openin If suspended wooden f	•		ed) or 0.	1 (seale	ed). else	enter 0				0	(12)
If no draught lobby, ent			,	(						0	(13)
Percentage of windows	s and doors dr	aught st	ripped						-	0	(14)
Window infiltration					0.2 <b>5 - [</b> 0.2	x (14) ÷ 10	= [00			0	(15)
Infiltration rate					(8) + (10)	+ <b>(11) + (</b> 1:	2) + (13) <del>1</del>	+ (15) =		0	(16)
Air permeability value,	q50, expresse	ed in cub	ic metre	s per ho	our per so	quare me	etre of e	nvelope	area	7	(17)
If based on air permeabil	· ·									0.5	(18)
Air permeability value applie		on test has	been don	e or a deg	ree air per	meability i	s being us	sed			_
Number of sides on which Shelter factor	n sheltered				(20) = 1 - [	<b>0 075 x</b> (1)	9)1 =			0	(19)
Infiltration rate incorporat	ing shelter fac	tor			(21) = (18)		• • • •			0.5	(20) (21)
Infiltration rate modified for	-				()	()				0.5	(21)
	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind sp			ouri		, (49	000		1101	200		
	5.1 4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5 <b>.1</b>		
Wind Factor (22a)m = (22	-	<b>,</b>									
(22a)m= 1.35 1.27	1.27 1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27		

Adjust	ed infiltr	ation rat	e (allowi	ng for sl	nelter an	d wind s	speed) =	(21a) x	(22a)m	-				
	0.68	0.64	0.64	0.57	0.52	0.49	0 <u>.</u> 47	0 <u>.</u> 47	0.53	0.57	0.6	0.64		
		<i>tive air -</i> al ventila	-	rate for t	he appli	cable ca	se						0	(23a)
				endix N (2	(23a) = (23a	a) x Emv (e	auation ( <b>1</b>	N5)) , othe	wise (23h	) = (23a)			0	
		• •			, ,	, .		n Table 4h		) (200)		·	0	(23b)
			-		-			HR) (24a		$\frac{1}{2}$	23h) y [1	(23a)	0 ÷ 1001	(23c)
(24a)m=	-				0			0	0	0	200) ^ [	0	- 100]	(24 <b>a</b> )
		-	_	_		_		//√) (24b	_		Ŭ	Ū		(_ · - )
(24b)m=	· · · · · · · · · · · · · · · · · · ·							0	$0 = \frac{22}{2}$	0	230)	0		(24b)
			_						-	0	Ŭ	v		(=)
								on from c c) = (22t		.5 × (23b	))			
(24c)m=	· · ·	0	0	0	0	0	0	0	0	0	0	0		(24c)
d) lf	natural	ventilatio	on or wh	ole hous	se positiv	ve input	ventilatio	on from I	oft					
								0.5 + [(2		0.5]	-	_		
( <b>24d</b> )m=	0.73	0.71	0.71	0.66	0.63	0.62	0.61	0 <u>.</u> 61	0.64	0.66	0.68	0.71		(24 <b>d</b> )
Effe	ctive air	change	rate - er	nter (24a	) or (24t	o) or (24	c) or (24	d) in boy	(25)	_				
(25)m=	0.73	0.71	<mark>0.71</mark>	0.66	0.63	0.62	<mark>0.61</mark>	0.61	0.64	0.66	0.68	0.71		(25)
3 He	at losse	s and he	at loss	paramet	er.									_
ELEN		Gros		Openin		Net Ar	ea	U-valu	Je	AXU		k-value	,	AXk
		area	and the second se	m	-	A ,r		W/m2		(W/I	K)	kJ/m²·k		kJ/K
Windo	ws Type	1		-		1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Windo	ws Type	2				1.44	x1	/[1/( 1.8 )+	0.04] =	2.42				(27)
Floor						25		0.14	] = [	3.5	F r			(28)
Walls <sup>·</sup>	Type1	6		2.88		3.12	×	0.32	   =	1	٦ ř			(29)
Walls <sup>·</sup>	Type2	20	,	0		20	x	0.27	= - i	5.4	<b>-</b>		╡ ├─	(29)
Total a	area of e	lements	, m²			51	=		'					(31)
* for win	dows and	roof winde	ows, use e	effective wi	ndow U-va		ated using	j formula 1,	/[(1/U-valu	re)+0.04] a	is given in	paragraph	3.2	
** inclua	le the area	as on both	sides of ir	nternal wal	ls and part	titions								
Fabric	heat los	s, W/K	= S (A x	U)				(26)(30)	) + (32) =				14.73	(33)
Heat c	apacity	Cm = S(	(A x k )						((28)	(30) + (32	2) + (32a).	(32e) =	2958.08	(34)
Therm	al mass	parame	eter (TMI	⊃ = Cm +	+ TFA) ir	ו kJ/m²K			Indica	tive Value	: Medium		250	(35)
	•		ere the de tailed calc		construct	ion are no	t known pr	recisely the	e indicative	values of	TMP in Te	able 1f		
				culated	usina Ar	nnendix l	к						4.08	(36)
	Ū	•	•	own (36) =	• •	•							4.00	(00)
	abric he			1 /	(	,			<b>(</b> 33) +	(36) =			18.81	(37)
Ventila	ation hea	at loss ca	alculated	d monthly	y				(38)m	= 0.33 × (	25)m x (5)		-	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(38)m=	15.69	15.15	15.15	14 <b>.1</b> 7	13.59	13.31	13.05	13.05	13.73	<b>14</b> .17	14.65	15.15		(38)
Heat tr	ansfer o	coefficier	nt, W/K						(39)m	= (37) + (3	38)m			
( <b>39)</b> m=	34.5	33.97	33.97	32.99	32.4	32.13	31.87	31.87	32.54	32.99	33.46	33.97		
			-	-		-	-		,	Average =	Sum(39)1	.12 /12=	33.05	(39)

Heat lo	ss para	ımeter (I	HLP), W	/m²K					(40)m	= (39)m ÷	(4)			
(40)m=	1.38	1.36	1.36	1.32	1.3	1.29	1 <u>.</u> 27	1 <u>.</u> 27	1.3	1.32	1.34	1.36		
Numbe	or of day	rs in mo	nth (Tab	le 1a)		-		-	,	Average =	Sum(40)₁	.12 /12=	1.32	(40)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31		(41)
•				•										
4. Water heating energy requirement: kWh/year:													ear:	
if TF	A > 13.9			[1 - exp	0(-0.0003	349 x (TI	=A -13.9	)2)] + 0.(	0013 x (1	TFA -13.		1885		(42)
if TFA $\pounds$ 13.9, N = 1 Annual average hot water usage in litres per day Vd, average = (25 x N) + 36 60.052 (43 Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)													(43)	
