

# Residential Energy Report

October 2015

## CLIVE CHAPMAN

A R C H I T E C T S SUSTAINABILITY CONSULTANTS

4 EEL PIE ISLAND TWICKENHAM MIDDX TWI 3DY TELEPHONE 020 8891 4837 FACSIMILE 020 8744 1152 EMAIL INFO@CCAR.CO.UK WEB WWW.CCAR.CO.UK

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### Revision Log

First Issue

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Planning Report

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#### 1.0 Introduction

Clive Chapman Sustainability Consultants have been appointed to carry out a sustainability assessment and energy statement for the new build dwellings of a proposed development at 45-49 Station Road, Hampton.

The scheme involves the demolition of the existing car showroom and workshops, and redevelopment of the site to comprise of a new car showroom, associated car repair workshop, and eight new-build residential units. Of the eight dwellings, six are three-bedroom dwellings, and two are two-bedroom flats located on the first floor above the car showroom fronting Station Road.

A sustainability assessment for the commercial aspect of the scheme is provided as a separate report and has been prepared by Metroplis Green.<sup>1</sup>

For new build dwellings, the London Borough of Richmond upon Thames (LBRuT) has a Sustainable Construction Checklist, the current sustainability criteria are listed below. A detailed study has been carried out to assess options to meet these criteria:

- Assessment of the development using the London Borough of Richmond Thames Sustainable Construction Checklist (September 2015).
- A maximum water consumption of 105 litres per person, per day.
- A minimum reduction in carbon dioxide emissions of 35% over Building Regulations Approved Document L1A 2010, 2013 edition.
- Endeavour to achieve reductions of 20% of the predicted carbon dioxide emissions by on-site renewable energy generation (Policy DM SD 2).

<sup>&</sup>lt;sup>1</sup> See submitted report 'BREEAM Pre-assessment' for further information. Clive Chapman Sustainability Consultants

#### 2.0 LBRUT Sustainable Construction Checklist

#### 2.1 SCC Requirements:

The Sustainable Construction Checklist states that all developments and applications undertaken in the London Borough of Richmond will be expected to be assessed against the following seven checklist items:

#### 2.2 SCC Assumptions and Compliance:

Category	Score
Minimum Policy Compliance	8
Energy Use and Pollution	15
Transport <sup>1</sup>	9
Biodiversity	15
Flooding and Drainage	3
Improving Resource Efficiency	7
Design Standards and Accessibility	5
TOTAL	63

The score above, assesses the development as a whole (commercial and residential uses) as the SCC (Sep 2015) does not have methods to determine a mixed use scheme. Elements that contribute to the sustainability of the site – that do not fall within residential use – should not be overlooked in determining the assessment of the overall development.

An overall score of 63 credits will be achieve a A rating. Please see Appendix A for the completed Sustainable Construction Checklist.

#### 3.0 Water Efficiency Measures

At construction stage, the Water Efficiency Calculator for new dwellings will be used to calculate the water usage for the dwellings.

Suggested flow rates of fittings to meet the required maximum of 105 litres/per person/day are listed here:

WC full/part flush: Basin/Kitchen taps: Bath capacity: Shower (if separate from bath taps): 5/3 litres 6 litres/minute 160 litres to overflow 7 litres/minute

#### 4.0 Energy Efficiency Measures

This section sets out the detailed analysis and results of the annual  $CO_2$  emission calculations of the proposed dwelling. The dwelling has been modelled using the Government Standard Assessment Procedure (SAP) 2012 to determine the impact of building services options and to investigate the use of renewable energy sources, their impact on emissions, and their approximate cost of installation. The reductions of  $CO_2$  emissions achieved through the application of renewable energy technologies have been tested and calculated in accordance with London Borough of Richmond upon Thames' Sustainable Construction Checklist Guidance adopted in September 2015.

Notes:

Please note that assumptions will have to be confirmed by an M&E Consultant and that any changes will have an impact on the SAP results and therefore the achieved reduction in CO2 and % Renewables.

#### 4.1 Suitable Renewable/Low or Zero Carbon Technologies

The London Plan was published in 2004 and stipulates that the development plans for all London Boroughs should eventually comply with the requirements. The Mayor's Energy Hierarchy, described in the London Plan, comprises three stages of application: use less energy, use renewable energy and supply energy efficiently. This hierarchy has been adopted for this project and various high efficiency communal services systems and renewable energy systems have been investigated.

The LBRuT Sustainable Construction Checklist (SCC) requires the development to reduce the predicted site  $CO_2$  emissions by at least 35% over Building Regulations Approved Document L1A 2010, 2013 edition through the use of high efficiency building fabric and on-site renewable energy generation. In addition, it is encouraged that the developments seek to provide 20% reductions in  $CO_2$  through the use of onsite renewable technologies (Policy DM SD 2).

The feasibility of renewable energy systems for this development has been investigated using the broad guidelines published by the Mayor of London in the document *Integrating Renewable Energy into New Developments: A toolkit for planners, Developers and Consultants.* (Normally referred to as *The Toolkit.*) The Toolkit includes a list of renewable energy system options which should be considered for specific building types in London.

The table below summarises the systems available and their suitability for this project:

System	Preliminary Assessment	Decision
Wind generators	Planning and local community issues associated with noise and visual obstruction. Average wind speeds in urban/suburban locations are unlikely to achieve the required speed of 6 m/s.	Rejected.
Photovoltaic, roof top	The proposed dwellings have either pitched or flat roofs suitable for the application of photovoltaic panels. They are a commonly used renewable technology and not prohibitively expensive.	Likely to be suitable for this site.
Solar water heating	The building has a pitched roof that can be used for Solar Thermal tubes. However, the contribution of solar hot water towards the LBRuT 20% renewables target is significantly lower than the contribution of Photovoltaic Panels. The reason being that the solar water panels reduce the running times of the gas boiler for space & hot water generation, whereas PVs reduce the electricity consumption of the building, and electricity generation has a larger carbon footprint.	May be suitable for this site.
Biomass CHP	Limited suppliers to the London area. Biomass CHP is a renewable and energy efficient system providing electricity and space and hot water heating. However, CHP systems are more suitable for applications where there is a high heat demand throughout the year. The building fabric has been designed to be efficient and airtight, and therefore should not require high levels of heating.	Rejected.
Ground source heat pumps for heating (space and hot water)	Ground area available to each unit is not sufficient enough to accommodate horizontal pipe system. Ground may be accessible for vertical pipe systems. The most appropriate use would be a low temperature system such as underfloor heating. Secondary heating unit for hot water would be needed.	Rejected.
Ground sourced inc. borehole cooling, either direct or via a chiller	There is no need of a mechanical cooling system for the proposed dwellings.	Rejected.

Renewable energy technologies suitable for London

Acceptable renewable energy technologies (not covered in detail in the toolkit);

'London renewables, Toolkit for planners, developers and consultants' September 2004

2004		
System	Preliminary Assessment	Decision
Micro-hydro, small and low head	Some limited applications in London.	Rejected
Gas from anaerobic digestion	Technology being developed.	Rejected
Geothermal heat, hot rocks	Could be available in London but unlikely due to geology under London.	Rejected
Solar air collectors	Very small energy contribution and difficult to calculate and measure.	Rejected
Ground cooling air systems	No experience currently in the UK.	Rejected
Fuel cells using hydrogen from renewable sources	Not currently commercially available.	Rejected

LZC technologies (not covered in the toolkit; www.lowcarbonbuildings.org.uk/micro/)

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System	Preliminary Assessment	Decision
External and Exhaust Air source heat pumps for heating (space and hot water)	Air is an easily accessible means of heating, the most appropriate use would be low temperature system such as under floor heating. However, as it runs on electricity the contribution of the system to the 20% renewable target is very low.	Rejected
Micro Combined Heat and Power (CHP)	Micro CHP units are energy efficient systems generating electricity and providing space and hot water heating. These gas fired systems are available for domestic use, although are more suitable for dwellings with a high annual heat demand. Also these systems are fairly cost prohibitive in comparison with other more efficient renewable technologies.	Rejected
Biomass heating. Fuels – wood, pellets, woodchips, some industrial waste products.	Biomass heating is a renewable energy technology. However, the system requires extensive space for storing the fuel (chips/pellets). The London Plan advises that the use of Biomass should be limited.	Rejected

#### 4.2 Energy Effeciency Measures: Options, Calculations and Results

Options have been modelled using NHER SAP 2012 to calculate the energy use of the properties and predict the reduction of  $CO_2$  emissions achieved through the application of building envelope upgrades and renewable energy technologies.

The two proposed dwellings that have been analysed represent the worst case scenarios out of the two flat and six house types. They have been picked as worse case scenarios based upon their orientation, number of exposed sides, number of openings, size, and available roof space to accommodate renewable technologies. The other dwellings not modelled should therefore perform similarly or exceed the values shown in these calculations.

No community heating schemes are in close proximity to the site, therefore this option was not investigated further.

Option	Specification	DER/TER Variance BREGS L1A 2012 TARGET 0% LBRUT TARGET -35%	% reduction through renewables
Flat Base Case	DER U values in accordance with B minimum allowable limiting pa -Floors -External wall -Party Walls -Roofs -Windows / Doors U-value of first floor subject to heat loss to commercial premises below (heated, but on a different schedule) is	61.84%	n/a

#### 4.2.1 FLAT 1

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	assumed to be reduced by a u =0.12W/m <sup>2</sup> K factor of 2 in accordance with guidance in "The Governments Standard Assessment Procedure for Energy Rating of Dwellings" SAP 2012. -Air tightness 10 m <sup>3</sup> /hrm <sup>2</sup> -50% energy efficient lighting -Thermal bridging: default 0.15. Services in accordance with CSH Table Cat 1.3 Standard CO2 emissions Calculation -Instantaneous regular boiler 88% efficient (SEDBUK 2009)	2	
Flat Improved Case	Improved build ups/services chosen to reach BRegs L1A 2013	-4.12%	4.59%
	$\begin{array}{llllllllllllllllllllllllllllllllllll$		
	-First floor heat loss to u =0.1W/m <sup>2</sup> K commercial below		
	-Thermal bridging: 0.0507 calculated. -Air tightness 4.5 m <sup>3</sup> /hrm <sup>2</sup> -Instantaneous Combi boiler 90% efficient -100% energy efficient lighting		
	-1 no. 320 Wp Sunpower panels* Overall approx. 3.2m <sup>2</sup> , 0.64kWp, mounted at 30° angle on pitched roof all panels South West facing.		
Flat Proposed Case	Build ups/services as 'Improved Case' with additional <b>PV</b> to meet LBRUT requirement:	-48.67%	27.97%
Case	-First floor heat loss u =0.1W/m <sup>2</sup> K to commercial below		
	<ul> <li>- 6no. 320kWp Sunpower PV panels</li> <li>Overall approx. 9.8m<sup>2</sup>, 1.92kWp, mounted at 30° angle on pitched roof, all panels South West facing.</li> </ul>		

45-49 Station Road, Hampton \_ Energy Report \* In reality, it is unlikely that this small number of PVs would be an appropriate installation but is included for illustration purposes

#### 4.2.1 House 1 – End Terrace

Option	Specification	DER/TER Variance BREGS L1A 2012 TARGET 0% LBRUT TARGET -35%	% reduction through renewables
House Base Case	DER U values in accordance with BRegs L1A 2013 minimum allowable limiting parameters -Floors u =0.25W/m <sup>2</sup> K -Basement Floor u =0.25W/m <sup>2</sup> K -External wall u =0.3W/m <sup>2</sup> K -Basment wall u =0.3W/m <sup>2</sup> K -Party Walls u =0.2W/m <sup>2</sup> K -Roofs u =0.2W/m <sup>2</sup> K -Glass bay roof u =0.2W/m <sup>2</sup> K -Glass bay roof u =0.2W/m <sup>2</sup> K -Glass Bay Curtain wall u =2.0W/m <sup>2</sup> K -Glass Bay Curtain wall u =2.0W/m <sup>2</sup> K -Air tightness 10 m <sup>3</sup> /hrm <sup>2</sup> -50% energy efficient lighting -Thermal bridging: default 0.15. Services in accordance with CSH Table Cat 1.2 Standard CO2 emissions Calculation -Instantaneous regular boiler 88% efficient (SEDBUK 2009)	94.08%	n/a
House Improved Case	Improved build ups/services chosen to reach BRegs L1A 2013 -Insulated ground floor u =0.11W/m <sup>2</sup> K -Insulated basement Floor u =0.11W/m <sup>2</sup> K -External wall u =0.15W/m <sup>2</sup> K -Basment wall u =0.17W/m <sup>2</sup> K -Party Walls u =0.2W/m <sup>2</sup> K -Roofs u =0.12W/m <sup>2</sup> K -Glass bay roof u =0.18W/m <sup>2</sup> K -Windows u =1.1W/m <sup>2</sup> K -Front Door u =1.1W/m <sup>2</sup> K -Glass Bay Curtain wall u =1.2W/m <sup>2</sup> K -Thermal bridging: 0.0639 calculated. -Air tightness 4.5 m <sup>3</sup> /hrm <sup>2</sup> -Regular gas boiler 89.6% efficient -100% energy efficient lighting -3 no. 245 Wp Sunpower panels* Overall approx. 4.8m <sup>2</sup> , 0.735kWp, mounted at 30° angle on pitched roof all panels South East	-1.14%	-7.8%

	facing.		
House Case 1	<ul> <li>Build ups/services as 'Improved Case' with additional PV and MVHR to meet LBRUT requirement:</li> <li>- 6no. 320kWp Sunpower PV panels Overall approx. 9.8m<sup>2</sup>, 1.92kWp, mounted at 30° angle on pitched roof, 3 panels South East facing, 3 panels North West facing.</li> </ul>	-36.49%	19.30%
House Case 2	Build ups/services as 'Improved Case' with additional <b>PV</b> and <b>MVHR</b> to meet LBRUT requirement: - 3no. 320kWp Sunpower PV panels Overall approx. 9.8m <sup>2</sup> , 1.92kWp, mounted at 30° angle on pitched roof, all panels South East facing	-21.46%	11.0%

\* In reality, it is unlikely that this small number of PVs would be an appropriate installation but is included for illustration purposes.

#### 4.3 Conclusion

It can be seen that both worst case residential unit types:

- Can achieve the LBRUT requirement to reduce the carbon dioxide emissions by at least 35% over Building Regulations AD L1A 2010, 2013 edition, and
- Both endeavour to offset the predicted carbon emissions by 20% through the use of renewable Energy Technologies.

