

Sheldon House Development

8 Cromwell Road, Teddington, London TWII 9EJ

Energy & Sustainability Report

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1.0 Introduction

Clive Chapman Architects has been appointed to carry out a sustainability assessment inclusive of energy reporting for a proposed residential development at 8 Cromwell Road, Teddington.

The scheme comprises the demolition of an existing block of flats, circa 1970s, that has severe structural issues, and its replacement with 27 No. affordable dwellings: 16 No. 1-bed flats (at 43.5-55.5m²), 8 No. 2-bed flats (at 61-85m²), and 3 No. 3-bed flats (at 86m²). It will incorporate 3 No. wheelchair units on the ground floor, and provision of cycle / refuse / recycling storage, 6 No. parking spaces, a delivery bay, and associated amenity space.

For 'major' new-build residential schemes, the following policy standards apply:

Approved Document Part L1A 2021 – Proposed new dwellings must meet minimum energy performance requirements, and shall not exceed CO₂ emission, target fabric energy, and target primary energy rates.

London Plan 2021 SI 2 – Developments should be 'net zero-carbon', in accordance with the energy hierarchy of Be Lean, Be Clean, Be Green and Be Seen. That a minimum on-site CO₂ reduction of at least 35% beyond Building Regulations 2013 be demonstrated, together with 10% through energy efficiency measures. However, where zero-carbon target cannot be achieved, a cash-in-lieu contribution will be sort for the boroughs carbon offset fund.

LBRuT Local Plan 2018 LP22 – The London Borough of Richmond upon Thames (LBRuT) requires the following of the London Plan standards, together with the completion of the Sustainable Construction Checklist (June 2020), and water conservation measures demonstrating a maximum water consumption of 110 litres per person per day, including an allowance of 5 litres.

2.0 LBRUT Sustainable Construction Checklist

2.1 SCC Requirements:

The Sustainable Construction Checklist (June 2020) states that all developments and applications undertaken in the LBRuT will be expected to be assessed against the following seven checklist items:

Category	Score
Minimum Policy Compliance 1B (Residential)	
Energy Use and Pollution	19
Transport ¹	9
Biodiversity	19.5
Flooding and Drainage	13
Improving Resource Efficiency	4
Accessibility	4
TOTAL	69.5

An overall score of **69.5 credits** is achieved, or an **A+** rating – 'project strives to achieve higher standard in energy efficient sustainable development'. Please see **Appendix A** for the completed Sustainable Construction Checklist.

3.0 Water Efficiency Standards New Homes

The LBRuT has adopted the 'optional' higher national technical standard for water consumption of 110 litres per person per day (including an allowance of 5 litres or less per person per day for external water consumption) in line with the national technical standard set out in Part G2 of the Building Regulations (updated 2016). All new residential developments including conversions, reversions, change of use and extensions that create one or more new dwellings must meet this target.

Within the Building Regulations Approved Document G2, maximum flow rates of specific fittings are specified, which cannot be exceeded, and are listed below:

WC full/part flush: 4/2.6 litres (dual flush)
Shower: 8 litres/minute
Bath capacity: 170 litres to overflow
Basin taps: 5 litres/minute
Kitchen taps: 6 litres/minute

This is further supported by the LBRuT Sustainable Construction Checklist (June 2020) Policy 1B Minimum Policy Compliance (Residential) - Water Usage. It specifies that calculations using a 'water efficiency calculator' need to be submitted to demonstrate compliance.

Therefore, a completed water efficiency calculation has been carried out and the results page is appended to this report. It demonstrates the achieved reduction of this higher standard of water consumption efficiency of 101.31 litres person per day on average per each new dwelling. Please refer to Appendix E for the water calculator results.

4.0 Energy Strategy

This section sets out the detailed analysis and results of the annual CO₂ emission calculations of the proposed dwellings. The building has been modelled using the Government Standard Assessment Procedure – SAP 10, to determine the impact of building services options and to investigate the use of renewable energy sources, and their impact on emissions. The reductions of CO₂ emissions achieved through the application of renewable energy technologies have been tested and calculated in accordance with LBRuTs' Sustainable Construction Checklist Guidance adopted in June 2020.

To achieve the targets set out in policy, the following energy hierarchy has been adhered to, based on the London Plan.

- **Be Lean:** Reduce the energy demand through fabric efficiency measures building form, thermal envelope, reduced air permeability, and daylighting strategy.
- **Be Clean:** Connection and use, where possible, of District Heating (DH) networks or Combined Heat and Power (CHP), or through the supply of energy for space and water heating via small-scale, low or zero carbon technologies.
- **Be Green:**, The production, storing and use of renewable energy on-site.
- **Be Seen:** Monitor, verify and report on-site energy consumption.