[	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot wate	r usage i	n litres pei	r day for ea	•	Vd,m = fa	ctor from	Table 1c x	-						
(44)m=	66.06	63.66	61.25	58.85	56.45	54.05	54.05	56 <b>.4</b> 5	58.85	61.25	63.66	66.06		_
Energy c	ontent of	hot water	used - cal	culated mi	onthly = 4	190 x Vd i	т х пт х Г	0 Tm / 3600		Total = Su			720.6243	(44)
(45)m=	98.2	85.88	88.62	77.26	74.14	63.97	59.28	68.03	68.84	80.22	87.57	95.1		
(-0)11-	50.2	00.00	00.02	11.20	14.14	00.07	00.20			Total = Su	85687.0500	NO ADDRESS 11	947.1126	(45)
lf ins <mark>tanta</mark>	aneous w	ater heati	ng at point	of use (no	o hot water	storage),	enter 0 in	boxes (46						
(46)m=	14.73	12.88	13.29	11.59	11.12	9.6	8.89	10.2	10.33	12.03	13.14	14.26		(46)
Water a		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	clared lo	oss facto	or is know	vn (kWh	(day):				<b></b>	0		(47)
		1	m Table				addy).				_	0		(48)
			r storage		ear			(47) × (48)	) =			0		(49)
			ared cylin											
-		•	) includii 1 no tank in	<b>G</b> ,		U		9				0		(50)
	-	-		-				enter '0' in	box (50)					
Hot wa	ter stor	age loss	s factor fr	om Tab	le 2 (kW	h/litre/da	ay)					0		(51)
Volume	e factor	from Ta	ble 2a									0		(52)
			om Table									0		(53)
			r storage	, kWh/y	ear			<b>((50)</b> x (51	) <b>x (5</b> 2) x	(53) =		0		(54)
		54) in (5 Joss cal	culated f	for each	month			((56)m = (	55) × (41)	m		0		(55)
(56)m=	0				0	0	0		0	0	0	0		( <b>5</b> 6)
	•	Ť	÷	÷	-	-	•	Ŷ	•	÷	-	m Appendi	ix H	(/
(57)m=	0	0	0	0	0	0	0	0	0	0	0	0		(57)
Primary	y circuit	loss (ar	nual) fro	om Table	e 3	-	-	-		-		0		(58)
Primary	y circuit	loss cal	culated	fo <mark>r</mark> each	month (	,	. ,	65 × (41)						
ŗ	-	1	i	i	i	i	î	ng and a	-	î	· · · · · ·			
(59)m=	0	0	0	0	0	0	0	0	0	0	0	0		(59)
r		1	for each	Ī		<u> </u>	<u> </u>	í	00.00	04.54	01.00	00.00		104
(61)m=	33.66	29.3	31.21	29.02	28.77	26.65	27.54	28.77	29.02	<b>31.2</b> 1	31.39	33.66		(61)

Solar DHW input calculated using Appendix G or Appendix H (negative quarity) (enter '0' if no solar contribution to water heating)       (add additional lines if FGHRS and/or WWHRS applies, see Appendix G)       (63)         (64)m <sup>2</sup> 0       0 <th>Total h</th> <th>neat req</th> <th>uired for</th> <th>water he</th> <th>eating ca</th> <th>alculated</th> <th><b>fo</b>r</th> <th>each</th> <th>n month</th> <th>(62)</th> <th>m =</th> <th>0.85 × (</th> <th>45)m -</th> <th>+ (46)m +</th> <th>(57)m +</th> <th>(59)m + (61)n</th> <th>ı</th>	Total h	neat req	uired for	water he	eating ca	alculated	<b>fo</b> r	each	n month	(62)	m =	0.85 × (	45)m -	+ (46)m +	(57)m +	(59)m + (61)n	ı
(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)       (3)         (6)m=       0	(62)m=	131.86	1 <b>1</b> 5 <b>.1</b> 8	1 <b>1</b> 9.84	106.29	102.9	90	0.63	86.82	96.	79	97.86	<b>11</b> 1.44	118.96	<b>12</b> 8.76		(62)
(63)m=       0 <td>Solar DI</td> <td>HW input</td> <td>calculated</td> <td>using App</td> <td>endix G or</td> <td><sup>r</sup> Appendix</td> <td>(H (r</td> <td>negativ</td> <td>/e quantity</td> <td>/) (ent</td> <td>er '0'</td> <td>if no solar</td> <td>r contrib</td> <td>ution to wate</td> <td>er heating)</td> <td>-</td> <td></td>	Solar DI	HW input	calculated	using App	endix G or	<sup>r</sup> Appendix	(H (r	negativ	/e quantity	/) (ent	er '0'	if no solar	r contrib	ution to wate	er heating)	-	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	(add a	dditiona	al lines if	FGHRS	and/or \	NWHRS	s ap	plies,	see Ap	penc	lix C	<del>)</del> )				-	
	(63) <b>m=</b>	0	0	0	0	0		0	0	0	1	0	0	0	0		(63)
Output from water heating, kWh/month 0.25 ' [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]         (1307.3261         (49)           Heat gains from water heating, kWh/month 0.25 ' [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]         (40.04         (45)           (65)m = (11.07) 35.88 37.27 32.95 31.84 27.93 26.6 29.81 30.14 34.48 36.97 40.04         (65)m           include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating           Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec           (60)m= 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 64.43         (66)m= 54.43 54.44 56.44	Outpu	t from w	ater hea	ter													
Heat gains from water heating, kWh/month 0.25 $[0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$ (66)m 41.07 35.88 37.27 32.95 31.84 27.93 26.6 29.81 30.14 34.48 36.97 40.04 (65) include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating 5. Internal gains (see Table 5 and 5a): Metabolic gains (Table 5), Watts Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 54.43 (66) Lighting gains (calculated in Appendix L, equation L19 or L9a), also see Table 5 (67)me 902 6.01 6.51 4.93 3.69 3.11 3.36 4.37 5.87 7.49 6.7 9.27 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 (68)me 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 (28.44 28.44 28.44 28.44 (28.44 28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 28.44 28.44 (28.44 28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 28.44 (28.44 (28.44 28.44 (28.44 (28.44 (28.44 (28.44 28.44 (28.44 (28.44 (28.44 (28.44 (28.44 (28.44 (28.44 (28.44	(64) <b>m=</b>	131.86	1 <b>15.18</b>	1 <b>19.</b> 84	106.29	102.9	90	0.63	86.82	96.	79	97.86	<b>11</b> 1.44	118.96	128.76		