#### Flat

As seen from the results, the worst case flat exceeds the required LBRuT targets by achieving a 48% reduction in CO<sub>2</sub> emissions, with a 27% reduction provided by photovoltaic panels (PVs). PV panels seem the most appropriate for the two flats because they can be positioned on the rear of the roof, ensuring that they do not impact the street scene along Station Road. They also require little maintenance, which is suitable for a flat of its nature.

#### House

We have shown on the submitted planning drawings and roof plan (see pg. 13) PV panels in accordance with the proposed 'House Case 1', which complies with the LBRuT requirement to reduce  $CO_2$  emissions by at least 35%.

However, we recommend that the 'House Case 2' would be more suitable (without PV's on the front 'West' elevation) from a visual impact point of view, especially considering that the site is within a Conservation Area.

Other renewable technologies have been explored to improve 'House Case 2' without the additional PVs to the front elevation, although have been dismissed for the following reasons:

- Ground source heat pumps: Insufficient individual land footprint to be accommodated.

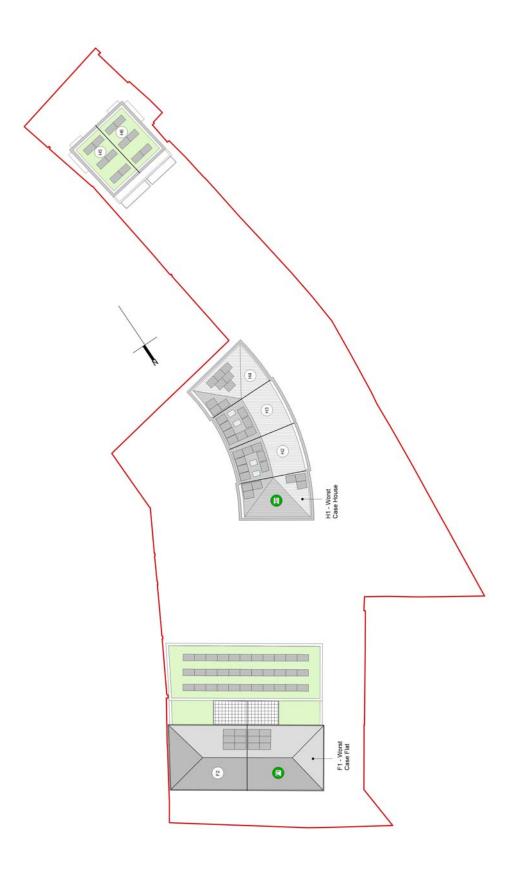
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- Air source heat pumps: We have used these systems on other projects and have found them to be unneighbourly in terms of noise impact. This would be unacceptable for both the proposed terraced housing and existing neighbouring properties.
- Solar thermal: Orientation is not suitable to receive substantial hot water heating gains.

The recommended 'House Case 2' achieves a 21.46% CO<sub>2</sub> emission reduction over BRegs Part L 2013. Although this falls below LBRuT's required target of 35% reduction, it must be noted that this dwelling is the worst case scenario. The other houses are likely to meet or surpass LBRuT's target requirements based on their improved orientation/positioning. In addition, the roof size and orientation of the other houses can accommodate more PVs (see attached roof plan pg.13), without compromising the front elevations. Further improvements above the LBRuT target CO<sub>2</sub> reductions to these other five dwellings and two flats could be seen to offset the single unit (House Case 2) that is predicted to be below target level.

If the PV location of the proposed 'House Case 1' is seen to be contentious, we would be willing to discuss these matters with the LBRuT Urban design team, and for the recommended 'House Case 2' to be considered as an alternative.

Proposed roof layout:



#### 4.4 Cost of options

A review of the most current information relating to the suitable option has been carried out to establish the likely costs of the complete system, and the sizing implications.

The cost for PV Panels has been based on quotations given by MCS installers and comparable developments.

The financial viability will need to be assessed against the financial incentives available and the overall development proposal.

# Proposed Flat Case – Gas Combi-Boiler with 1.92 kWp 320Wp Photovoltaic Panels

1.92kWp (6 x 320Wp) Sunpower PV, which equals approx. 9.8m<sup>2</sup> of PV panels: £5,000. Gas Combi-boiler, supply & installation: £2,500.

Total estimated cost for Boiler & PVs: £7,500.

#### House Case 1 – Gas Boiler, MVHR, and 1.92 kWp 320Wp Photovoltaic Panels

1.92kWp (6 x 320Wp) Sunpower PV, which equals approx. 9.8m<sup>2</sup> of PV panels:  $\pounds$ 5,000. Gas boiler, supply & installation:  $\pounds$  TBC MVHR system & installation:  $\pounds$  TBC

Total estimated cost for Boiler, MVHR, and PV's: £ TBC

#### Grants available

For financial incentives for heat and electricity generating renewables, such as the Feed-In-Tariff (FIT) and the Domestic Renewable Heat Incentive (RHI) please refer to Appendix D.

PV's are eligible for the Feed-In-Tariff (FIT) when an overall SAP D Rating has been achieved. Therefore, for each kWh of electricity generated, a guaranteed tariff will be paid over 20 years (see appendix D).

#### 4.5 Calculations

#### FLAT

	Total kgCO2/y	r	
Unit	Base Case	Improved	Proposed Case
		Case	
Space Heating	1577	694	666
Secondary Heating	N/A	N/A	N/A
Hot Water Heating	587	521	521
Fixed Electrical	39	39	39
Lighting	282	188	188
Cooking	180	180	180
Appliances	1339	1339	1339
TOTAL	4004	2961	2933
% reduction overall <sup>1</sup>	n/a	26.05%	26.75%
Less amount of	n/a	136	820
renewables			
% reduction through	n/a	4.59%	27.97%
renewables <sup>2</sup>			
DER/TER variance	61.84%	-4.12%	-48.67%

#### HOUSE – END TERRACE

	Total kgCO2	2/yr		
Unit	Base Case	Improved Case	Case 1	Case 2
Space Heating	2141	1095	647	647
Secondary Heating	508	N/A	N/A	N/A
Hot Water Heating	649	589	596	596
Fixed Electrical	39	39	190	190
Lighting	470	274	274	274
Cooking	189	189	189	189
Appliances	1805	1805	1805	1805
TOTAL	5800	3990	3700	3700
% reduction overall <sup>1</sup>	n/a	31.2%	36.2%	36.2%
Less amount of renewables	n/a	314	716	410
% reduction through renewables <sup>2</sup>	n/a	7.8%	19.3%	11.0%
DER/TER variance	94.08%	-1.14%	-36.49%	-21.46%

<sup>1</sup> This is the total % reduction in kgCO2/year displaced by incorporation of energy efficiency measures.

 $^2$  This is the total % reduction in kgCO2/year by the incorporation of renewable energy – after the incorporation of energy efficiency measures.

## 5.0 Appendices

Appendix A - LBRuT Sustainable Construction Checklist

#### LBRUT Sustainable Construction Checklist - Draft for Consultation, September 2015

This document forms part of the Sustainable Construction Checklist SPD. This document**must** be filled out as part of the planning application for the following developments: all residential development providing **one or more new residential units (including conversions leading to one or more new units)**, and all other forms of development providing **100sqm or more of non-residential floor space**. Developments including new non-residential development of less than 100sqm floor space, extensions less than 100sqm, and other conversions are strongly encouraged to comply with this checklist. Where further information is requested, please either fill in the relevant section, or refer to the document where this information may be found in detail, e.g. Flood Risk Assessment or similar. **Further guidance** on completing the Checklist may be found in the Justification and Guidance section of this SPD. SPD.

Property Name (if relevant):	45-49 Station Road		Application No.	(if known):		
Address (include. postcode) Completed by:	45-49 Station Road, Hampton, TW12 2BU Metropolis Green Ltd Clive Chapman Architects					
For Non-Residential Size of development (m2)	372		For Residential Number of dwellings	8		
1 MINIMUM COMPLIA	NCE (RESIDENTIAL AND NON-RESIDENTIAL	.)				
	sment been submitted that demonstrates the ex asures, including the feasibility of CHP/CCHP a			efficiency and	Yes	
	eduction oxide emissions reduction against a Building Re .ondon Plan Policy 5.2 (2015) require a 35% red		ding Regulations 2013.		35%	
Ŭ	te CO2 emissions saved through renewable en OMPLIANCE (NON-RESIDENTIAL AND DOM				20.35%	
		ance Section of this SPD for the po	licv requirements			
Environmental Rating of dev		· · · · · · · · · · · · · · · · · · ·	7			
Non-Residential new-build (10 BREEAM Level Extensions and conversions for	Exc	ellent	Have you attached a pre-as	sessment to support this?	V	
BREEAM Domestic R	efurbishment Please	e Select	Have you attached a pre-as	sessment to support this?		
Extensions and conversions fo BREEAM Level		e Select	Have you attached a pre-as	sessment to support this?		
Score awarded for En BREEAM:	vironmental Rating: Good = 0, Very Good = 4, Excellent = 8, Outs	standing = 16			Subtotal	8
1B MINIMUM POLICY C	OMPLIANCE (RESIDENTIAL)					

Water Usage Internal water usage limited to 105 litres person per day. (Excluding an allowance 5 litres per person per day for external water consumption). Calculations using the water efficiency calculator for new dwellings have been submitted.

**√** 1 Subtotal 1

<ul> <li>a. How does the development incorporate cooling measures? Tick all that appy:</li> <li>Energy efficient design incorporating specific heat deniand to less than or equal to 15 kWh/sgm</li> <li>Beduce heat entering a building through providing/improving insulation and living roofs and walls</li> <li>Prastive entail ation</li> <li>Prastiv</li></ul>	2.1 Ne	eed for Cooling	Score
Energy efficient design incorporating specific heat demand to less than or equal to 15 WM/sqm  Reduce heat entering a building through providing/improving insulation and living roots and walls  Reduce heat entering a building through providing/improving insulation and living roots and walls  Reduce heat entering a building through providing/improving insulation and living roots and walls  Reduce heat entering a building through shading  Reduce heat entering a building thro	a.	How does the development incorporate cooling measures? Tick all that apply:	
Reduce heat entering a building through providing/improving insulation and living roofs and walls     Reduce heat entering a building through shading     Exposed thermal mass and high ceilings     Passive venillation     Mechanical venillation with heat recovery     Active cooling systems, i.e. Air Conditioning Unit  2.2 Heat Generation b. How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan poliop5.6)? Tick all heating and     cooling systems that will be used in the development:     Connection to existing heating or cooling networks powered by renewable energy     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Site wide CHP network powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling onewared by gas or electricity     Individual heating and cooling onewared by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and cooling powered by gas or electricity     Individual heating and powered by gas or electricity     In			D 6
Reduce heat entering a building through shading       3         Exposed thermal mass and high ceilings       3         Passive ventilation       3         Mechanical ventilation with heat recovery       3         Active cooling systems, i.e. Air Conditioning Unit       0         22.1 Heat Generation       0         b.       How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy5.6)? Tick all heating and cooling systems that will be used in the development:       6         Connection to existing heating or cooling networks powered by renewable energy       6         Connection to existing heating or cooling networks powered by gas or electricity       5         Site wide CHP network powered by gas or electricity       3         Communal heating and cooling powered by gas or electricity       3         Individual heating and cooling powered by gas or electricity       3         individual heating and cooling powered by gas or electricity       7         Individual heating and cooling powered by gas or electricity       7         Individual heating and cooling powered by gas or electricity       3         Individual heating and cooling powered by gas or electricity       1         Individual heating and cooling powered by gas or electricity       2         Individual heating and cooling owered by gas or electric			12
Exposed thermal mass and high ceilings       4         Passive venillation       3         Mechanical venillation with heat recovery       3         Active cooling systems, i.e. Air Conditioning Unit       0         22 Heat Generation       0         b:       How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy5.6)? Tick all heating and cooling systems, i.e. Air Conditioning Unit         b:       How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy5.6)? Tick all heating and cooling networks powered by gas or electricity         Connection to existing heating or cooling networks powered by gas or electricity       6         Site wide CHP network powered by gas or electricity       2         Communal heating and cooling powered by gas or electricity       2         communal heating and cooling powered by gas or electricity       2         information. If the proposed boiler is of a qualifying size, you may need to completed the information request form found on the Richmond website.       2         c.       Please tick only one option below       3         d.       Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site?       3         e.       Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site?			
Passive ventilation with heat recovery Active cooling systems, i.e. Air Conditioning Unit 2.2 Heat Generation b. How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy5.6)? Tick all heating and cooling systems that will be used in the development: Connection to existing heating or cooling networks powered by renewable energy Site wide CHP network powered by gas or electricity Site wide CHP network powered by gas or electricity Individual heating and cooling nowered by gas or electricity Individual heating and cooling nowered by gas or electricity Information. If the proposed boiler is of a qualifying size, you may need to completed the information request form found on the Richmond website. c. Please tick only one option below Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site? Has the development taken care to not create any new noise generation/transmission issues in its intended operation? d. Has the development taken care to not create any new noise generation/transmission issues in its intended operation? e. Have you attached a Lighting Pollution Report? Please give any additional relevant comments to the Energy Use and Polluton Secton below Ausuboner care parking with be incorporated in the si			
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<ul> <li>Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity?</li> <li>Have you attached a Lighting Pollution Report?</li> <li>- Please give any additional relevant comments to the Energy Use and Pollution Section below</li> <li>A customer car parking will be incorporated into the site, which will minimise on-street car parking within the local area, and 10 cycle storage space will be provided for the employees/use</li> </ul>			
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A customer car parking will be incorporated into the site, which will minimise on-street car parking within the local area, and 10 cycle storage space will be provided for the employees/use			Subtotal 1
Light Pollution: A more domestic approach to lighting rather than industrial.			ployees/users of th
voise Pollution: Reduction in the size and scope of the existing workshops should positively improve noise pollution to the area.			

3. TRANSPORT
 3.1 Provision for the safe efficient and sustainable movement of people and goods
 a. Does your development provide opportunities for occupants to use innovative travel technologies?