Be lean: use less energy

Energy efficiency target

Be clean: supply energy efficiently

Be green: use renewable energy

Offset

This sustainability approach is clearly set out with the following diagram:

4.1 Renewable / Low or Zero Carbon Technologies

The London Plan 2021 stipulates that the development plans for all London Boroughs should eventually comply with the requirements set out in the plan. The Mayor's Energy Hierarchy, described in the London Plan, comprises 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 service systems, and renewable energy systems have been investigated.

Zero carbon target

Further information and specification of renewables that are considered appropriate for the development are provided in **Appendix F**. This includes considerations for monitoring of energy demand and use, as well as CO₂ emissions to ensure planning commitments are delivered, plus display Energy Certificates (DEC) and reporting to The Mayor for at least five years via an online portal to enable the GLA to identify good practice and reporting on the operational performance of new developments in London (London Plan 2021, Policy S1 2, paragraph 9.2.10).

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 following summarises the systems available and their suitability for this project:

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Renewable energy technologies suitable for London

System	Preliminary Assessment	Decision
Wind generators	Planning and local community issues associated with noise and visual obstruction.	Rejected
Photovoltaic	The building has a flat green roof that can be used for photovoltaic	Likely to
panels	panels. They will be angled to target best orientation. PV panels are a	be suitable
	commonly used renewable technology and not prohibitively expensive.	for this site
Solar water	As above, the building has a sufficient flat roof that can be used for Solar	May be
heating	Thermal tubes. However, the contribution of solar hot water towards	suitable for
panels	the LBRUT 20% renewables requirement is significantly lower than the	this site
	contribution of Photovoltaic Panels. The reason being that the solar	
	water panels reduce the running times of boilers for space and hot	
	water generation, whereas PVs reduce the electricity consumption of the	
	building, and electricity generation has a larger carbon footprint.	
Biomass CHP	Biomass CHP is a renewable and energy efficient system providing	
	electricity and space and hot water heating. As this is a small-scale	Rejected
	development, it is not suitable for a communal biomass CHP. Micro	
	biomass CHPs are not readily available on the open market and there	
6 1	are limited suppliers to the London area.	1.00
Ground source	The site is likely suitable for a vertical borehole system, with the removal	Likely to
heat pumps for	of the existing tower block and its subsequent foundations, with a level	be suitable
heating - space	of ground works being required already.	for this site
and hot water		D "11
Ground sourced	There is no need of a mechanical cooling system.	Possibly
inc. borehole		suitable for
cooling, either		this site
direct or via a		
chiller		

Acceptable renewable energy technologies (not covered in detail in the toolkit); 'London renewables, Toolkit for planners, developers and consultants' September 2004

System	Preliminary Assessment	Decision
Micro-hydro, small and low head	Not appropriate for this suburban London location.	Rejected
Gas from anaerobic digestion	Technology being developed.	Rejected
Geothermal heat, hot rocks	Could be available in London but unlikely due to expected locations geology.	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/)

LZC technologies (not covered in the toolist, www.lowcarbonbulldings.org.arxinicror)				
System	Preliminary Assessment	Decision		
Air source heat	Air is an easily accessible means of heating especially with the use of a	Likely to		
pumps (ASHP)	low temperature system such as under floor heating. As it runs on	be suitable		
for heating -	electricity, the system could use the energy generated from PV panels	for this site		
space and	and it is preferred small-scale renewable tech.			
domestic hot				
water)				

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Micro Combined Heat and Power (CHP)	Micro CHP units are energy efficient systems generating electricity and providing space and hot water heating. Gas fired systems are available for domestic use, in larger developments. However, the proposal is too small to gain any meaningful benefit from this type of system.	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 Calculations and Results

Options have been modelled using the approved SAP 10 to calculate the energy use of the properties and predict the reduction of CO_2 emissions achieved via fabric efficiencies, and through the application of renewable energy technologies. The software used will be Elmhurst Energy's Design SAP 10 which is widely used for building energy calculations throughout the construction (on-construction) industry.