(66)m       41.07       35.88       37.27       32.95       31.84       27.93       26.6       29.81       30.14       34.48       36.97       40.04       (65)         include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating       5.       Internal gains (see Table 5 and 5a):         Metabolic gains (Table 5), Watts       Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec         68/me       54.43       56.53       70.73       76.8       82.5       (66)         (69)me       gains (calculated in Appendix L, equation											Outp	ut from wa	ate <mark>r he</mark> ai	er (annual)	112	1307.3261	(64)
include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating <b>5.</b> Internal gains (see Table 5) watts Metabolic gains (Table 5), Watts (66)m = $54.43$ $28.44$	Heat g	ains fro	m water	heating,	kWh/m	onth 0.2	5 ´ [	0.85	× (45)m	+ (6	1)m	] + 0.8 x	(46)r	n + (57)m	+ (59)m	]	
S. Internal gains (see Table 5 and 5a):         Metabolic gains (Table 5), Watts         Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec         (66)m       5443       5444       2844       2844       2844       2844       2844<	(65) <b>m=</b>	41.07	35.88	37.27	32.95	31.84	27	7.93	26.6	29.	81	30.14	34.48	36.97	40.04		(65)
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	inclu	ude (57)	m in calc	culation of	of (65)m	only if c	ylin	der is	s in the c	well	ing	or hot w	ater is	from com	imunity h	neating	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	5. In	ternal g	ains (see	Table 5	i and 5a	):											
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Metab	olic gair	ıs (Table	5). Wat	ts												
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 (67)m 9.02 6.01 6.51 4.93 3.69 3.11 3.36 4.37 5.87 7.45 8.7 9.27 (67) Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 (68)m 86.3 87.2 84.94 80.14 74.07 68.37 64.56 63.67 65.93 70.73 76.8 82.5 (68) Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 (69)m 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 28.44 (69) Pumps and fans gains (Table 5a) (70)m 10 10 10 10 10 10 10 10 10 10 10 10 10	motab					May		Jun	Jul	A	ug	Sep	Oct	Nov	Dec		
	(66)m=	54.43	54.43	54.43	54.43	54.43	54	4.43	54.43	5 <b>4.</b>	43	54.43	54.43	54.43	5 <b>4.</b> 43		(66)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5         (68)m=       86.3       87.2       84.94       80.14       74.07       68.37       64.56       63.87       65.93       70.73       76.8       82.5       (68)         Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5       (69)       (70)       (71)       (70)       (70)       (71)       (71)       (71)       (71)       (71)       (71)       (71)       (71)       (72)       (72)       (73)	Lightin	g gains	(calculat	ted in Ap	pendix	L, equat	ion	L9 or	<sup>.</sup> L9a), a	so s	ee	Fable 5		<u>₽</u>		4	
	-		<u> </u>		· · · · · · · · · · · · · · · · · · ·		r		-				7.45	8.7	9.27		(67)
	Applia	nces ga	ins (calc	ulated in	Append	dix L, eq	uati	on L1	13 or L1	3a), i	also	see Tal	ole 5				
		-						-	_			-	-	76.8	82.5		(68)
	Cookir	ng gains	(calcula	ted in A	opendix	L. equa	tion	L15	or L15a)	, als	o se	e Table	5			1	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		-	<u> </u>	_			-			-	-			28.44	28.44	1	(69)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Pumps	s and fa	ns gains	(Table 5	5a)											1	
Losses e.g. evaporation (negative values) (Table 5) (71)m= $43.54 + 19.87 + 13.85 + $	1.5	-		-		10		10	10	1(	D	10	10	10	10	1	(70)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		sed e	/aporatio	n (nega												1	
Water heating gains (Table 5)         (72)m= $55.2$ $53.39$ $50.09$ $45.76$ $42.8$ $38.8$ $35.75$ $40.07$ $41.87$ $46.34$ $51.34$ $63.81$ (72)         Total internal gains =       (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m         (73)m=         199.85       197.93       190.88       180.16       169.89       159.61       153       157.44       162.99       173.85       186.16       194.9       (73)         6. Solar gains:         Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.         Orientation: Access Factor       Area       Flux $g_{-}$ FF       Gains         Table 6a       Table 6a       Table 6b       Table 6c       (W)         East $0.9x$ 1       x $1.44$ x $19.87$ x $0.63$ x $0.7$ = $6.13$ (76)         East $0.9x$ 1       x $1.44$ x $19.87$ x $0.63$ x $0.7$ = <td< td=""><td></td><td></td><td><u> </u></td><td><u>`</u></td><td></td><td><i>,</i> ,</td><td>-</td><td><u> </u></td><td>-43.54</td><td>-43</td><td>.54</td><td>-43.54</td><td>-43.54</td><td>-43.54</td><td>-43.54</td><td>1</td><td>(71)</td></td<>			<u> </u>	<u>`</u>		<i>,</i> ,	-	<u> </u>	-43.54	-43	.54	-43.54	-43.54	-43.54	-43.54	1	(71)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$																	