Please explain:

	Does your development include charging point(s) for electric cars?	2
	For major developments ONLY: Has a Transport Assessment been produced for your development based on TfL's Best Practice Guidance? If you have provided a Transport Assessment as part of your planning application, please tick here and move to Section 3 of this Checklist.	5
	For smaller developments ONLY: Have you provided a Transport Statement?	✓ 5
	Does your development provide cycle storage? (Standard space requirements are set out in the the Council's Parking Standards - DM DPD Appendix 4) If so, for how many bicycles? Is this shown on the site plans?	₹ 2 ₹
	Will the development create or improve links with local and wider transport networks? If yes, please provide details.	
		Subtotal
Plea	se give any additional relevant comments to the Transport Section below	
n c	ustomer car parking will be incorporated into the site, which will minimise on-street car parking within the local area, and 10 cycle storage space will be provided for the en the residential units, 2 secure cycle spaces are allocated to each of the 3-bed houses, and 1 secure cycle space is allocated to each of the 2-bed flats. Total of 14 assigne	

4	BIODIVERSITY		
	Minimising the threat to b	iodiversity from new buildings, lighting, hard surfacing and people nt involve the loss of an ecological feature or habitat, including a loss of garden or other green space? (Indicate if yes) If so, please state how much in sqm?	□-2 sqm
b.	Does your developme	nt involve the removal of any tree(s)? (Indicate if yes) If so, has a tree report been provided in support of your application? (Indicate if yes)	
с.	Does your developme	nt plan to add (and not remove) any tree(s) on site? (Indicate if yes)	-12
d.		features and/or habitats that your development will incorporate to improve on site biodiversity:       Pond, reedbed or extensive native planting       6       Area provided:         An extensive green roof       5       Area provided:       Area provided:         An intensive green roof       4       Area provided:       Area provided:         Garden space       4       Area provided:       Area provided:         Additional native and/or wildlife friendly planting to peripheral areas       3       Area provided:         Additional planting to peripheral areas       2       Area provided:         Alditional planting to peripheral areas       2       Area provided:         Bit boxes       0.5       4       4         Other       0.5       4       4	sqm sqm sqm sqm sqm sqm sqm sqm sqm
Plea	ase give any additional rele	vant comments to the Biodiversity Section below	
5	FLOODING AND DRA		
a.		ig and other impacts of climate change in the borough high flood risk zone (Zone 3)? (Indicate if yes) Have you submitted a Flood Risk Assessment? (Indicate if yes)	□-2 □ -
b.	Which of the following	measures of the drainage hierarchy are incorporated onto your site? (tick all that apply) Store rainwater for later use Use of infiltration techniques such as porous surfacing materials to allow drainage on-site Attenuate rainwater in ponds or open water features Store rainwater in tanks for gradual release to a watercourse Discharge rainwater directly to watercourse Discharge rainwater to surface water drain Discharge rainwater to combined sewer	□ 5 ☑ 3 □ 4 □ 3 □ 2 □ 1 ☑ 0
C.		e in area of permeable surfacing which will result from your development proposal: of the permeable surfacing below please represent a loss in permeable area as	1790 sqm s a negative number Subtotal 3
Site	is within Flood Zone 1	vant comments to the Flooding and Drainage Section below ther information regarding permeable materials	
6	IMPROVING RESOU	RCE EFFICIENCY	
<b>6.1</b> I a.		and amount disposed of by landfill though increasing level of re-use and recycling uired on your site prior to construction? [Points will only be awarded if 10% or greater of demolition waste is reused/recycled	V 1
		If so, what percentage of demolition waste will be reused in the new development?	%
		What percentage of demolition waste will be recycled?	10%
b.	Does your site have a	ny contaminated land? Have you submitted an assessment of the site contamination? Are plans in place to remediate the contamination? Have you submitted a remediation plan? Are plans in place to include composting on site?	☑ 1 ☑ 2 □ 2 □ 1 □ 1
<b>6.2</b>   a.	Reducing levels of water Will the following mea:	waste sures of water conservation be incorporated into the development? (Please tick all that apply): Fitting of water efficient taps, shower heads etc Use of water efficient A or B rated appliances Rainwater harvesting for internal use Greywater systems Fit a water meter	<ul> <li>✓ 1</li> <li>✓ 1</li> <li>✓ 4</li> <li>✓ 4</li> <li>✓ 1</li> </ul>
Ples	ase give any additional relev	vant comments to the Improving Resource Efficiency Section below	Subtotal 7
	usive site contamination rep		

	ACCESSIBILITY			
7.1		table and long	term use of structures	
a.		residential, wi	it meet the requirements of the nationally described space standard for internal space and I	
		If the standard	s are not met, in the space below, please provide details of the functionality of the internal sp	pace and layout
AND				
b.	If the development is	residential wi	it meet Building Regulation Reguirement M4 (2) 'accessible and adaptable dwellings'?	<b>I</b> 2
υ.	in the development is		et, in the space below, please provide details of any accessibility measures included in the d	
			-,	
			dential developments, are 10% or more of the units in the development to Building Regulatio	n Requirement
OR		M4 (3) Wheel	hair user dwellings'?	
C.	If the development is	non-residenti	I, does it comply with requirements included in Richmond's Design for Maximum Access SP	G 🛛 🖸 2
0.	in the development is		e details of the accessibility measures specified in the Maximum Access SPG that will be incl	
		development		
			See Design and Access State	ement for further information
Diagon		unt commonte	a the Design Clandards and Assassibility Castion below	Subtotal 5
			o the Design Standards and Accessibility Section below	Subtotal 5
	give any additional relev sign and Access Statem			Subtotal 5
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				Subtotal 5
See De	sign and Access Statem	nent for further i	formation	
See De	sign and Access Statem	nent for further i		
See De	sign and Access Statem	nent for further i n Checklist- Sc	nformation formation (Non-Residential and domestic re	
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See De	stainable Construction Score 80 or more 71-79 51-70 36-50 35 or less	n Checklist- Sc Rating A+ B C FAIL	formation (Non-Residential and domestic re Significance Project strives to achieve highest standard in energy efficient sustainable development Makes a major contribution towards achieving sustainable development in Richmond Helps to significantly improve the Borough's stock of sustainable developments Minimal effort to increase sustainability beyond general compliance Does not comply with SPD Policy	
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See De	stainable Construction Score 80 or more 71-79 51-70 36-50 35 or less stainable Construction Score 81 or more	n Checklist- Sc Rating A+ C FAIL n Checklist- Sc Rating A++	formation          (Non-Residential and domestic re         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Makes a major contribution towards achieving sustainable development in Richmond         Helps to significantly improve the Borough's stock of sustainable developments         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         pring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable development	
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See De	stainable Construction Score 80 or more 71-79 51-70 36-50 35 or less stainable Construction Score 81 or more 64-80 55-63 35-54	n Checklist- Sc Rating A+ B C FAIL n Checklist- Sc Rating A++ A++ A+ A B	formation          (Non-Residential and domestic re         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         oring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable developments         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         oring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Makes a major contribution towards achieving sustainable development in Richmond         Helps to significantly improve the Borough's stock of sustainable developments	
See De	stainable Construction Score 80 or more 71-79 51-70 36-50 35 or less stainable Construction Score 81 or more 64-80 55-63 35-54 20-34	n Checklist- Sc Rating A+ B C FAIL n Checklist- Sc Rating A++ A+ A+ A B C C Rating A++ A+ A B C C C C C C C C C C C C C C C C C C	formation          (Non-Residential and domestic re          Significance         Project strives to achieve highest standard in energy efficient sustainable development         Makes a major contribution towards achieving sustainable development in Richmond         Helps to significantly improve the Borough's stock of sustainable developments         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         oring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Project strives to achieve highest standard in energy efficient sustainable development         Makes a major contribution towards achieving sustainable development in Richmond         Helps to significantly improve the Borough's stock of sustainable developments         Minimal effort to increase sustainability beyond general compliance	
See De	stainable Construction Score 80 or more 71-79 51-70 36-50 35 or less stainable Construction Score 81 or more 64-80 55-63 35-54	n Checklist- Sc Rating A+ B C FAIL n Checklist- Sc Rating A++ A++ A+ A B	formation          (Non-Residential and domestic re         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         oring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable developments         Minimal effort to increase sustainability beyond general compliance         Does not comply with SPD Policy         oring Matrix for New Construction         Residential new-build         Significance         Project strives to achieve highest standard in energy efficient sustainable development         Makes a major contribution towards achieving sustainable development in Richmond         Helps to significantly improve the Borough's stock of sustainable developments	

Signature

Date 27.10.2015

#### Appendix B – Proposed Flat Case

#### SAP worksheet Flat 1

# Sap Worksheet Design - Draft



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

Assessor name	Mrs Lizzie	e Stokes					As	sessor num	ber	1031		
Client								st modified		22/10	/2015	
	45.40.0		l la ucir 4	T\4/4 0 000			La			-2,10	_015	
Address	45-49 Sta	tion Road,	Hampton,	IW12 2B	U							
1. Overall dwelling dimer	sions											
					Area (m²)			age storey ight (m)		Vo	lume (m³)	
Lowest occupied					6.40	(1a) x		2.76	(2a) =	<b></b>	17.66	(3a)
+1					77.16	](10) x		2.75	(2b) =		212.19	] (3b)
Total floor area	(1a)	+ (1b) + (1c	)+(1d) (	1n) =	83.56	] (10) ×	L	2.75	] (20) -		212.15	] (36)
Dwelling volume	(10)	. (10) . (10	, , (10)(	in, -	03.50		(3a)	+ (3b) + (3	c) + (3d)(3n	) =	229.85	(5)
							(34)	. (55) . (5	c) · (3u)(3u	/	223.03	] (3)
2. Ventilation rate												
										m³	per hour	
Number of chimneys								0	] x 40 =		0	(6a)
Number of open flues								0	] x 20 =		0	(6b)
Number of intermittent far	าร							3	) x 10 =		30	(7a)
Number of passive vents								0	] x 10 =		0	(7b)
Number of flueless gas fire	s							0	) x 40 =		0	(7c)
										Air c	hanges pei hour	·
											noui	
Infiltration due to chimney	s, flues, fans	, PSVs		(6a	) + (6b) + (7	a) + (7b) + (7	7c) =	30	÷ (5) =		0.13	(8)
Infiltration due to chimney If a pressurisation test has			ntended, pl						] ÷ (5) =			(8)
	been carried	l out or is in	· ·	roceed to	(17), otherw	ise continue/	e from (9) t		] ÷ (5) =			] (8) ] (17)
If a pressurisation test has	<i>been carried</i> , expressed	<i>l out or is in</i> in cubic me	tres per h	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t		] ÷ (5) =		0.13	
<i>If a pressurisation test has</i> Air permeability value, q50	been carried , expressed y value, then	<i>l out or is in</i> in cubic me i (18) = [(17	tres per h ) ÷ 20] + (8	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t		] ÷ (5) =		0.13	] (17)
If a pressurisation test has Air permeability value, q50 If based on air permeability	been carried , expressed y value, then	<i>l out or is in</i> in cubic me i (18) = [(17	tres per h ) ÷ 20] + (8	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t	o (16)	] ÷ (5) = [0.075 × (19)]	] =	0.13 4.50 0.36	] (17) ] (18)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which	been carried , expressed y value, then the dwelling	l out or is in in cubic me (18) = [(17 is sheltered	tres per h ) ÷ 20] + (8	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t	o (16)			0.13 4.50 0.36 2	] (17) ] (18) ] (19)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor	been carried ), expressed y value, then the dwelling ng shelter fa	l out or is in in cubic me (18) = [(17 is sheltered	tres per h ) ÷ 20] + ({	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t	o (16)	[0.075 x (19)		0.13 4.50 0.36 2 0.85	] (17) ] (18) ] (19) ] (20)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati	been carried ), expressed y value, then the dwelling ng shelter fa	l out or is in in cubic me (18) = [(17 is sheltered	tres per h ) ÷ 20] + ({	<i>roceed to</i> our per so	(17), otherw Juare metre	<i>vise continue</i> of envelope	e from (9) t	o (16)	[0.075 x (19)		0.13 4.50 0.36 2 0.85	] (17) ] (18) ] (19) ] (20)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for	been carried , expressed y value, then the dwelling ng shelter fa or monthly w Feb	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar	tres per h ) ÷ 20] + (8 d	roceed to our per sq 3), otherw	(17), otherw Juare metre ise (18) = (1	vise continue of envelope 6)	e from (9) t	o (16) 1 -	[0.075 x (19) (18) x (20	) =	0.13 4.50 0.36 2 0.85 0.30	] (17) ] (18) ] (19) ] (20)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan	been carried , expressed y value, then the dwelling ng shelter fa or monthly w Feb	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar	tres per h ) ÷ 20] + (8 d	roceed to our per sq 3), otherw	(17), otherw Juare metre ise (18) = (1	vise continue of envelope 6)	e from (9) t	o (16) 1 -	[0.075 x (19) (18) x (20	) =	0.13 4.50 0.36 2 0.85 0.30	] (17) ] (18) ] (19) ] (20)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan	been carried , expressed y value, then the dwelling ing shelter fa or monthly w <b>Feb</b> ed from Tabl	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar le U2	tres per h ) ÷ 20] + ({ d <b>Apr</b>	roceed to our per sq 3), otherw May	(17), otherw Juare metre ise (18) = (1 Jun	vise continue of envelope 6) Jul	e from (9) to area Aug	o (16) 1 - Sep	[0.075 x (19) (18) x (20 <b>Oct</b>	) = Nov	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b>	] (17) ] (18) ] (19) ] (20) ] (21)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan Monthly average wind spec 5.10	been carried , expressed y value, then the dwelling ing shelter fa or monthly w <b>Feb</b> ed from Tabl	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar le U2	tres per h ) ÷ 20] + ({ d <b>Apr</b>	roceed to our per sq 3), otherw May	(17), otherw Juare metre ise (18) = (1 Jun	vise continue of envelope 6) Jul	e from (9) to area Aug	o (16) 1 - Sep	[0.075 x (19) (18) x (20 <b>Oct</b>	) = Nov	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b>	] (17) ] (18) ] (19) ] (20) ] (21)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan Monthly average wind spec 5.10 Wind factor (22)m ÷ 4	been carried , expressed y value, then the dwelling ng shelter fa or monthly w Feb ed from Tabl 5.00	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar le U2 4.90 1.23	tres per h ) ÷ 20] + (8 d <b>Apr</b> <u>4.40</u> <u>1.10</u>	May 4.30 1.08	(17), otherw uare metre ise (18) = (1 Jun 3.80	vise continue of envelope 6) Jul 3.80	Aug 3.70	o (16) 1 - Sep 4.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70	] (17) ] (18) ] (19) ] (20) ] (21) ] (22)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan Monthly average wind spec 5.10 Wind factor (22)m ÷ 4 1.28	been carried , expressed y value, then the dwelling ng shelter fa or monthly w Feb ed from Tabl 5.00	l out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar le U2 4.90 1.23	tres per h ) ÷ 20] + (8 d <b>Apr</b> <u>4.40</u> <u>1.10</u>	May 4.30 1.08	(17), otherw uare metre ise (18) = (1 Jun 3.80	vise continue of envelope 6) Jul 3.80	Aug 3.70	o (16) 1 - Sep 4.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70	] (17) ] (18) ] (19) ] (20) ] (21) ] (22)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan Monthly average wind spen 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a	been carried , expressed y value, then the dwelling ng shelter fa or monthly w Feb ed from Table 5.00 1.25 allowing for s 0.38	in cubic me in cubic me i (18) = [(17 is sheltered actor vind speed: Mar le U2 4.90 1.23 shelter and 0.37	tres per h ) ÷ 20] + (8 d Apr 4.40 1.10 wind facto 0.33	roceed to         our per sq         3), otherw         May         4.30         1.08         or) (21) x (	(17), otherw uare metre ise (18) = (1 Jun 3.80 0.95 22a)m	vise continue of envelope 6) Jul 3.80	Aug 3.70	o (16) 1 - Sep 4.00 1.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50 1.13	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70	] (17) ] (18) ] (19) ] (20) ] (21) ] (22) ] (22a)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporati Infiltration rate modified for Jan Monthly average wind spec 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.39	been carried , expressed if y value, then the dwelling ing shelter fa or monthly w Feb ed from Tabl 5.00 1.25 allowing for s 0.38 ige rate for t	in cubic me in cubic me in (18) = [(17 is sheltered actor vind speed: Mar le U2 4.90 1.23 shelter and 0.37 he applicab	tres per h ) ÷ 20] + (8 d Apr 4.40 1.10 wind facto 0.33 ble case:	roceed to         our per sq         3), otherw         May         4.30         1.08         or) (21) x (         0.32	(17), otherw uare metre ise (18) = (1 Jun 3.80 0.95 22a)m	vise continue of envelope 6) Jul 3.80	Aug 3.70	o (16) 1 - Sep 4.00 1.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50 1.13	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70	] (17) ] (18) ] (19) ] (20) ] (21) ] (22) ] (22a)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporation Infiltration rate modified for Jan Monthly average wind spectrum 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.39 Calculate effective air chan	been carried , expressed y value, then the dwelling ing shelter fa or monthly w Feb ed from Table 5.00 1.25 allowing for s 0.38 ge rate for t n: air change	d out or is in in cubic me (18) = [(17 is sheltered actor vind speed: Mar le U2 4.90 1.23 shelter and 0.37 he applicab e rate throu	tres per h ) ÷ 20] + (§ d Apr 4.40 1.10 wind facto 0.33 ble case: gh system	roceed to         our per sq         3), otherw         May         4.30         1.08         or) (21) x (         0.32	(17), otherw juare metre ise (18) = (1 Jun 3.80 0.95 22a)m 0.29	vise continue of envelope 6) Jul 3.80 0.95 0.29	Aug 3.70	o (16) 1 - Sep 4.00 1.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50 1.13	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70 4.70	] (17) ] (18) ] (19) ] (20) ] (21) ] (22) ] (22a) ] (22b)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporation Infiltration rate modified for Jan Monthly average wind spect 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.39 Calculate effective air chant If mechanical ventilation	been carried , expressed if y value, then the dwelling ing shelter fa or monthly w Feb ed from Table 5.00 1.25 allowing for s 0.38 ige rate for t n: air change ecovery: effic	in cubic me in cubic me in cubic me is sheltered actor vind speed: Mar le U2 4.90 1.23 shelter and 0.37 he applicab e rate throu	tres per h ) $\div$ 20] + (8 d Apr 4.40 1.10 wind facto 0.33 ble case: gh system allowing for	roceed to         our per sq         3), otherw         May         4.30         1.08         or) (21) x (         0.32         or in-use from the set of the	(17), otherw uare metre ise (18) = (1 Jun 3.80 0.95 22a)m 0.29 actor from T	vise continue of envelope 6) Jul 3.80 0.95 0.29	Aug 3.70	o (16) 1 - Sep 4.00 1.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50 1.13	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70 4.70 1.18 0.36	] (17) ] (18) ] (19) ] (20) ] (21) ] (22) ] (22a) ] (22a) ] (22b) ] (23a)
If a pressurisation test has Air permeability value, q50 If based on air permeability Number of sides on which Shelter factor Infiltration rate incorporation Infiltration rate modified for Jan Monthly average wind spect 5.10 Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.39 Calculate effective air chan If mechanical ventilatio If balanced with heat rest	been carried , expressed if y value, then the dwelling ing shelter fa or monthly w Feb ed from Table 5.00 1.25 allowing for s 0.38 ige rate for t n: air change ecovery: effic	in cubic me in cubic me in cubic me is sheltered actor vind speed: Mar le U2 4.90 1.23 shelter and 0.37 he applicab e rate throu	tres per h ) $\div$ 20] + (8 d Apr 4.40 1.10 wind facto 0.33 ble case: gh system allowing for	roceed to         our per sq         3), otherw         May         4.30         1.08         or) (21) x (         0.32         or in-use from the set of the	(17), otherw uare metre ise (18) = (1 Jun 3.80 0.95 22a)m 0.29 actor from T	vise continue of envelope 6) Jul 3.80 0.95 0.29	Aug 3.70	o (16) 1 - Sep 4.00 1.00	[0.075 x (19) (18) x (20 <b>Oct</b> 4.30	) = Nov 4.50 1.13	0.13 4.50 0.36 2 0.85 0.30 <b>Dec</b> 4.70 4.70 1.18 0.36	] (17) ] (18) ] (19) ] (20) ] (21) ] (22) ] (22a) ] (22a) ] (22b) ] (23a)