A 'worst case' dwelling is used to generate typical results, using the 'Limiting' dwelling specification Table 4.1 of the Building Regulations Part L1A (refer to table in **Appendix B**). This then sets a benchmark or 'Baseline' case. It is then re-calculated based on the Part L1A methodology of an average target primary energy rate, target emission rate and target fabric energy efficiency rate calculated as an alternative to individual target rates for each dwelling. The floor-area-weighted average should be calculated using the following formula:

[(target primary energy rate1 × floor area1) + (target primary energy rate2 × floor area2) + (target primary energy rate3 × floor area3) + ...]

(floor areal + floor area2 + floor area3 + ...)

From this point in the assessment, the apartments are re-calculated based upon the 'notional dwelling specification for new dwelling', Table 1.1 of the Building Regulations Part L1A (refer to table in **Appendix B**). This sets a benchmark of results or an 'Improved' case.

The re-calculation looks at each stage of the assessment hierarchy:

- **Be Lean:** Utilising 'notional' U-values for new fabric elements and air permeability in the new dwellings, BRegs LTA, Table 4.1.
- **Be Clean:** Change of space and water heating away from mains gas to ground source heat pumps, with a combined system linked to individual heat pump units within each apartment.
- Be Green: The introduction of on-site renewable energy in the form of photovoltaic arrays.

The results are documented below, with full SAP outputs provided in Appendices C & D.

Baseline Case 'Limiting' Specification	Results (per unit)
Target Primary Energy Rate	69.86 kWh/m²/yr
CO2 Emission:	I.7 t/yr
DER:	23,29 kgCO₂/yr/m²
TER:	13.14 kgCO₂/yr/m²
%DER <ter:< td=""><td>-77.25%</td></ter:<>	-77.25%

Improved Case 'Notional' Specification	Results (per unit)	
Target Primary Energy Rate	67.62 kWh/m²/yr	
CO2 Emission:	0.51 t/yr	
DER:	6.99 kgCO ₂ /yr/m ²	
TER:	12.72 kgCO ₂ /yr/m ²	
%DER <ter:< td=""><td>45.05%</td></ter:<>	45.05%	

4.3 SAP Specification and Variance Reductions

Below are the specification data used with the SAP 10, related to both the baseline and improved cases. The variance between the DER and TER are then calculated, together with the percentage reductions with energy efficient measures and renewables:

Option	Typical Dwelling Specification	DER/TER Variance LBRUT TARGET 35% reduction (minimum)	% Reduction through energy efficient measures	% Reduction through renewables
Baseline Case (Limiting)	U-values in accordance with B.Regs Part L1A 2021 Edition – Limiting U-values for new fabric elements and air permeability in new dwellings (Table 4.1) - Roof U = 0.16 W/m²K - External walls U = 0.26 W/m²K - Floor U = 0.18 W/m²K - Windows (double-glazed) U = 1.6 W/m²K - Front door (solid) U = 1.6 W/m²K - Thermal bridging: standard psi values - Air permeability 8.0 m³/hrm² - Combination gas boiler - Underfloor heating (in screed) and radiators - No PV panels - Passive (natural) ventilation - 100% energy efficient lighting	-77.25% Not compliant.	N/A Not compliant.	N/A Not compliant.
Improved Case	U-values in accordance with B.Regs Part L1A 2021 Edition – Notional dwelling specification for new dwelling (Table 1.1). Plus low carbon / renewable measures to reach LBRuT carbon reduction targets. - Roof U = 0.11 W/m²K - External walls U = 0.18 W/m²K - Floor U = 0.13 W/m²K - Windows (double-glazed) U = 1.2 W/m²K - Front door (solid) U = 1.0 W/m²K - Thermal bridging: Default psi values - Air permeability 5.0 m³/hrm² - Space heating and hot water provided by vertical bore ground source heat pumps (wet system), plus individual	45.05% Compliant.	35.88% Compliant.	5.88% Compliant.

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'Shoebox' GSHP		
- 150L storage cylinder per each 1B/2P, 170L storage		
cylinder per 2B4P units, & 170L storage cylinder per		
3B6P units		
- Underfloor heating and radiators		
- 2 × 455 kW PV panels per unit		
- Passive (natural) cross-ventilation		
- 100% energy efficient lighting		

4.4 CO2 Emission Calculations and Reductions

All the 27 dwellings have been modelled and the total tonnes of CO_2 emissions per year has been calculated. This is used to outline any possible cash-in-lieu contribution to the borough carbon offset fund, generated over 30 years at the nationally recognized non-traded price of £95, as required for 'major' residential developments.