Total internal gains = $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$ $(73)m=$ 199.85       197.93       190.88       180.16       169.89       159.61       153       157.44       162.99       173.85       186.16       194.9       (73)         6. Solar gains:       Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.       Orientation: Accesss Factor Area m <sup>2</sup> Flux       g_       FF       Gains (W)         East       0.9x       1       x       1.44       x       19.87       x       0.63       x       0.7       =       6.13       (76)         East       0.9x       1       x       1.44       x       19.87       x       0.63       x       0.7       =       6.13       (76)					45.76	42.8	3	8.8	35.75	40.	07	41.87	46.34	51.34	53.81	1	(72)
(73)m=       199.85       197.93       190.88       180.16       169.89       159.61       153       157.44       162.99       173.85       186.16       194.9       (73)         6. Solar gains:       Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.       Orientation: Access Factor Area Flux g_ FF Gains Table 6a       FF Gains (W)         East $0.9x$ 1       x       1.44       x       19.87       x       0.63       x       0.7       =       6.13       (76)         East $0.9x$ 1       x       1.44       x       38.52       x       0.63       x       0.7       =       11.89       (76)																	
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         Marceler Table 6d       Marceler Table 6a         Table 6d       Marceler Table 6a         Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.         Orientation:       Access Factor Area marceler Table 6a         Table 6d       Marceler Table 6a         Table 6b       Table 6c         (W)       East         0.9x       1         X       1.44         X       19.87         X       0.63         X       0.77         East       0.9x         X       1.44         X       38.52         X       0.63         X       0.77         East       0.9x         X       1.44         X       38.52         X       0.63         X       0.77         East       0.63			<u> </u>		180.16	169.89	15		. ,	``	·	. ,	,			1	(73)
Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.Orientation:Access Factor Table 6dArea m²Flux Table 6ag_FF Table 6bGains Table 6cEast $0.9x$ 1x $1.44$ x $19.87$ x $0.63$ x $0.7$ = $6.13$ (76)East $0.9x$ 1x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $11.89$ (76)East $0.9x$ 1x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $11.89$ (76)																	. ,
Table 6d $m^2$ Table 6a       Table 6b       Table 6c       (W)         East $0.9x$ 1       x $1.44$ x $19.87$ x $0.63$ x $0.7$ = $6.13$ (76)         East $0.9x$ 1       x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $6.13$ (76)         East $0.9x$ 1       x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $11.89$ (76)				using sola	r flux from	Tab <b>l</b> e 6a	and a	associ	ated equa	tions	to co	nvert to th	e applic	able orienta	tion.		
Table 6d $m^2$ Table 6a       Table 6b       Table 6c       (W)         East $0.9x$ 1       x $1.44$ x $19.87$ x $0.63$ x $0.7$ = $6.13$ (76)         East $0.9x$ 1       x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $6.13$ (76)         East $0.9x$ 1       x $1.44$ x $38.52$ x $0.63$ x $0.7$ = $11.89$ (76)	Orient	ation:	Access F	actor	Area			Flu	x			<u>g_</u>		FF		Gains	
East $0.9x$ 1 x 1.44 x 38.52 x $0.63$ x $0.7$ = 11.89 (76)		-	Table 6d		m²			Tab	ole 6a		Т			Table 6c		(W)	
	East	0.9x	1	x	1.4	4	x	1	9.87	x		0.63	x	0.7	-	6.13	(76)
East $0.9x$ 1 x 1.44 x 61.57 x 0.63 x 0.7 = 19 (76)	East	0.9x	1	x	1.4	4	×	3	8.52	x		0.63	X	0.7	=	11.89	(76)
	East	0.9x	1	x	1.4	4	×	6	1.57	x		0.63	×	0.7	=	19	(76)
East 0.9x 1 x 1.44 x 91.41 x 0.63 x 0.7 = 28.21 (76)	East	0.9x	1	x	1.4	4	×	9	1.41	x		0.63	X	0.7	=	28.21	(76)
East 0.9x 1 x 1.44 x 111.22 x 0.63 x 0.7 = 34.33 (76)	East	0.9x	1	×	1.4	4	×	11	1.22	×		0.63	×	0.7	=	34.33	(76)
East 0.9x 1 x 1.44 x 116.05 x 0.63 x 0.7 = 35.82 (76)	East	0.9x	1	x	1.4	4	x	11	16.05	x		0.63	×	0.7	=	35.82	(76)
East 0.9x 1 x 1.44 x 112.64 x 0.63 x 0.7 = 34.76 (76)	East	0.9x	1	x	1.4	4	×	11	12.64	x		0.63	T x	0.7	=	34.76	(76)
East 0.9× 1 × 1.44 × 98.03 × 0.63 × 0.7 = 30.26 (76)	East	0.9x	1	×	1.4	4	×	9	8.03	×		0.63	×	0.7	=	30.26	(76)

East	0.9x	4	x	1.4	4	v	-	70.0	x	0.63	٦ × ٦	0.7		00.70	(76)
East	0.9×	1	╡^	<u> </u>		Ĵ		73.6 6.91	x					22.72	(76)