	0.57 0.56	0.55	0.54 0.5	0.54	0.55	0.55 0.56	0.56	(2
3. Heat losses and heat loss parameter								
Element	Gross area, m²	Openings m <sup>2</sup>	Net area A, m²	U-value W/m <sup>2</sup> K	A x U W/I	К к-value, kJ/m².К	Ахк, kJ/K	
Door			2.30	x 1.00	= 2.30	]		(20
Window			13.10	x 1.05	= 13.80			(2
Ground floor			6.40	x 0.11	= 0.70			(28
Exposed floor			68.77	x 0.07	= 4.81			(28
Party wall			29.77	x 0.00	= 0.00			(32
External wall			71.94	x 0.15	= 10.79			(29
Roof			76.73	x 0.12	= 9.21			(30
Fotal area of external elements ∑A, m <sup>2</sup>			239.24					(3:
Fabric heat loss, W/K = ∑(A × U)					(26)	(30) + (32) =	41.62	(33
Heat capacity Cm = ∑(A x κ)				(28).	(30) + (32) +	(32a)(32e) =	N/A	(34
۲hermal mass parameter (TMP) in kJ/m²۱	К						250.00	(3
Thermal bridges: $\Sigma(L \times \Psi)$ calculated using	g Appendix K						12.12	<b>(3</b>
Fotal fabric heat loss						(33) + (36) =	53.74	(3
Jan Feb	Mar Apr	May	Jun Ju	il Aug	Sep	Oct Nov	Dec	
/entilation heat loss calculated monthly	0.33 x (25)m x (5)					1	-	-
43.56 43.34	43.12 42.12	41.93	41.05 41.	05 40.89	41.39	41.93 42.31	42.71	(38
Heat transfer coefficient, W/K (37)m + (3						i		-
97.30 97.08	96.86 95.86	95.67	94.79 94.	79 94.63	95.13	95.67 96.05	96.45	
Heat loss parameter (HLP), W/m²K (39)m	n ÷ (4)					39)112/12 =	95.86	_ (39
1.16 1.16	1.16 1.15	1.14	1.13 1.1	1.13	1.14	1.14 1.15	1.15	
					Average = ∑(4	40)112/12 =	1.15	(40
Number of days in month (Table 1a)								_
31.00 28.00	31.00 30.00	31.00	30.00 31.	00 31.00	30.00	31.00 30.00	31.00	
4. Water heating energy requirement								(40
Assumed occupancy, N								(40
							2.53	) (4) ) (4)
	per day Vd,average	= (25 x N) + 3	36					_
	per day Vd,average Mar Apr	= (25 x N) + 3 <b>May</b>	36 Jun Ju	ıl Aug	Sep	Oct Nov	2.53	] (4:
nnual average hot water usage in litres Jan Feb	Mar Apr	May	Jun Ju	l Aug	Sep	Oct Nov	2.53 94.21	] (4:
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each	Mar Apr	May	Jun Ju		Sep 92.33	Oct Nov 96.10 99.87	2.53 94.21	] (4:
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each	Mar Apr n month Vd,m = fact	May or from Tabl	Jun Ju le 1c x (43)			96.10 99.87	2.53 94.21 Dec	] (4:
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87	Mar         Apr           n month Vd,m = fact         96.10         92.33	May or from Tabl	Jun Ju le 1c x (43) 84.79 84.	79 88.56		96.10 99.87	2.53 94.21 Dec 103.64	] (4: ] (4: ]
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18	Mar         Apr           n month Vd,m = fact         96.10         92.33	May for from Tabl 88.56 8600 kWh/mo	Jun Ju le 1c x (43) 84.79 84.	79 88.56 s 1b, 1c 1d)	92.33	96.10 99.87	2.53 94.21 <b>Dec</b> 103.64 1130.58	] (4: ] (4: ]
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87	Mar         Apr           n month Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3	May for from Tabl 88.56	Jun         Ju           le 1c x (43)         84.79           84.79         84.           onth (see Tables)	79 88.56 s 1b, 1c 1d)	92.33	96.10     99.87       Σ(44)112 =	2.53 94.21 <b>Dec</b> 103.64 1130.58	] (4: ] (4: ]
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42	Mar         Apr           n month Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3	May for from Tabl 88.56	Jun         Ju           le 1c x (43)         84.79           84.79         84.           onth (see Tables)	79 88.56 s 1b, 1c 1d)	92.33	96.10     99.87       Σ(44)112 =	2.53 94.21 <b>Dec</b> 103.64 1130.58	] (4) ] (4) ] (44
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42 Distribution loss 0.15 x (45)m	Mar         Apr           n month Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3	May for from Tabl 88.56	Jun         Ju           le 1c x (43)         84.79           84.79         84.           onth (see Tables)	79 88.56 s 1b, 1c 1d) 78 106.47	92.33	96.10     99.87       Σ(44)112 =	2.53 94.21 <b>Dec</b> 103.64 1130.58	] (4) ] (4) ] (44
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42 Distribution loss 0.15 x (45)m 23.05 20.16	Mar         Apr           n month         Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14	May or from Tabl 88.56 8600 kWh/mo 116.03	Jun         Ju           le 1c x (43)         84.79         84.           84.79         84.         98.           onth (see Tables         100.13         92.	79 88.56 s 1b, 1c 1d) 78 106.47	92.33	96.10       99.87 $\Sigma$ (44)112 =	2.53 94.21 <b>Dec</b> 103.64 1130.58 148.84 1482.37	) (4) (4) (4) (4) (4)
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42 Distribution loss 0.15 x (45)m 23.05 20.16	Mar         Apr           n month         Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14	May or from Tabl 88.56 8600 kWh/mo 116.03	Jun         Ju           le 1c x (43)         84.79         84.           84.79         84.         98.           onth (see Tables         100.13         92.	79     88.56       s 1b, 1c 1d)       78     106.47       92     15.97	92.33	96.10       99.87 $\Sigma$ (44)112 =	2.53 94.21 <b>Dec</b> 103.64 1130.58 148.84 1482.37	) (4) (4) (4) (4) (4)
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42 Distribution loss 0.15 x (45)m 23.05 20.16 Water storage loss calculated for each me 0.00 0.00	Mar         Apr           n month         Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14           nonth         (55) x (41)m           0.00         0.00	May cor from Tabl 88.56 3600 kWh/mo 116.03 17.41 0.00	Jun         Ju           le 1c x (43)         84.79         84.3           onth (see Tables         100.13         92.3           15.02         13.3           0.00         0.00	79     88.56       s 1b, 1c 1d)       78     106.47       92     15.97       00     0.00	92.33	96.10       99.87 $\Sigma$ (44)112 =	2.53 94.21 Dec 103.64 1130.58 148.84 1482.37 22.33	] (4: ] (4: ] (4: ] (4: ] (4:
Annual average hot water usage in litres Jan Feb Hot water usage in litres per day for each 103.64 99.87 Energy content of hot water used = 4.18 153.69 134.42 Distribution loss 0.15 x (45)m 23.05 20.16 Water storage loss calculated for each me	Mar         Apr           n month         Vd,m = fact           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14           nonth         (55) x (41)m           0.00         0.00	May cor from Tabl 88.56 3600 kWh/mo 116.03 17.41 0.00	Jun         Ju           le 1c x (43)         84.79         84.3           onth (see Tables         100.13         92.3           15.02         13.3           0.00         0.00	79       88.56         s 1b, 1c 1d)         78       106.47         92       15.97         00       0.00         (47), else (56)	92.33	96.10       99.87 $\Sigma$ (44)112 =	2.53 94.21 Dec 103.64 1130.58 148.84 1482.37 22.33	] (4: ] (4: ] (4: ] (4: ] (4:
Annual average hot water usage in litresJanFebHot water usage in litres per day for each103.6499.87Energy content of hot water used = 4.18153.69134.42Distribution loss0.15 x (45)m23.0520.16Water storage loss calculated for each medicated for each medicated solar store0.000.00	Mar         Apr           96.10         92.33           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14           onth (55) x (41)m           0.00         0.00           rage or dedicated W           0.00         0.00	May cor from Tabl 88.56 3600 kWh/md 116.03 17.41 0.00 /WHRS (56)m	Jun         Jun           le 1c x (43)         84.79         84.           84.79         84.           onth (see Tables         100.13         92.           15.02         13.           0.00         0.0           n x [(47) - Vs] ÷ (	79       88.56         s 1b, 1c 1d)         78       106.47         92       15.97         00       0.00         (47), else (56)	92.33 107.74 16.16 0.00	96.10       99.87 $\Sigma$ (44)112 =	2.53         94.21         Dec         103.64         1130.58         148.84         1482.37         22.33         0.000	) (42 ) (43 ) (44 ) (44 ) (44 ) (44 ) (44
Annual average hot water usage in litresJanFebHot water usage in litres per day for each $103.64$ 99.87Energy content of hot water used = 4.18 $153.69$ $134.42$ Distribution loss $0.15 \times (45)m$ $23.05$ $20.16$ Water storage loss calculated for each medicated solar stor $0.00$ $0.00$	Mar         Apr           96.10         92.33           96.10         92.33           x Vd,m x nm x Tm/3           138.71         120.93           20.81         18.14           onth (55) x (41)m           0.00         0.00           rage or dedicated W           0.00         0.00	May cor from Tabl 88.56 3600 kWh/md 116.03 17.41 0.00 /WHRS (56)m	Jun         Jun           le 1c x (43)         84.79         84.           84.79         84.           onth (see Tables         100.13         92.           15.02         13.           0.00         0.0           n x [(47) - Vs] ÷ (	79       88.56         s 1b, 1c 1d)         78       106.47         92       15.97         90       0.00         (47), else (56)         90       0.00	92.33 107.74 16.16 0.00	96.10       99.87 $\Sigma$ (44)112 =	2.53         94.21         Dec         103.64         1130.58         148.84         1482.37         22.33         0.000	) (42 ) (43 ) (44 ) (44 ) (44 ) (44 ) (44