East	0.9×	1		1.4		x			1 I 1 I	0.63	╡╎	0.7		14.48	(76)
East	0.9×	1		1.4		x		4.71	x x	0.63		0.7		7.63	(76)
West	0.9x	1		1.4		x		6.39	:	0.63	╡	0.7		5.06	(70)
West	0.9x	0.54		1.4		x	·	9.87	x x	0.63		0.7		6.13	(80)
West	0.9×	0.54		1.4		X		8.52	:	0.63		0.7		11.89	(80)
West	0.9x	0.54	×	1.4		x		1.57	×	0.63	╡╎	0.7		19	
West		0.54		1.4		X		1.41	X	0.63		0.7		28.21	(80)
West	0.9x	0.54	×	1.4		X		11.22	X	0.63		0.7		34.33	(80)
West	0.9x	0.54	×	1.4		х		16.05	X	0.63		0.7		35.82	(80)
	0.9x	0.54	×	1.4		X		12.64	X	0.63		0.7		34.76	(80)
West	0.9x	0.54	×	1.4		×		8.03	×	0.63		0.7	=	30.26	(80)
West	0.9x	0.54	×	1.4		X		73.6	X	0.63	×	0.7	=	22.72	(80)
West	0.9x	0.54	×	1.4	4	X	4	6.91	X	0.63		0.7		14.48	(80)
West	0.9x	0.54	×	1.4		x		4.71	X	0.63	×	0.7	=	7.63	(80)
West	0.9x	0.54	X	1.4	4	x	1	6.39	X	0.63	X	0.7	=	5.06	(80)
Solar gains in watts, calculated for each month (83)m = Sum(74)m(82)m															
Solar ( (83)m=	12.27	23.78	38	for each	68.65	1	1.63	69.53	(83)m	= Sum(74)m .	<mark>(8</mark> 2)m 28.95	15.25	10.12	ľ	(83)
		ternal an	N				and the state	Contraction of the	00.	45.45	20.95	10.20	10.12		(00)
(84)m=	212.11		228.88	236.58	238.54	-	31.25	222.53	217	95 208.42	202.8	201.41	205.02	ř –	(84)
(0,),						7									
						100		-	1				-		
		nal tempe						Tak		Th4 (%C)		-			
Temp	erature	during he	eating p	eriods ir	n the liv	ring			ole 9,	Th1 (°C)				21	(85)
Temp	erature	during he tor for gai	eating po ins for li	eriods ir ving are	n the liv ea, h1,r	ring n (s	ee Ta	ble 9a)	-		Oct	Nov	Dee	21	(85)
Temp Utilisa	erature ation fact Jan	during he tor for gai Feb	eating p ins for li Mar	eriods ir ving are Apr	n the liv ea, h1,r May	ring m (s	ee Ta Jun	ble 9a) Jul	A	ıg Sep	Oct		Dec	21	
Temp Utilisa (86)m=	Jan 0.99	during he tor for ga Feb 0.99	eating po ins for li Mar 0.98	eriods ir ving are Apr 0.96	n the liv ea, h1,r May 0.9	ring n (s	ee Ta Jun 0.77	ble 9a) Jul 0.57	Au 0.5	ıg Sep 8 0.84	Oct 0.96	Nov 0.99	Dec 0.99	21	(85)
Temp Utilisa (86)m= Mear	erature ation fact Jan 0.99 n internal	during he tor for ga Feb 0.99 tempera	eating po ins for li Mar 0.98 iture in l	eriods ir ving are Apr 0.96 iving are	n the liv ea, h1,r May 0.9 ea T1 (	ring n (s follo	ee Ta Jun 0.77 w ste	ble 9a) Jul 0.57 ps 3 to 7	Au 0.5 7 in T	ug Sep 8 0.84 able 9c)	0.96	0.99	0.99	21	(86)
Temp Utilisa (86)m=	Jan 0.99	during he tor for ga Feb 0.99	eating po ins for li Mar 0.98	eriods ir ving are Apr 0.96	n the liv ea, h1,r May 0.9	ring n (s follo	ee Ta Jun 0.77	ble 9a) Jul 0.57	Au 0.5	ug Sep 8 0.84 able 9c)		0.99		21	
Temp Utilisa (86)m= Mean (87)m= Temp	berature of ation fact Jan 0.99 internal 19.71 berature	during he tor for ga Feb 0.99 tempera 19.83 during he	eating po ins for li Mar 0.98 iture in l 20.07 eating po	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o	follo	ee Ta Jun 0.77 ww.ste 20.9 /elling	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta	Au 0.5 7 in T 20.9	ug Sep 8 0.84 able 9c) 98 20.84 9, Th2 (°C)	0.96	0.99	0.99	21	(86) (87)
Temp Utilisa (86)m= Mean (87)m=	ation fact Jan 0.99 internal 19.71	during he tor for ga Feb 0.99 tempera 19.83	eating po ins for li Mar 0.98 iture in l 20.07	eriods ir ving are Apr 0.96 iving are 20.35	n the liv ea, h1,r May 0.9 ea T1 ( 20.68	follo	ee Ta Jun 0.77 ow ste 20.9	ble 9a) Jul 0.57 ps 3 to 7 20.98	Au 0.5 7 in T 20.9	ug Sep 8 0.84 able 9c) 98 20.84 9, Th2 (°C)	0.96	0.99 20.02	0.99	21	(86)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m=	oerature of ation fact Jan 0.99 internal 19.71 oerature 19.78	during he tor for ga Feb 0.99 tempera 19.83 during he	eating points for line Mar 0.98 ature in l 20.07 eating points 19.8	Apr 0.96 iving are 20.35 eriods ir 19.83	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85	follo	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86	Au 0.5 7 in T 20.9 able 9	ug Sep 8 0.84 able 9c) 98 20.84 9, Th2 (°C)	0.96 20.48	0.99 20.02	0.99 19.76	21	(86) (87)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m=	oerature of ation fact Jan 0.99 internal 19.71 oerature 19.78	during he tor for ga Feb 0.99 tempera 19.83 during he 19.8	eating points for line Mar 0.98 ature in l 20.07 eating points 19.8	Apr 0.96 iving are 20.35 eriods ir 19.83	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85	ring m (s follo f dw f dw	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86	Au 0.5 7 in T 20.9 able 9	ug         Sep           8         0.84           able 9c)         20.84           98         20.84           9, Th2 (°C)         36	0.96 20.48	0.99 20.02	0.99 19.76	21	(86) (87)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m=	ation fact Jan 0.99 internal 19.71 perature 19.78 ation fact 0.99	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98	eating points for li Mar 0.98 ature in l 20.07 eating points 19.8 ins for r 0.97	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86	ring n (s follo follo f dw 1 1	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86 ,m (se 0.67	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4	ug Sep 8 0.84 able 9c) 98 20.84 9, Th2 (°C) 36 19.84	0.96 20.48 19.83 0.94	0.99 20.02 19.81	0.99 19.76 19.8	21	(86) (87) (88)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m=	ation fact Jan 0.99 internal 19.71 perature 19.78 ation fact 0.99	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98	eating points for li Mar 0.98 ature in l 20.07 eating points 19.8 ins for r 0.97	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86	ring n (s follo f dw f dw h2, n2, h2,	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86 ,m (se 0.67	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4	Ig         Sep           8         0.84           able 9c)         98           98         20.84           9, Th2 (°C)           36         19.84           3         0.76           to 7 in Table	0.96 20.48 19.83 0.94	0.99 20.02 19.81 0.98	0.99 19.76 19.8	21	(86) (87) (88)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean	ation fact Jan 0.99 internal 19.71 perature 19.78 ation fact 0.99	during he tor for ga Feb 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera	eating p ins for li Mar 0.98 iture in l 20.07 eating p 19.8 ins for r 0.97	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest	n the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel	ring n (s follo f dw f dw h2, n2, h2,	ee Ta Jun 0.77 ww ste 20.9 velling 9.86 ,m (se 0.67 T2 (fo	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 te Table 0.42 bllow ste	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4 eps 3	ug         Sep           8         0.84           able 9c)         98           98         20.84           9, Th2 (°C)         96           36         19.84           3         0.76           to 7 in Tabl         19.76	0.96 20.48 19.83 0.94 e 9c) 19.43	0.99 20.02 19.81 0.98	0.99 19.76 19.8 0.99 18.7	0.4	(86) (87) (88) (89)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m=	ation fact Jan 0.99 internal 19.71 oerature 19.78 ation fact 0.99 internal 18.64	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77	eating period	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31	the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel 19.63	ring n (s follo follo f dw h2, h2, 1 1 1	ee Ta Jun 0.77 w ste 20.9 velling 9.86 ,m (se 0.67 T2 (fo 9.81	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42 bllow ste 19.86	Au 0.5 7 in T 20.9 able S 19.8 9a) 0.4 eps 3 19.8	Ig         Sep           8         0.84           able 9c)         98           98         20.84           9, Th2 (°C)           36         19.84           3         0.76           to 7 in Table           36         19.76	0.96 20.48 19.83 0.94 e 9c) 19.43	0.99 20.02 19.81 0.98 18.97	0.99 19.76 19.8 0.99 18.7		(86) (87) (88) (89) (90)
Temp Utilisa (86)m= Mear (87)m= Temp (88)m= Utilisa (89)m= Mear (90)m=	ation fact Jan 0.99 internal 19.71 oerature 19.78 ation fact 0.99 internal 18.64	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77	eating points for line for line for line for line for line for reacting points for reacting points for reacting for reacti	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31	the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel 19.63	ring n (s follo f dw f dw h2, n 1 n 1 n 1 n 1 n 1	ee Ta Jun 0.77 w ste 20.9 velling 9.86 ,m (se 0.67 T2 (fo 9.81	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42 bllow ste 19.86	Au 0.5 7 in T 20.9 able S 19.8 9a) 0.4 eps 3 19.8	Ig         Sep           8         0.84           able 9c)         98           98         20.84           9, Th2 (°C)           36         19.84           3         0.76           to 7 in Table           36         19.76           9         19.76	0.96 20.48 19.83 0.94 e 9c) 19.43	0.99 20.02 19.81 0.98 18.97 ring area ÷ (4	0.99 19.76 19.8 0.99 18.7		(86) (87) (88) (89) (90)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m=	ation fact Jan 0.99 internal 19.71 oerature 19.78 ation fact 0.99 internal 18.64	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77 tempera 19.19	eating print for li Mar 0.98 ature in l 20.07 eating print 19.8 ins for r 0.97 ature in t 19.01	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31	the liv ea, h1,r May 0.9 ea T1 ( 20.68 19.85 welling 0.86 of dwel 19.63	ring n (s follo follo f dw h2, h2, n 1 n t 1 s lling 2	ee Ta Jun 0.77 w ste 20.9 (elling 9.86 ,m (se 0.67 T2 (fc 9.81 g) = fl 20.24	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42 bllow ste 19.86 LA × T1 20.31	Au 0.5 7 in T 20.9 able S 19.8 9a) 0.4 eps 3 19.8 + (1	Ig         Sep           8         0.84           able 9c)         98           98         20.84           