													٦
	50.96	45.97	48.97	45.53	45.13	41.82	43.21	45.13	45.53	48.97	49.25	50.96	(61)
Total heat requ	ired for wate	er heating c	alculated f	or each mo	nth 0.85 x	(45)m + (4	6)m + (57)r	n + (59)m +	· (61)m				
	204.65	180.38	187.68	166.46	161.16	141.94	135.99	151.60	153.28	174.53	186.31	199.80	(62)
Solar DHW inpu	t calculated	using Appe	endix G or A	Appendix H									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from wa		for each mo	nth (kWh/r		)m + (63)m	1		1	II			1	
e acpat i en m		,	-				125.00	151.00	152.20	174 52	100.01	100.00	7
	204.65	180.38	187.68	166.46	161.16	141.94	135.99	151.60	153.28	174.53	186.31	199.80	
										∑(64)1	.12 = 2	2043.80	(64)
Heat gains from	water heat	ing (kWh/m	nonth) 0.25	5 × [0.85 × (	45)m + (61	)m] + 0.8 ×	: [(46)m + (!	57)m + (59)	m]				_
	63.84	56.19	58.36	51.59	49.86	43.75	41.65	46.68	47.21	53.99	57.89	62.23	(65)
5. Internal gain	าร												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)												
	151.62	151.62	151.62	151.62	151.62	151.62	151.62	151.62	151.62	151.62	151.62	151.62	(66)
Lighting gains (o	alculated in	Appendix L	, equation	L9 or L9a),	also see Ta	ble 5							
0 00 .	51.24	45.51	37.01	28.02	20.95	17.68	19.11	24.84	33.34	42.33	49.40	52.67	(67)
							13.11	24.04	55.54	42.55	49.40	52.07	
Appliance gains		,											-
	338.39	341.90	333.05	314.21	290.43	268.08	253.15	249.64	258.49	277.33	301.11	323.46	(68)
Cooking gains (	alculated in	n Appendix I	L, equation	L15 or L15	a), also see	Table 5							
	52.69	52.69	52.69	52.69	52.69	52.69	52.69	52.69	52.69	52.69	52.69	52.69	(69)
Pump and fan g	ains (Table S	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evap			5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
Lusses e.g. evap	01 ation (1 ai												
	-	· · · ·									1	1	٦
	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	(71)
Water heating §		-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	-101.08	(71)
Water heating g		-101.08	-101.08 78.44	-101.08 71.66	-101.08 67.02	-101.08	-101.08 55.99	-101.08 62.75	-101.08 65.57	-101.08	-101.08 80.40	-101.08 83.64	] (71) ] (72)
Water heating g Total internal ga	gains (Table 85.81	-101.08 5) 83.61	78.44	71.66	67.02	60.76						1	
-	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)ı	71.66 m + (70)m -	67.02 + (71)m + (7	60.76 72)m	55.99	62.75	65.57	72.57	80.40	83.64	] (72)
-	gains (Table 85.81	-101.08 5) 83.61	78.44	71.66	67.02	60.76						1	
-	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)ı	71.66 m + (70)m -	67.02 + (71)m + (7	60.76 72)m	55.99	62.75	65.57	72.57	80.40	83.64	] (72)
Total internal g	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)ı	71.66 n + (70)m + 520.12	67.02 + (71)m + (7	60.76 72)m 452.75	55.99	62.75	65.57 463.62	72.57	80.40	83.64	] (72)
Total internal g	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)ı 554.74	71.66 m + (70)m + 520.12 actor	67.02 + (71)m + (7 484.63	60.76 72)m 452.75 Sol	55.99	62.75 443.45	65.57	72.57 498.45	80.40	83.64	] (72)
Total internal g	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)1 554.74 Access f	71.66 m + (70)m + 520.12 actor	67.02 + (71)m + (7 484.63 Area	60.76 72)m 452.75 Sol	55.99 434.47 ar flux	62.75 443.45 spec	65.57 463.62 g	72.57 498.45 FF	80.40 537.13	83.64 565.99 Gains	] (72)
Total internal g	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)1 554.74 Access f	71.66 m + (70)m + 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area	60.76 72)m 452.75 Sol W	55.99 434.47 ar flux V/m <sup>2</sup>	62.75 443.45 spec or T	65.57 463.62 g ific data	72.57 498.45 FF specific c or Table	80.40 537.13	83.64 565.99 Gains	] (72)
Total internal ga 6. Solar gains West	gains (Table 85.81 ains (66)m +	-101.08 5) 83.61 + (67)m + (6	78.44 8)m + (69)r 554.74 Access f Table	71.66 m + (70)m + 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58	60.76 72)m 452.75 Sol W	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x	62.75 443.45 spec or T 0.9 x	65.57 463.62 g ific data able 6b 0.63 x	72.57 498.45 FF specific c or Table 0.70	80.40 537.13 lata	83.64 565.99 Gains W 51.29	] (72) ] (73) ] (80)
Total internal ga 6. Solar gains West East	gains (Table 85.81 ains (66)m + 581.66	-101.08 5) 83.61 + (67)m + (6 577.25	78.44 8)m + (69)t 554.74 Access f Table	71.66 m + (70)m + 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup>	60.76 72)m 452.75 Sol W	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x	62.75 443.45 spec or T 0.9 x	65.57 463.62 fic data able 6b	72.57 498.45 FF specific c or Table	80.40 537.13 data 6c	83.64 565.99 Gains W	] (72) ] (73)
Total internal ga 6. Solar gains West	ains (Table 85.81 ains (66)m - 581.66	-101.08 5) 83.61 + (67)m + (6 577.25	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00	71.66 m + (70)m - 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52	60.76 72)m 452.75 Sol M 2 x 1 3 x 1	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x	62.75 443.45 spec or T 0.9 x (0) 0.9 x (0)	65.57 463.62 ific data able 6b 0.63 x 0.63 x	72.57 498.45 FF specific c or Table 0.70 0.70	80.40 537.13 data 6c =	83.64 565.99 Gains W 51.29 50.82	] (72) ] (73) ] (80) ] (76)
Total internal ga 6. Solar gains West East Solar gains in w	ains (Table <u>85.81</u> ains (66)m + <u>581.66</u> 581.66 102.12	-101.08 5) 83.61 + (67)m + (6 577.25	78.44 8)m + (69)t 554.74 Access f Table 1.00 1.00 328.98	71.66 m + (70)m + 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58	60.76 72)m 452.75 Sol W	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x	62.75 443.45 spec or T 0.9 x	65.57 463.62 g ific data able 6b 0.63 x	72.57 498.45 FF specific c or Table 0.70	80.40 537.13 data 6c	83.64 565.99 Gains W 51.29	] (72) ] (73) ] (80)
Total internal ga 6. Solar gains West East	ains (Table <u>85.81</u> ains (66)m + <u>581.66</u> 581.66 102.12	-101.08 5) 83.61 + (67)m + (6 577.25	78.44 8)m + (69)t 554.74 Access f Table 1.00 1.00 328.98	71.66 m + (70)m - 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52	60.76 72)m 452.75 Sol M 2 x 1 3 x 1	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x	62.75 443.45 spec or T 0.9 x (0) 0.9 x (0)	65.57 463.62 ific data able 6b 0.63 x 0.63 x	72.57 498.45 FF specific c or Table 0.70 0.70	80.40 537.13 data 6c =	83.64 565.99 Gains W 51.29 50.82	] (72) ] (73) ] (80) ] (76)
Total internal ga 6. Solar gains West East Solar gains in w	ains (Table <u>85.81</u> ains (66)m + <u>581.66</u> 581.66 102.12	-101.08 5) 83.61 + (67)m + (6 577.25	78.44 8)m + (69)t 554.74 Access f Table 1.00 1.00 328.98	71.66 m + (70)m - 520.12 actor 6d	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52	60.76 72)m 452.75 Sol M 2 x 1 3 x 1	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x	62.75 443.45 spec or T 0.9 x (0) 0.9 x (0)	65.57 463.62 ific data able 6b 0.63 x 0.63 x	72.57 498.45 FF specific c or Table 0.70 0.70	80.40 537.13 data 6c =	83.64 565.99 Gains W 51.29 50.82	] (72) ] (73) ] (80) ] (76)
Total internal ga 6. Solar gains West East Solar gains in w Total gains - int	ains (Table <u>85.81</u> ains (66)m + <u>581.66</u> 581.66 102.12 ernal and so <u>683.78</u>	-101.08 5) 83.61 + (67)m + (6 577.25 (82)m 199.76 olar (73)m + 777.01	78.44 8)m + (69)1 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72	71.66 m + (70)m - 520.12 actor 6d 0 x [ 0 x [ 0 x [ 479.80	67.02 + (71)m + (7 484.63 <b>Area</b> m <sup>2</sup> 6.58 6.52 588.01	60.76 72)m 452.75 Sol W 2 x 1 3 x 1 601.94	55.99 434.47 ar flux V/m <sup>2</sup> 9.64 x 9.64 x 573.07	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26	65.57 463.62 <b>g</b> ific data able 6b 0.63 x 0.63 x 382.62	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04	80.40 537.13 data 6c = 127.33	83.64 565.99 Gains W 51.29 50.82 83.98	] (72) ] (73) ] (80) ] (80) ] (76) ] (83)
Total internal ga 6. Solar gains West East Solar gains in w Total gains - internation 7. Mean internation	ains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 nal tempera	-101.08 5) 83.61 + (67)m + (6 577.25 (82)m 199.76 blar (73)m + 777.01 ture (heatin	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season)	71.66 m + (70)m - 520.12 actor 6d 0 x 0 x 479.80 999.92	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64	60.76 72)m 452.75 Sol W 1 x 1 601.94 1054.69	55.99 434.47 ar flux V/m <sup>2</sup> 9.64 x 9.64 x 573.07	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26	65.57 463.62 <b>g</b> ific data able 6b 0.63 x 0.63 x 382.62	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04	80.40 537.13 data 6c = 127.33	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97	] (72) ] (73) ] (80) ] (80) ] (76) ] (83) ] (84)
Total internal ga 6. Solar gains West East Solar gains in w Total gains - int	ains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 nal tempera	-101.08 5) 83.61 + (67)m + (6 577.25 (82)m 199.76 blar (73)m + 777.01 ture (heatin	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season)	71.66 m + (70)m - 520.12 actor 6d 0 x 0 x 479.80 999.92	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64	60.76 72)m 452.75 Sol W 1 x 1 601.94 1054.69	55.99 434.47 ar flux V/m <sup>2</sup> 9.64 x 9.64 x 573.07	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26	65.57 463.62 <b>g</b> ific data able 6b 0.63 x 0.63 x 382.62	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04	80.40 537.13 data 6c = 127.33	83.64 565.99 Gains W 51.29 50.82 83.98	] (72) ] (73) ] (80) ] (80) ] (76) ] (83)
Total internal ga 6. Solar gains West East Solar gains in w Total gains - internation 7. Mean internation	ains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 nal tempera	-101.08 5) 83.61 + (67)m + (6 577.25 (82)m 199.76 blar (73)m + 777.01 ture (heatin	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season)	71.66 m + (70)m - 520.12 actor 6d 0 x 0 x 479.80 999.92	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64	60.76 72)m 452.75 Sol W 1 x 1 601.94 1054.69	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 573.07	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26	65.57 463.62 <b>g</b> ific data able 6b 0.63 x 0.63 x 382.62	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04	80.40 537.13 data 6c = 127.33	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97	] (72) ] (73) ] (80) ] (80) ] (76) ] (83) ] (84)
Total internal ga 6. Solar gains West East Solar gains in w Total gains - internation 7. Mean internation	atts $\Sigma(74)$ m 581.66 581.66 102.12	-101.08 5) 83.61 + (67)m + (6 577.25 577.25 199.76 blar (73)m + 777.01 ture (heating periods in Feb	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season) the living a Mar	71.66 m + (70)m - 520.12 actor 6d 0 x 0 479.80 999.92 area from T Apr	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64 able 9, Th1 May	60.76 72)m 452.75 Sol M X 1 601.94 1054.69 (°C)	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 9.64 x 573.07 1007.54	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26 935.71	65.57 463.62 <b>g</b> <b>ific data</b> <b>able 6b</b> 0.63 x 0.63 x 382.62 846.24	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04 735.49	80.40 537.13 <b>data</b> 6 <b>6</b> 127.33 664.46	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97 21.00	] (72) ] (73) ] (80) ] (80) ] (76) ] (83) ] (84)
Total internal ga <b>6. Solar gains</b> West East Solar gains in w Total gains - intern <b>7. Mean intern</b> Temperature du	atts $\Sigma(74)$ m 581.66 581.66 102.12	-101.08 5) 83.61 + (67)m + (6 577.25 577.25 199.76 blar (73)m + 777.01 ture (heating periods in Feb	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season) the living a Mar	71.66 m + (70)m - 520.12 actor 6d 0 x 0 479.80 999.92 area from T Apr	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64 able 9, Th1 May	60.76 72)m 452.75 Sol M X 1 601.94 1054.69 (°C)	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 9.64 x 573.07 1007.54	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26 935.71	65.57 463.62 <b>g</b> <b>ific data</b> <b>able 6b</b> 0.63 x 0.63 x 382.62 846.24	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04 735.49	80.40 537.13 <b>data</b> 6 <b>6</b> 127.33 664.46	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97 21.00	] (72) ] (73) ] (80) ] (80) ] (76) ] (83) ] (84)
Total internal ga <b>6. Solar gains</b> West East Solar gains in w Total gains - intern <b>7. Mean intern</b> Temperature du Utilisation factor	gains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 hal tempera uring heating Jan or for gains for 0.99	-101.08 5) 83.61 + (67)m + (6 577.25 577.25 199.76 blar (73)m + 777.01 ture (heating g periods in Feb or living are 0.98	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season) the living a Mar ea n1,m (see 0.96	71.66 m + (70)m - 520.12 actor 6d 0 x 0 x 0 x 479.80 999.92 area from T Apr e Table 9a) 0.89	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64 able 9, Th1 May 0.75	60.76 72)m 452.75 Sol M 3 x 1 3 x 1 601.94 1054.69 (°C) Jun	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 573.07 1007.54	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26 935.71 Aug	65.57 463.62 g ific data able 6b 0.63 x 0.63 x 382.62 846.24 Sep	72.57 498.45 FF specific c or Table 0.70 0.70 237.04 735.49	80.40 537.13 data 66c = = [ ] = [ ] 127.33 664.46	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97 21.00 Dec	] (72) ] (73) ] (80) ] (76) ] (83) ] (83) ] (84) ] (85)
Total internal ga <b>6. Solar gains</b> West East Solar gains in w Total gains - intern <b>7. Mean intern</b> Temperature du	ains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 hal temperation uring heating Jan or for gains fr 0.99 emp of living	-101.08 5) 83.61 + (67)m + (6 577.25 577.25 199.76 blar (73)m + 777.01 ture (heating g periods in Feb or living are 0.98 g area T1 (s	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season) the living a Mar ea n1,m (see 0.96 teps 3 to 7	71.66         m + (70)m -         520.12         actor         6d         D       x         D       x         479.80         999.92         area from T         Apr         e Table 9a)         0.89         in Table 9c	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64 able 9, Th1 May 0.75 )	60.76 72)m 452.75 Sol M 2 1 3 x 1 601.94 1054.69 (°C) Jun 0.56	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 573.07 1007.54 Jul 0.41	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26 935.71 Aug 0.46	65.57 463.62 g ific data able 6b 0.63 x 0.63 x 382.62 846.24 846.24	72.57 498.45 <b>FF</b> specific c or Table 0.70 0.70 237.04 735.49 <b>Oct</b> 0.93	80.40 537.13 data 66c = [ ] = [ ] 127.33 664.46 Nov 0.98	83.64 565.99 6ains W 51.29 50.82 83.98 83.98 649.97 21.00 Dec 0.99	] (72) ] (73) ] (73) ] (80) ] (76) ] (83) ] (83) ] (84) ] (85) ] (86)
Total internal ga <b>6. Solar gains</b> West East Solar gains in w Total gains - intern <b>7. Mean intern</b> Temperature du Utilisation factor	gains (Table 85.81 ains (66)m + 581.66 581.66 102.12 ernal and so 683.78 hal temperation uring heating Jan or for gains fr 0.99 emp of livin 20.15	-101.08 5) 83.61 + (67)m + (6 577.25 (82)m 199.76 blar (73)m + 777.01 ture (heating g periods in Feb or living area 0.98 g area T1 (s 20.27	78.44 8)m + (69)r 554.74 Access f Table 1.00 1.00 328.98 (83)m 883.72 ng season) the living a Mar ea n1,m (see 0.96 teps 3 to 7 20.48	71.66         m + (70)m -         520.12         actor         6d         D       x         0       x         479.80         999.92         area from T         Apr         e Table 9a)         0.89         in Table 9c         20.72	67.02 + (71)m + (7 484.63 Area m <sup>2</sup> 6.58 6.52 588.01 1072.64 able 9, Th1 May 0.75 ) 20.87	60.76 72)m 452.75 Sol W 2 X 1 601.94 1054.69 (°C) Jun 0.56 20.93	55.99 434.47 ar flux //m <sup>2</sup> 9.64 x 9.64 x 573.07 1007.54	62.75 443.45 spec or T 0.9 x (0 0.9 x (0 492.26 935.71 Aug	65.57 463.62 g ific data able 6b 0.63 x 0.63 x 382.62 846.24 Sep	72.57 498.45 FF specific c or Table 0.70 0.70 237.04 735.49	80.40 537.13 data 66c = = [ ] = [ ] 127.33 664.46	83.64 565.99 Gains W 51.29 50.82 83.98 83.98 649.97 21.00 Dec	] (72) ] (73) ] (80) ] (76) ] (83) ] (83) ] (84) ] (85)