9, Th2 (°C)         96           36         19.84           3         0.76           to 7 in Tabl           36         19.76           19         19.76	0.96 20.48 19.83 0.94 e 9c) 19.43 LA = Liv	0.99 20.02 19.81 0.98 18.97 ring area ÷ (4	0.99 19.76 19.8 0.99 18.7 4) =		(86) (87) (88) (89) (90) (91)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m=	ation fact Jan 0.99 internal 19.71 oerature 19.78 ation fact 0.99 internal 18.64	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77 tempera 19.19	eating print for li Mar 0.98 ature in l 20.07 eating print 19.8 ins for r 0.97 ature in t 19.01	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31	the liv ea, h1,r May 0.9 ea T1 ( 20.68 19.85 welling 0.86 of dwel 19.63	ring n (s follo f dw f dw f dw f dw f dw f dw f dw f dw	ee Ta Jun 0.77 w ste 20.9 (elling 9.86 ,m (se 0.67 T2 (fc 9.81 g) = fl 20.24	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 re Table 0.42 bllow ste 19.86 LA × T1 20.31	Au 0.5 7 in T 20.9 able S 19.8 9a) 0.4 eps 3 19.8 + (1	Ig         Sep           8         0.84           able 9c)         38           38         20.84           9, Th2 (°C)         36           36         19.84           3         0.76           to 7 in Tabl           36         19.76           19         19.76           10         19.76           11         20.19           where approx	0.96 20.48 19.83 0.94 e 9c) 19.43 LA = Liv	0.99 20.02 19.81 0.98 18.97 ring area ÷ (4	0.99 19.76 19.8 0.99 18.7 4) =		(86) (87) (88) (89) (90) (91)
Temp Utilisa (86)m= Mean (87)m= Temp (88)m= Utilisa (89)m= Mean (90)m= Mean (90)m= Mean (92)m= Apply (93)m=	ation fact Jan 0.99 internal 19.71 oerature 19.78 ation fact 0.99 internal 18.64 internal 19.06 v adjustm 18.91	during he tor for ga Feb 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77 tempera 19.19 hent to the	eating print for line for reacting print for reacting print for reacting print for reacting fo	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31 r the wh 19.72 internal	the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel 19.63 ole dw 20.05	ring n (s follo f dw f dw f dw f dw f dw f dw f dw f dw	ee Ta Jun 0.77 ww ste 20.9 velling 9.86 	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 e Table 0.42 bllow ste 19.86 	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4 eps 3 19.8 19.8 + (1 20.3	Ig         Sep           8         0.84           able 9c)         38           38         20.84           9, Th2 (°C)         36           36         19.84           3         0.76           to 7 in Tabl           36         19.76           19         19.76           10         19.76           11         20.19           where approx	0.96 20.48 19.83 0.94 e 9c) 19.43 LA = Liv 19.85 opriate	0.99 20.02 19.81 0.98 18.97 ring area ÷ (* 19.39	0.99 19.76 19.8 0.99 18.7 4) = 19.12		(86) (87) (88) (89) (90) (91) (92)
Temp Utilisa (86)m= Mear (87)m= Temp (88)m= Utilisa (89)m= Mear (90)m= Mear (92)m= Apply (93)m= 8. Sp Set T	ation fact Jan 0.99 internal 19.71 berature 19.78 ation fact 0.99 internal 18.64 19.06 r adjustm 18.91 ace heat i to the n	during he tor for ga 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77 tempera 19.19 hent to the 19.04 ting requi	eating print for line for reacting print for reacting for reacti	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31 r the wh 19.72 internal 19.57	the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel 19.63 ole dw 20.05 tempe 19.9	ring n (s follo follo f dw f dw f dw f dw	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86 .m (se 0.67 T2 (fc 9.81 g) = fl 20.24 ure fro 20.09	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 e Table 0.42 bllow ste 19.86 LA × T1 20.31 m Table 20.16	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4 eps 3 19.8 19.8 4e, v 20.3	Ig         Sep           8         0.84           able 9c)         38           38         20.84           9, Th2 (°C)         36           36         19.84           3         0.76           to 7 in Tabl           36         19.76           19         19.76           10         19.76           11         20.19           where approx	0.96 20.48 19.83 0.94 e 9c) 19.43 LA = Liv 19.85 opriate 19.7	0.99 20.02 19.81 0.98 18.97 ring area ÷ (* 19.39 19.24	0.99 19.76 19.8 0.99 18.7 4) = 19.12 18.97	0.4	(86) (87) (88) (89) (90) (91) (92)