	19.95	19.95	19.95	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.96	19.96	(88)
Utilisation factor	r for gains for			m	1			1			1	•	], ,
	0.99	0.98	0.95	0.86	0.69	0.48	0.32	0.36	0.63	0.90	0.98	0.99	(89)
Mean internal te	emperature	in the rest	of dwelling		steps 3 to			1			1		], ,
	19.18	19.31	19.51	19.74	19.87	19.91	19.92	19.92	19.89	19.72	19.41	19.17	(90)
Living area fracti	ion								Li	ving area ÷	(4) =	0.38	(91)
Mean internal te	emperature	for the who	ole dwellin	g fLA x T1 +	-(1 - fLA) x 1	r2							-
	19.55	19.67	19.88	20.11	20.25	20.30	20.31	20.31	20.28	20.08	19.78	19.53	(92)
Apply adjustmer	nt to the me	ean internal	temperatu	ure from Ta	ble 4e whe	re appropr	iate	•			•	•	-
	19.55	19.67	19.88	20.11	20.25	20.30	20.31	20.31	20.28	20.08	19.78	19.53	(93)
													-
8. Space heatin				-		_			_	_		_	
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor	-											1	1
	0.99	0.98	0.95	0.86	0.71	0.50	0.35	0.39	0.66	0.91	0.98	0.99	(94)
Useful gains, ηm		· · · ·							_				1
<b>NA</b>	675.90	759.80	837.47	862.74	756.35	531.34	350.33	367.76	555.81	668.27	649.71	644.00	(95)
Monthly average				1	-								1
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate fo	[			1					_	1	1	1	1
	1483.69	1434.19	1295.57	1074.47	817.69	540.30	351.42	369.75	587.57	907.25	1217.60	1478.46	97) (97)
Space heating re													1
	601.00	453.19	340.83	152.45	45.64	0.00	0.00	0.00	0.00	177.80	408.88	620.84	
									∑(98	8)15, 10	.12 =	2800.62	(98)
<b>a</b> 1										(00)	(n) [	~~ ~~	1 (00)
Space heating re	equirement	kWh/m²/ye	ear							(98)	÷ (4)	33.52	<b>(99)</b>
Space heating re 9a. Energy requ		-		stems inclu	iding micro	-CHP				(98)	÷ (4)	33.52	] (99)
· -		-		stems inclu	ding micro	-CHP				(98)	÷ (4)	33.52	] (99)
9a. Energy requ	uirements -	individual	heating sys							(98)	÷ (4)	33.52 0.00	
9a. Energy requ Space heating	uirements - e heat from	individual secondary/	heating sys /suppleme							(98) 1 - (20			] (99) ] (201) ] (202)
9a. Energy request Space heating Fraction of space	uirements - e heat from e heat from	individual secondary/ main syste	heating sys /suppleme m(s)									0.00	] (201)
9a. Energy requ Space heating Fraction of space Fraction of space	uirements - e heat from e heat from e heat from	individual secondary/ main syste main syste	heating sys /suppleme m(s) m 2						(20		)1) =	0.00	] (201) ] (202)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space	uirements - e heat from e heat from e heat from space heat	individual secondary/ main syste main syste from main	heating sys /supplemen m(s) m 2 system 1						(20	1 - (20	)1) = 3)] =	0.00 1.00 0.00	] (201) ] (202) ] (202)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total	e heat from e heat from e heat from e heat from space heat space heat	individual secondary/ main syste main syste from main from main	heating sys /supplemen m(s) m 2 system 1						(20	1 - (20 )2) x [1- (20	)1) = 3)] =	0.00 1.00 0.00 1.00	] (201) ] (202) ] (202) ] (202) ] (204)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total	e heat from e heat from e heat from e heat from space heat space heat	individual secondary/ main syste main syste from main from main	heating sys /supplemen m(s) m 2 system 1				Jul	Aug	(20 Sep	1 - (20 )2) x [1- (20	)1) = 3)] =	0.00 1.00 0.00 1.00 0.00	] (201) ] (202) ] (202) ] (202) ] (204) ] (205)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan	individual secondary/ main syste main syste from main from main (%) Feb	heating sys /supplemen m(s) m 2 system 1 system 2 Mar	ntary system	m (table 11	)	Jul	Aug	·	1 - (20 )2) x [1- (20 (202) x (20	01) = 3)] = 03) =	0.00 1.00 0.00 1.00 0.00 90.90	] (201) ] (202) ] (202) ] (202) ] (204) ] (205)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan	individual secondary/ main syste main syste from main from main (%) Feb	heating sys /supplemen m(s) m 2 system 1 system 2 Mar	ntary system	m (table 11	)	Jul 0.00	Aug 0.00	·	1 - (20 )2) x [1- (20 (202) x (20	01) = 3)] = 03) =	0.00 1.00 0.00 1.00 0.00 90.90	] (201) ] (202) ] (202) ] (202) ] (204) ] (205)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai	e heat from e heat from e heat from space heat space heat in system 1 Jan tel (main sys	individual secondary/ main syste main syste from main from main (%) Feb stem 1), kW	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month	ntary system	m (table 11 May	) Jun	1	-	<b>Sep</b>	1 - (2( )2) x [1- (20 (202) x (20 <b>Oct</b>	01) = 3)] = 03) = Nov 449.81	0.00 1.00 0.00 1.00 0.00 90.90 Dec	] (201) ] (202) ] (202) ] (202) ] (204) ] (205)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai	e heat from e heat from e heat from space heat space heat in system 1 Jan tel (main sys	individual secondary/ main syste main syste from main from main (%) Feb stem 1), kW	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month	ntary system	m (table 11 May	) Jun	1	-	<b>Sep</b>	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60	01) = 3)] = 03) = Nov 449.81	0.00 1.00 1.00 1.00 90.90 90.90 <b>Dec</b> 682.99	] (201) ] (202) ] (202) ] (204) ] (205) ] (206)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of main Space heating fu	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan lel (main sys 661.16	individual secondary/ main syste main syste from main from main (%) Feb stem 1), kW	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month	ntary system	m (table 11 May	) Jun	1	-	<b>Sep</b>	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60	01) = 3)] = 03) = Nov 449.81	0.00 1.00 1.00 1.00 90.90 90.90 <b>Dec</b> 682.99	] (201) ] (202) ] (202) ] (204) ] (205) ] (206)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan lel (main sys 661.16	individual secondary/ main syste main syste from main from main (%) Feb stem 1), kW	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month	ntary system	m (table 11 May	) Jun	1	-	<b>Sep</b>	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60	01) = 3)] = 03) = Nov 449.81	0.00 1.00 1.00 1.00 90.90 90.90 <b>Dec</b> 682.99	] (201) ] (202) ] (202) ] (204) ] (205) ] (206)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan iel (main sy: 661.16	individual secondary, main syste from main from main (%) Feb stem 1), kW 498.56	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95	Apr 167.71	m (table 11 May 50.21	) Jun 0.00	0.00	0.00	<b>Sep</b> 0.00 Σ(21:	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60 1)15, 10	01) = 3)] = 03) = Nov 449.81 12 =	0.00 1.00 0.00 1.00 90.90 <b>Dec</b> 682.99 3080.99	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating Efficiency of wat	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan iel (main sy: 661.16	individual secondary, main syste from main from main (%) Feb stem 1), kW 498.56	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95	Apr 167.71	m (table 11 May 50.21	) Jun 0.00	0.00	0.00	<b>Sep</b> 0.00 Σ(21:	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60 1)15, 10	01) = 3)] = 03) = Nov 449.81 12 =	0.00 1.00 0.00 1.00 90.90 <b>Dec</b> 682.99 3080.99	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating Efficiency of wat	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan el (main system 1 (main system 1) (661.16) eer heater (88.10) uel, kWh/m	individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 498.56 87.78 onth	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95	Apr 167.71 85.33	May 50.21 82.83	) Jun 0.00 80.80	0.00	0.00	<b>Sep</b> 0.00 Σ(21: 80.80	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 195.60 1)15, 10	01) = 3)] = 03) = Nov 449.81 12 = 87.48 212.98	0.00 1.00 0.00 1.00 90.90 Dec 682.99 3080.99 888.22	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating Efficiency of wat	e heat from e heat from e heat from e heat from space heat space heat in system 1 Jan el (main system 1 (main system 1) (661.16) eer heater (88.10) uel, kWh/m	individual secondary, main syste main syste from main from main (%) Feb stem 1), kW 498.56 87.78 onth	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95	Apr 167.71 85.33	May 50.21 82.83	) Jun 0.00 80.80	0.00	0.00	<b>Sep</b> 0.00 Σ(21: 80.80	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 1)15, 10 85.60 203.90	01) = 3)] = 03) = Nov 449.81 12 = 87.48 212.98	0.00 1.00 0.00 1.00 0.00 90.90 Dec 682.99 3080.99 888.22 888.22	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211) ] (217)
9a. Energy requ Space heating Fraction of space Fraction of space Fraction of space Fraction of total Fraction of total Efficiency of mai Space heating fu Water heating Efficiency of wat	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan tel (main system 1 661.16 cer heater 88.10 uel, kWh/m 232.28	individual secondary, main syste from main from main (%) Feb stem 1), kW 498.56 87.78 onth 205.51	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95	Apr 167.71 85.33	May 50.21 82.83	) Jun 0.00 80.80	0.00	0.00	<b>Sep</b> 0.00 Σ(21: 80.80	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 1)15, 10 85.60 203.90	01) = 3)] = 03) = Nov 449.81 12 = 87.48 212.98 12 =	0.00 1.00 0.00 1.00 0.00 90.90 Dec 682.99 3080.99 888.22 888.22	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211) ] (217)
<ul> <li>9a. Energy requirements</li> <li>Space heating</li> <li>Fraction of space</li> <li>Fraction of space</li> <li>Fraction of space</li> <li>Fraction of total</li> <li>Fraction of total</li> <li>Efficiency of main</li> <li>Space heating for</li> <li>Water heating for</li> <li>Water heating for</li> <li>Water heating for</li> <li>Annual totals</li> </ul>	uirements - e heat from e heat from e heat from space heat space heat in system 1 Jan iel (main sy <u>661.16</u> eer heater <u>88.10</u> uel, kWh/m <u>232.28</u> iel - main sy uel	individual secondary, main syste from main from main (%) Feb stem 1), kW 498.56 87.78 onth 205.51	heating sys /supplemen m(s) m 2 system 1 system 2 Mar /h/month 374.95 87.04 215.63	Apr 167.71 85.33 195.07	May 50.21 82.83	) Jun 0.00 80.80	0.00	0.00	<b>Sep</b> 0.00 Σ(21: 80.80	1 - (20 )2) x [1- (20 (202) x (20 <b>Oct</b> 1)15, 10 85.60 203.90	01) = 3)] = 03) = Nov 449.81 12 = 87.48 212.98 12 =	0.00 1.00 0.00 1.00 0.00 90.90 Dec 682.99 3080.99 888.22 226.49 2407.74	] (201) ] (202) ] (202) ] (204) ] (205) ] (206) ] (206) ] (211) ] (217)