Temp Utilisa (86)m= Mear (87)m= Temp (88)m= Utilisa (89)m= Mear (90)m= Mear (92)m= Apply (93)m= 8. Sp Set T	ation fact Jan 0.99 internal 19.71 berature 19.78 ation fact 0.99 internal 18.64 19.06 r adjustm 18.91 ace heat i to the n	during he tor for ga Feb 0.99 tempera 19.83 during he 19.8 tor for ga 0.98 tempera 18.77 tempera 19.19 hent to the 19.04 ting requi	eating print for line for reacting print for reacting for reacti	eriods ir ving are Apr 0.96 iving are 20.35 eriods ir 19.83 est of dv 0.95 he rest 19.31 r the wh 19.72 internal 19.57	the liv ea, h1,r May 0.9 ea T1 ( 20.68 n rest o 19.85 welling 0.86 of dwel 19.63 ole dw 20.05 tempe 19.9	ring n (s follo follo f dw f dw f dw f dw f dw f dw f a f dw f a f dw f a f a f a f a f a f a f a f a	ee Ta Jun 0.77 ww ste 20.9 /elling 9.86 .m (se 0.67 T2 (fc 9.81 g) = fl 20.24 ure fro 20.09	ble 9a) Jul 0.57 ps 3 to 7 20.98 from Ta 19.86 e Table 0.42 bllow ste 19.86 LA × T1 20.31 m Table 20.16	Au 0.5 7 in T 20.9 able 9 19.8 9a) 0.4 eps 3 19.8 19.8 4e, v 20.3	Ig         Sep           8         0.84           able 9c)         38           38         20.84           9, Th2 (°C)           36         19.84           3         0.76           to 7 in Table           36         19.76           1         20.19           where approximation           16         20.04	0.96 20.48 19.83 0.94 e 9c) 19.43 LA = Liv 19.85 opriate 19.7	0.99 20.02 19.81 0.98 18.97 ing area ÷ (* 19.39 19.24 =(76)m an	0.99 19.76 19.8 0.99 18.7 4) = 19.12 18.97	0.4	(86) (87) (88) (89) (90) (91) (92)

Utilisa	ation fac	tor for g	ains hm	·										
(94)m=	0.99	0.98	0.97	0.94	0.86	0.7	0.46	0.47	0.77	0.93	0.98	0.99		(94)
Usefu	I gains,	hmGm	W = (94	4)m x (8	4)m									
(95)m=	209.1	217.59	221.66	222.86	205.58	16 <b>1.</b> 06	102.2	102.05	<b>1</b> 61.02	189.22	19 <b>7</b>	202.19		(95)
Mont	h <b>ly a</b> ver	age exte	rnal tem	perature	e from Ta	able 8								
(96)m=	<b>4.</b> 5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9		(96)
Heat	-	e for mea	an intern	al temp	erature,	Lm,W =	=[(39)m :	x [(93)m	– (96)m	]				
(97)m=	497.32	476.94	423.89	358.68	265.76	176.52	103.85	103.83	186.85	293.68	409.65	478		(97)
Space	e heatin	g require	ement fo	r each n	nonth, k	Wh/mon	th = 0.02	24 x [(97	)m – (95	<u>)</u> m] x (4	1)m			
(98)m=	214.43	174.29	150.46	97.79	44.77	0	0	0	0	77.72	<b>1</b> 53.11	205.2		_
								Tota	l per year	(kWh/year	') = Sum(9	8) =	1117.77	(98)
Space	e heatin	g require	ement in	kWh/m <sup>2</sup>	²/year								44.71	(99)
9a <b>.</b> En	ergy rea	quiremer	nts – Indi	ividual h	eating s	ystems i	ncluding	micro-C	CHP)					
-	e heatiı	•										r		_
Fract	ion of sp	bace hea	at from se	econdar	y/supple	ementary	-						0	(201)
Fract	ion of sp	bace hea	at from m	nain syst	em(s)			(202) = 1 -	- (201) =				1	(202)
Fract	ion of to	tal heati	ng from	main sy	stem 1			(204) = (2	02) × [ <b>1 –</b>	(203)] =			1	(204)
Efficie	ency of	main spa	ce heat	ing syste	em 1								84.8	(206)
Efficie	ency of	seconda	ry/supple	ementar	y heatin	g system	n, %						0	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/ye	ar
Space	e heatin	g require	ement (c	alculate	d above	)								
	214.43	174.29	150.46	97.79	44.77	0	0	0	0	77.72	153.11	205.2		
(211)m	n = {[(98	)m x (20	4)] + (21	0)m } x	100 ÷ (2	206)								(211)
	252.86	205.53	177.43	115.32	52.79	0	0	0	0	91.65	180.55	241.98		
								Tota	l (kWh/yea	ar) =Sum(2	21 <b>1)<sub>15,1012</sub></b>	=	<b>1</b> 318.12	(211)
Space	e heatin	g fuel (s	econdar	y), kWh/	month							-		
= {[(98	)m x (20	01)] + (2 <sup>-</sup>	14) m } x	(100 ÷ (	208)	-				-				
( <b>21</b> 5)m=	0	0	0	0	0	0	0	0	0	0	0	0		_
								Tota	l (kWh/yea	ar) =Sum(2	21 <b>5)<sub>15,1012</sub></b>	=	0	(215)
	heating	-												
Output		ater hea				00.00	00.00	00.70	07.00	444.44	449.00	400.70		
<b>–</b>	131.86	115.18	1 <b>19.84</b>	106.29	102.9	90.63	86.82	96.79	97.86	111.44	118.96	<b>128.</b> 76		
	<u> </u>	ater hea						<b>.</b>					80.5	(216)
( <b>21</b> 7)m=		85.85	85.42	84.7	83.11	80.5	80.5	80.5	80.5	84.08	85.48	85.97		(217)
		heating, m x 100												
• •	153.29	134.16	140.28	125.48	123.82	112.58	107.85	120.24	121.57	132.54	139.17	149.77		
								Tota	I = Sum(2	19a)=			1560.75	(219)
Annua	al totals									k	Wh/year	. I	kWh/yea	
		fuel use	ed, main	system	1						-		1318.12	
Water	heating	fuel use	d									Ì	1560.75	Ī
												L		_

Electricity for pumps, fans and electric keep-hot

central heating pump:			130		(230c)
boiler with a fan-assisted flue			45		(230e)
Total electricity for the above, kWh/year	sum	of (230a)(230g) =		175	(231)
Electricity for lighting				159.28	(232)
12a. CO2 emissions – Individual heating systems i	including micro-CHP				
	<b>Energy</b> kWh/year	<b>Emission fac</b> kg CO2/kWh	tor	<b>Emissions</b> kg CO2/yea	ır
Space heating (main system 1)	(211) x	0.198	=	260.99	(261)
Space heating (secondary)	(215) x	0	=	0	(263)
Water heating	(219) x	0.198	=	309.03	(264)
Space and water heating	(261) + (262) + (263) + (2	264) =		570.02	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.517	=	90.48	(267)
Electricity for lighting	(232) x	0.517	=	82.35	(268)
Total CO2, kg/year		sum of (265)(271) =		742.84	(272)
Dwelling CO2 Emission Rate	_	(272) ÷ (4) =		29.71	(273)
El rating (section 14)				86	(274)