central heating pump or water pump within warm air heating	unit		30.00			(230c)
boiler flue fan			45.00			(230e)
Total electricity for the above, kWh/year					75.00	(231)
Electricity for lighting (Appendix L)					361.97	(232)
Energy saving/generation technologies						
electricity generated by PV (Appendix M)					-1580.83	(233)
Total delivered energy for all uses		(211)	)(221) + (231) + (2	32)(237b) =	4344.87	(238)
10a. Fuel costs - individual heating systems including micro-CH	Р					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3080.99	x	3.48	x 0.01 =	107.22	(240)
Water heating	2407.74	x	3.48	x 0.01 =	83.79	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	361.97	x	13.19	x 0.01 =	47.74	(250)
Additional standing charges					120.00	(251)
Energy saving/generation technologies						
pv savings	-1580.83	x	13.19	x 0.01 =	-208.51	(252)
Total energy cost			(240)(242) + (	245)(254) =	160.13	(255)
11a. SAP rating - individual heating systems including micro-CH	IP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					0.52	(257)
SAP value					92.70	]
SAP rating (section 13)					93	(258)
SAP band					A	]
12a. CO <sub>2</sub> emissions - individual heating systems including micro	o-CHP	-				
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	3080.99	x	0.22	=	665.49	(261)
Water heating	2407.74	x	0.22	=	520.07	(264)
Space and water heating			(261) + (262) + (2	263) + (264) =	1185.57	(265)
Pumps and fans	75.00	x	0.52	=	38.93	(267)
Electricity for lighting	361.97	x	0.52	=	187.86	(268)
Energy saving/generation technologies						
pv savings	-1580.83	x	0.52	=	-820.45	(269)
Total CO <sub>2</sub> , kg/year			(	265)(271) =	591.90	(272)
Dwelling CO <sub>2</sub> emission rate				(272) ÷ (4) =	7.08	(273)
El value					93.83	]
El rating (section 14)					94	(274)
El band					Α	]
13a. Primary energy - individual heating systems including mic	ro-CHP					
	Energy		Primary factor		Primary Energy	,

	Energy kWh/year		Primary factor		Primary Energy kWh/year	,
Space heating - main system 1	3080.99	] x	1.22	=	3758.81	(261)
Water heating	2407.74	] x	1.22	=	2937.44	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	6696.25	(265)
Pumps and fans	75.00	] x	3.07	=	230.25	(267)

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Electricity for lighting	361.97	x	3.07	=	1111.26 (268)
Energy saving/generation technologies					
Electricity generated - PVs	-1580.83	x	3.07	=	-4853.15 ( <mark>269</mark> )
Primary energy kWh/year					3184.61 (272)
Dwelling primary energy rate kWh/m2/year					38.11 (273)

### Appendix C – Proposed House Case

#### SAP worksheet House 1

# Sap Worksheet Design - Draft



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

Assessor name	Mrs Lizzie	e Stokes					As	sessor num	ber	1031		
Client							La	st modified		21/10	/2015	
Address	45-49 Sta	ation Road	Hampton I	Middlesex	, TW12 2BU							
71001055	45 45 500		numpton, i	maarcsex	, 10012 200	·						
1. Overall dwelling dimen	sions											
				А	area (m²)			age storey ight (m)		Vo	lume (m³)	
Lowest occupied					30.83	(1a) x		2.20	(2a) =		67.83	(3a)
+1					52.27	(1b) x		2.80	(2b) =		146.36	(3b)
+2					53.75	(1c) x		2.70	(2c) =		145.13	(3c)
Total floor area	(1a)	+ (1b) + (1c	c) + (1d)(1	.n) =	136.85	(4)						
Dwelling volume							(3a)	+ (3b) + (3d	c) + (3d)(3	3n) =	359.31	(5)
2. Ventilation rate												
										m	' per hour	
Number of chimneys								0	] x 40 =	:	0	(6a)
Number of open flues								0	x 20 =		0	(6b)
Number of intermittent fan	S							0	] x 10 =		0	(7a)
Number of passive vents								0	] x 10 =	:	0	(7b)
Number of flueless gas fires	5							0	x 40 =	:	0	(7c)
										Air o	hanges per hour	
Infiltration due to chimneys	s flues fan	s PSVs		(6a)	) + (6b) + (7a	a) + (7h) + (	7c) =	0	÷ (5) =		0.00	(8)
If a pressurisation test has l			ntended, pr				· ·	-	] . (3)		0.00	
, Air permeability value, q50,			· · ·								4.50	(17)
If based on air permeability							e ureu				0.23	(18)
Number of sides on which t				,,		- /					1	(19)
Shelter factor		,						1 -	[0.075 x (1	9)] =	0.93	(20)
Infiltration rate incorporation	ng shelter f	actor							(18) x (2		0.21	(21)
Infiltration rate modified fo	-		:						( - / (		-	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spee	d from Tab	le U2										
F 10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
5.10												
Wind factor (22)m ÷ 4												
	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Wind factor (22)m ÷ 4	1.25					0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Wind factor (22)m ÷ 4	1.25					0.95	0.93	1.00 0.21	1.08 0.22	1.13 0.23	0.24	(22a) (22b)
Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a	1.25 Ilowing for 2	shelter and 0.25	wind facto 0.23	r) (21) x (2	22a)m		1					
Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.27	1.25 Ilowing for 0.26 ge rate for t	shelter and 0.25 the applicat	wind facto 0.23 ole case:	r) (21) x (2	22a)m		1					
Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.27 Calculate effective air changed	1.25 Ilowing for 1 0.26 ge rate for t n: air change	shelter and 0.25 the applicat e rate throu	wind facto 0.23 ole case: ugh system	r) (21) x (2 0.22	22a)m 0.20	0.20	1				0.24	(22b)
Wind factor (22)m ÷ 4 1.28 Adjusted infiltration rate (a 0.27 Calculate effective air chan If mechanical ventilation	1.25 Ilowing for a 0.26 ge rate for t n: air change covery: effic	shelter and 0.25 the applicat e rate throu ciency in %	wind facto 0.23 ole case: ugh system allowing fo	r) (21) x (2 0.22 r in-use fa	22a)m 0.20	0.20 able 4h	0.19				0.24	(22b) (23a)



0	0.31	0.29	0.30	0.30	0.32	0.33	0.36	0.36	0.37
---	------	------	------	------	------	------	------	------	------

Element			а	Gross rea, m²	Openings m <sup>2</sup>	Net a A, i		U-value W/m²K	Α >	αUW/K		value, /m².K	Ахк, kJ/K	
Door						1.8	30 x	1.00	=	1.80	]			(26)
Window						14.	63 x	1.05	=	15.41	]			(27)
Ground floor						20.	77 x	0.11	=	2.28	]			<b>(2</b> 8a
Basement floor						29.	61 x	0.11	=	3.26	]			(28)
Ground floor						0.2	26 x	0.20	=	0.05	]			(28a
Party wall						67.	08 x	0.00	=	0.00	]			(32)
External wall						92.	67 x	0.15	=	13.90	]			(29a
External wall						5.2	L7 x	1.10	=	5.69	]			(29a
Basement wall						44.	75 x	0.17	=	7.61				(29)
Basement wall						1.7	71 x	0.15	=	0.26				(29)
Roof						52.	01 x	0.12		6.24				(30)
Roof						0.3				0.06				(30)
otal area of ex	ternal eleme	ents ΣA. m²	2			263					1			(31)
abric heat loss		_								(26)	.(30) + (	32) =	56.56	(33)
leat capacity C								(28)	(30) +		32a)(3		N/A	(34)
hermal mass p		MP) in kl/r	m²K					(20)		(52) · (	24,(5		250.00	(35)
Thermal bridge				div K									16.86	(36)
Total fabric hea			ыпд Аррен								(22) . (	26) - [		
	Jan	Feb	Mar	Apr	May	lun		Aug	5.	-	(33) + (		73.43 Dec	(37)
/entilation hea				Apr	Мау	Jun	Jul	Aug	Se	:h	Oct	Nov	Dec	
rentilation nea					20.44	25.26	25.26	2474	- 26	-0	20.44	20.00	40.04	
	43.38	42.76	42.15	39.06	38.44	35.36	35.36	34.74	36.	59	38.44	39.68	40.91	(38)
leat transfer c				1	T				1				1	_
	116.81	116.19	115.57	112.49	111.87	108.79	108.79	108.17	110		111.87	113.11		4
leat loss paran	neter (HLP), '	W/m²K (39	9)m ÷ (4)						Avera	ge = ∑(3	9)112,	/12 =	112.34	(39)
	0.85	0.85	0.84	0.82	0.82	0.79	0.79	0.79	0.8	30	0.82	0.83	0.84	
lumber of day	s in month (T	able 1a)							Avera	ge = ∑(4	0)112,	/12 =	0.82	(40)
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.	00	31.00	30.00	31.00	(40)
								•	•			4	-	
4. Water heat	ing energy re	equiremen	t	-										
ssumed occup	oancy, N												2.91	(42)
Annual average	e hot water u	sage in litr	es per day	Vd,average	= (25 x N) +	36							103.33	(43)
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Se	p	Oct	Nov	Dec	
lot water usag	e in litres pe	r day for ea	ach month	Vd,m = fact	or from Tab	le 1c x (43)								
	113.67	109.53	105.40	101.27	97.13	93.00	93.00	97.13	101	.27	105.40	109.53	113.67	
											∑(44)1	.12 =	1239.99	(44)
energy content	of hot water	r used = 4.2	18 x Vd,m x	nm x Tm/3	600 kWh/m	onth (see	Tables 1	b, 1c 1d)						
	168.56	147.43	152.13	132.63	127.26	109.82	101.76	5 116.77	118	.17	137.71	150.33	163.24	
											∑(45)1	.12 =	1625.82	(45)
Distribution los	s 0.15 x (45)	m												
	25.28	22.11	22.82	19.89	19.09	16.47	15.26	17.52	17.	73	20.66	22.55	24.49	(46)
itorage volume							0	1 2002	/.	-			200.00	(47)
LOI UBC VOIUITE		ang any S		ing storag	C WICHINI Sdll	10 103301							200.00	(+/)

							or T	able 6b	or Table	e 6c	
6. Solar gains			Access factor Table 6d	Area m²		r flux /m²	•	g fic data	FF specific d		Gains W
6 Soler geine	785.82	779.82	750.53 705	.27 658.51	617.45	594.15	604.48	631.19	676.68	726.95	765.38
otal internal gai ا						F04 4 F	604.40	624.40	676.60	720.05	765.20
		135.71	130.75 124		113.48	108.24	114.95	117.33	124.31	132.18	135.72
Water heating ga	ins (Table 5)								-		
- '		-116.43	-116.43 -116	5.43 -116.43	-116.43	-116.43	-116.43	-116.43	-116.43	-116.43	-116.43
ا osses e.g. evapc۔			5.55 5.6	5.00	5.00	2.00	1 0.00	5.00	0.00	0.00	5.00
oump and fan ga	3.00	) 3.00	3.00 3.0	0 3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
ump and for an	55.38	55.38	55.38 55.	38 55.38	55.38	55.38	55.38	55.38	55.38	55.38	55.38
Cooking gains (ca			, I				1			1	
[	456.42	461.16	449.22 423	.81 391.74	361.59	341.46	336.72	348.65	374.06	406.14	436.28
Appliance gains (	calculated in	Appendix	L, equation L13	or L13a), also s	ee Table 5						
	74.71	66.36	53.97 40.		25.78	27.86	36.21	48.61	61.72	72.03	76.79
ا ighting gains (ca۔						1. 1105		2, 1100			
See one Band		174.65	174.65 174	.65 174.65	174.65	174.65	174.65	174.65	174.65	174.65	174.65
Metabolic gains (	Jan Table 5)	Feb	Mar Ap	or May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5. Internal gains		E c h	Mari				• • •	6	0	NI	Der
	· · · · ·	I		·						•	
	102.74	91.20	97.28 89.		81.70	80.53	85.52	84.48	92.49	95.17	100.97
leat gains from	water heatin	g (kWh/m	onth) 0.25 × [0.	85 x (45)m + (61	1)ml + 0.8 ×	[(46)m + (	57)m + (59)	ml	∑(64)1	.12 = 2	313.07
	226.93	200.15	210.50 189	.12 185.63	166.30	160.13	175.14	174.65	196.08	206.81	221.61
utput from wat			nth (kWh/month								
	0.00	0.00	0.00 0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00
olar DHW input	calculated u	sing Appe	ndix G or Appen	dix H						-	
[	226.93	200.15	210.50 189	.12 185.63	166.30	160.13	175.14	174.65	196.08	206.81	221.61
otal heat requir			alculated for eac		1 1		1				]
	0.00	0.00	0.00 0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ا Combi loss for ea	23.26	21.01		51   23.20	22.51	23.20	23.20	22.51	23.20	22.31	23.26
rimary circuit lo				51 23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26
	35.11	31.71	35.11 33.	97 35.11	33.97	35.11	35.11	33.97	35.11	33.97	35.11
f the vessel cont	ains dedicate	ed solar st	orage or dedicat	ed WWHRS (56	)m x [(47) - \	/s] ÷ (47),	else (56)				
	35.11	31.71	35.11 33.	97 35.11	33.97	35.11	35.11	33.97	35.11	33.97	35.11
Vater storage lo	ss calculated	for each i	month (55) x (41	1)m							
inter (50) or (54)											1.13
			h/day) (47) x (51	L) x (52) x (53)							1.13
Temperature											0.54
Volume facto	r from Tablo	<b>7</b> -1		-, , ,							0.84
Hot water sto	rage loss fac	tor from i	able 2 (kWh/litr	e/davi							0.01

East			1.00	)	x [	1.99	x		19.64	] x 0.9	x	0.63	x	0.70	=	15.51	(76)
South			1.00	)	x [	7.66	x		46.75	] x 0.9	x	0.63	x	0.70	=	142.14	(78)
North			0.77	7	x [	1.24	x		10.63	] x 0.9	x	0.63	х	0.70	=	4.03	(74)
Solar gains in wa	atts ∑(74)m	n(82)m															
	177.46	301.00	410.85	511	.38	577.78	57	6.57	554.5	9 5	04.08	445.24	ŀ	332.16	212.27	152.10	(83)
Total gains - inte	ernal and so	olar (73)m + (8	33)m														
	963.28	1080.81	1161.38	1216	6.65	1236.29	119	94.02	1148.7	74 11	L08.56	1076.4	3	1008.84	939.21	917.48	(84)
7. Mean intern	al tempera	ture (heating	season)														
Temperature du				area fr	om -	Table 9 Th1	്റ									21.00	(85)
	Jan	Feb	Mar	Ap		May		un	Jul		Aug	Sep		Oct	Nov	Dec	
Utilisation facto				•		•											
	0.99	0.99	0.97	0.9		, 0.78	0	.58	0.42		0.45	0.68		0.92	0.99	1.00	(86)
Mean internal te									0.12		0.15	0.00		0.52	0.55	1.00	
	20.42	20.52	20.66	20.		20.92	20	).96	20.96	5 7	20.96	20.95		20.83	20.61	20.41	(87)
Temperature du		I I										20.00		10.00	20101		
	20.21	20.21	20.21	20.		20.24	-	).26	20.26	5 2	20.26	20.25		20.24	20.23	20.22	(88)
Utilisation facto		I							1 10110	-					10.110		
	0.99	0.98	0.96	0.8	39	0.74	0	.51	0.35		0.38	0.62		0.90	0.98	0.99	(89)
Mean internal to											0.00	0.01		0.00	0.00	0.00	
	19.67	19.78	19.92	20.		20.17		).22	20.22	2 2	20.22	20.20		20.10	19.88	19.68	(90)
Living area fract						1			1	- ! -						0.23	(91)
Living area fractionLiving area $\div$ (4) = 0.23 (91)Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2																	
	19.84	19.95	20.08	20.		20.34		.38	20.39	9 2	20.39	20.37		20.27	20.04	19.84	(92)
Apply adjustme		I				1											] (/
	19.69	19.80	19.93	20.		20.19	1	).23	20.24	1 2	20.24	20.22		20.12	19.89	19.69	(93)
														1			
8. Space heating	ng requirem	nent															
	Jan	Feb	Mar	Ap	or	May	J	un	Jul		Aug	Sep		Oct	Nov	Dec	
Utilisation facto	r for gains,	ηm															-
	0.99	0.98	0.96	0.8	38	0.73	0.	.51	0.34		0.37	0.62		0.89	0.98	0.99	(94)
Useful gains, ηm												1					-
	955.09		1111.08	1075	5.20	906.09	60	9.63	395.2	7 4	14.87	662.59	)	899.58	919.48	911.45	(95)
Monthly average									-			1		1			-
	4.30	4.90	6.50	8.9		11.70		1.60	16.60	)   1	16.40	14.10		10.60	7.10	4.20	(96)
Heat loss rate fo												1					7
	1797.90		1552.65	1260	-	949.93		2.79	395.4	5 4	15.18	673.47	7	1064.66	1447.1	5 1771.54	(97)
Space heating re	-								_			1					-
	627.05	450.28	328.53	133	.19	32.62	0.	.00	0.00		0.00	0.00		122.82	379.92		
												Σ	(98)	15, 10		2714.31	_ (98)
Space heating re	equirement	kWh/m²/yea	r											(98) -	÷ (4)	19.83	(99)
9a. Energy req	uirements -	individual he	eating sys	stems	inclu	uding micro	-CHP										
Space heating																	
Fraction of spac	e heat from	secondary/s	upplemer	ntary	syste	em (table 11	)									0.00	(201)
Fraction of spac	e heat from	i main system	(s)											1 - (20	1) =	1.00	(202)
Fraction of spac	e heat from	i main system	2													0.00	(202)
Fraction of total	l space heat	from main sy	/stem 1									(	202	.) x [1- (203	3)] =	1.00	(204)
Fraction of total	l space heat	from main sy	/stem 2											(202) x (20	3) =	0.00	(205)

Efficiency of main system 1 (%)							90.60	(206)
Jan Feb Mar Apr	May Jun	Jul	Aug	Sep	Oct	Nov	Dec	] (200)
Space heating fuel (main system 1), kWh/month			U	·				
692.11 497.00 362.61 147.0	01 36.00 0.00	0.00	0.00	0.00	135.56	419.34	706.29	]
				∑(211	.)15, 1012	2 = 2	995.92	_ ] (211)
Water heating								_
Efficiency of water heater								
87.49 87.01 86.10 84.00	0 81.34 79.90	79.90	79.90	79.90	83.71	86.52	87.58	(217)
Water heating fuel, kWh/month								_
259.39 230.02 244.49 225.1	4 228.23 208.14	200.42	219.20	218.59	234.25	239.04	253.03	]
					∑(219a)112	2 = 2	759.94	(219)
Annual totals								
Space heating fuel - main system 1						2	995.92	]
Water heating fuel						2	759.94	]
Electricity for pumps, fans and electric keep-hot (Table 41	f)							
mechanical ventilation fans - balanced, extract or posi	itive input from outside		29	90.41				(230a)
central heating pump or water pump within warm air	heating unit		3	0.00				(230c)
boiler flue fan			4	5.00				(230e)
Total electricity for the above, kWh/year						3	365.41	(231)
Electricity for lighting (Appendix L)						5	527.78	(232)
Energy saving/generation technologies								
electricity generated by PV (Appendix M)						-1	.381.32	(233)
Total delivered energy for all uses			(211)(221)	+ (231) +	(232)(237b	) = 5	267.73	(238)
10a. Fuel costs - individual heating systems including m								
reaching systems meruang h								
	Fuel		Fue	el price			Fuel	
	Fuel kWh/year		Fue	el price		cos	Fuel st £/year	
Space heating - main system 1		x		el price 3.48	x 0.01 =			] (240)
Space heating - main system 1 Water heating	kWh/year	x x			x 0.01 = x 0.01 =	1	st £/year	] (240) ] (247)
	<b>kWh/year</b> 2995.92	=		3.48			st £/year	
Water heating	kWh/year 2995.92 2759.94	×		3.48	x 0.01 =		<b>st £/year</b> 104.26 96.05	(247)
Water heating Pumps and fans	kWh/year 2995.92 2759.94 365.41	x x		3.48 3.48 3.19	x 0.01 = x 0.01 =		st £/year 104.26 96.05 48.20	] (247) ] (249)
Water heating Pumps and fans Electricity for lighting	kWh/year 2995.92 2759.94 365.41	x x		3.48 3.48 3.19	x 0.01 = x 0.01 =		<b>t f/year</b> 104.26 96.05 48.20 69.61	) (247) ) (249) ] (250)
Water heating Pumps and fans Electricity for lighting Additional standing charges	kWh/year 2995.92 2759.94 365.41	x x		3.48 3.48 3.19	x 0.01 = x 0.01 =		<b>t f/year</b> 104.26 96.05 48.20 69.61	) (247) ) (249) ] (250)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies	kWh/year 2995.92 2759.94 365.41 527.78			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 =		tt £/year 104.26 96.05 48.20 69.61 120.00	] (247) ] (249) ] (250) ] (251)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		tt £/year 104.26 96.05 48.20 69.61 120.00 182.20	] (247) ] (249) ] (250) ] (251) ] (252)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost 11a. SAP rating - individual heating systems including references	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92	] (247) ] (249) ] (250) ] (251) ] (252) ] (255)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12)	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		tt £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42	(247) (249) (250) (251) (252) (255) (255)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF)	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59	] (247) ] (249) ] (250) ] (251) ] (252) ] (255)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including m</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		tt £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75	] (247) ] (249) ] (250) ] (251) ] (252) ] (255) ] (255) ] (256) ] (257)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13)	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75 92	(247) (249) (250) (251) (252) (255) (255)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including m</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		tt £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75	] (247) ] (249) ] (250) ] (251) ] (252) ] (255) ] (255) ] (256) ] (257)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13)	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =		t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75 92	(247) (249) (250) (251) (252) (255) (255) (255) (256) (257)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13) SAP band	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32			3.48 3.48 3.19 3.19 3.19 3.19	x 0.01 = x 0.01 = x 0.01 = x 0.01 =	(	t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75 92	(247) (249) (250) (251) (252) (255) (255) (255) (256) (257)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13) SAP band	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32 micro-CHP		Emissi kg Cu	3.48 3.48 3.19 3.19 3.19 0)(242) -	x 0.01 = x 0.01 = x 0.01 = x 0.01 =	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75 92 A nissions	] (247) ] (249) ] (250) ] (251) ] (252) ] (255) ] (255) ] (256) ] (257)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13) SAP band <b>12a. CO<sub>2</sub> emissions - individual heating systems includi</b>	kWh/year 2995.92 2759.94 365.41 527.78 -1381.32 micro-CHP micro-CHP		Emissi kg CU	3.48 3.48 3.19 3.19 3.19 0)(242) -	x 0.01 = x 0.01 = x 0.01 = x 0.01 = + (245)(254	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	t £/year 104.26 96.05 48.20 69.61 120.00 182.20 255.92 0.42 0.59 91.75 92 A nissions CO <sub>2</sub> /year	(247) (249) (250) (251) (252) (255) (255) (255) (257) (258) (258)
Water heating Pumps and fans Electricity for lighting Additional standing charges Energy saving/generation technologies pv savings Total energy cost <b>11a. SAP rating - individual heating systems including r</b> Energy cost deflator (Table 12) Energy cost factor (ECF) SAP value SAP rating (section 13) SAP band <b>12a. CO<sub>2</sub> emissions - individual heating systems includi</b> Space heating - main system 1	kWh/year           2995.92           2759.94           365.41           527.78   micro-CHP           Ing micro-CHP           Energy           kWh/year           2995.92		Emissi kg Cl (0)	3.48 3.48 3.19 3.19 3.19 0)(242) -	x 0.01 = x 0.01 = x 0.01 = + (245)(254	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	st £/year       104.26       96.05       48.20       69.61       120.00       182.20       255.92       0.42       0.59       91.75       92       A       nissions       CO2/year       647.12	] (247) ] (249) ] (250) ] (251) ] (252) ] (255) ] (255) ] (256) ] (257) ] (258) ] (258) ] (261)

Pumps and fans	365.41	х	0.52	] =	189.65	(267)
Electricity for lighting	527.78	x	0.52	] =	273.92	(268)
Energy saving/generation technologies						
pv savings	-1381.32	x	0.52	] =	-716.91	(269)
Total CO₂, kg/year				(265)(271) =	989.93	(272)
Dwelling CO <sub>2</sub> emission rate				(272) ÷ (4) =	7.23	(273)
El value					92.71	]
El rating (section 14)					93	(274)
El band					A	]
13a. Primary energy - individual heating systems including i	micro-CHP					

	Energy kWh/year		Primary factor		Primary Energy kWh/year	,
Space heating - main system 1	2995.92	x	1.22	=	3655.03	(261)
Water heating	2759.94	x	1.22	=	3367.13	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	7022.16	(265)
Pumps and fans	365.41	x	3.07	=	1121.81	(267)
Electricity for lighting	527.78	x	3.07	=	1620.28	(268)
Energy saving/generation technologies						
Electricity generated - PVs	-1381.32	x	3.07	=	-4240.66	(269)
Primary energy kWh/year					5523.59	(272)
Dwelling primary energy rate kWh/m2/year					40.36	(273)

#### Appendix D

#### Renewable Energy Technologies, Supporting Data

#### **Photovoltaic Panels:**

Photovoltaic systems convert sunlight into electricity through semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn their direct current (DC) output into alternating current (AC) electricity for use in the home and / or to export to the national grid. PV systems require only daylight, not sunlight to generate electricity, so energy can still be produced in overcast or cloudy conditions.

PV collectors can be 'bolted on' to a suitable roof, be integrated into the fabric of the roof and to the façade. In order to achieve the optimum results, any obstructions should be minimized and be placed on a pitch between 30-40°.

Typical domestic systems range from  $1 - 3.5 kW_p$  rating and can provide between 750 and 3,000kWh per year. From the DTI (domestic field trial performance analysis) domestic systems contribute on average 43% of the electrical load. Depending on the system, the efficiency of PVs range up to 15%.



PV Panels mounted above tiled roof



PV Panels semi-integrated to tiled roof

Fully installed the costs for roof mounted systems are approximately £2,500/kWp. There should be very little maintenance required as the technology has no moving parts. Technically reliable, they are generally guaranteed to last between 20-25 years.

#### Feed-In Tariffs and Selling Electricity:

In order to incentivise the generation of low carbon electricity, the Government launched the Feed-In-Tariff in April 2010. The tariff is a guaranteed payment which will be received for every kWh produced by an eligible technology. The amount received depends upon the type of technology and the date of installation, details of which are set-out at <u>www.fitariffs.co.uk</u>.

The technologies eligible for FITs include: wind; solar photovoltaics; hydro; anaerobic digestion; and domestic scale gas microCHP units.

In addition to the guaranteed FITs, producing electricity from renewable sources reduces the amount of conventionally generated electricity that needs to be bought from suppliers, further reducing costs. Any electricity produced in excess of the user's requirements can be sold back to the grid.

All applicable systems and installers need to be MCS certified and the house requires at least an EPC band D in solar to be eligible to receive the FIT.

New PV systems installed after April 2014 can be eligible for an index linked tariff per kWh generated. The tariff period is guaranteed for 20 years.

The tariff for exporting renewable electricity to the grid is 4.85p per kWh for all new solar PV installations between 1<sup>st</sup> April 2015 – 31<sup>st</sup> March 2016.