The results below show the total tonnes of CO_2 per stage, based upon the 'worst' case scenario multiplied by the number of units. However, the 'actual' result is based on the exact modelling of all 27 units, showing a 'calculated' improvement. The results are:

Hierarchy	Total Tonnes CO ₂ Emissions	Reduction No.	Reduction %
Baseline (Limiting)	45.9	0	0%
Be Lean (Fabric)	39.96	-5.94	12.94%
Be Clean (Heating/hot water)	16.47	-23.49	51.18%
Be Green (Renewables)	13.77	-2.7	5.88%
Improved	13.77	-32.13	70.00%
Actual (Calculated)	8.82		

4.5 Calculations – Regulated and Unregulated Energy

Below are the results of the assessment on estimated energy consumption related to both regulated and unregulated operation energy:

		Total kWhlyr	
	Baseline Case (Unit 1)	Improved Case (Unit 1)	Multiplied by 27 units
Regulated Energy			
Space Heating	2829.1458	2707.0316	15348.8682
Hot Water Heating	2883.5522	2835.6133	16077.9276
Fixed Electrical	86.0	86.0	322.0911
Lighting	197.3090	197.3090	768.9006
Un-regulated Energy			
Cooking/appliances	11.34	11.34	306.18
Less renewables	0	-376.3322	-2978.6076
Total	6007.347	5460.9617	29845.3599

4.6 Conclusion

The proposal gives an opportunity to provide a new affordable, residential development of 27 No. units in a 5-storey block, appropriate to the scale of the site and the neighbouring buildings, improving the long-term sustainability of the site. Much attention has been given to reducing the environmental impact of the building during its lifetime. The project suggests a structure of significantly improved fabric performance complemented with the incorporation of renewables that ensure less CO₂ emissions demonstrating compliance with local and regional policies.

The results show that providing PV panels for energy generation and ground-source heat pumps for space and water heating will be most appropriate and practical strategy to meet the energy efficiency and carbon reduction targets set by the council and central government. This report demonstrates compliance with the required standards and policies set out by LBRuT and their adopting of the London Plan:

- The proposal can achieve the required reduction of carbon dioxide emissions, with a demonstrated 45.05% reduction over Building Regulations Part LTA, bettering the reduction target of 35%;
- Provides a portion of **35.88%** reduction in CO₂ emissions and CO₂ sequestration through the provision of energy efficiency measures, in this case with ground source heat pumps, bettering the target of 10%;
- Provides a **5.88%** reduction of predicted carbon emissions through the use of small-scale renewable energy technologies, in this case with PV arrays;
- Achieves an A+ rating assessed against the LBRUT Sustainable Construction Checklist 2020
- Achieves the higher standard of water consumption efficiency of IOI.31 litres person per day per one new dwelling;

Additional Note – Following the adoption of Approved Document O - 'Overheating', the scheme has been assessed and a number of possible measures have been suggested, to mitigate any future possibility of overheating. These include peak-lopping Mechanical Ventilation Heat Recovery (MVHR), or Ground Source Heat Pumps (GSHPs) with cooling. These measures will need to be further assessed during the detailed design stage by the future appointed MEP consultants, to assess the suitability and cost effectiveness for the project. Therefore, this assessment is a benchmark for compliance, and will need to be re-evaluated for Building Control compliance.

Appendix A - LBRUT Sustainable Construction Checklist

LBRUT Sustainable Construction Checklist - June 2020

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.

Property Name (if relevant):	Sheldon House Residential Development	Application No. (if known): N/A		
Address (include, postcode)	Sheldon House, 8 Cromwell Road, Teddington			
Completed by:	Sileidon House, & Cromwell Road, Teddington			
	Clive Chapman Architects			
For Non-Residential		For Residential		
Size of development (m2)		Number of dwellings 27		
,				
1 MINIMUM COMPLIAN	NCE (RESIDENTIAL AND NON-RESIDENTIAL			
Energy Assessment				
	sment been submitted that demonstrates the expected energy and carbon dioxide en	missions saving from energy efficiency and	TRUE	
	easures, including the feasibility of CHP/CCHP and community heating systems? If ye			
Carbon Dioxide emissions re What is the on site car	eduction irbon dioxide emissions reduction against a Building Regulations Part L (2013) baseli	ine	45.05 %	
	Oraft London Plan Policy 9.2.5 require a 35% onsite reduction in CO 2 emissions bey		,5	
•				
	ge reduction from efficiency measures alone		35.88 %	
	Oraft London Plan Policy 9.2.6 require a 10% onsite reduction in CO2 emissions			
beyond Building Regi	ulations 2013 from efficiency measures for residential and 15% for non-residential.			
Percentage of total si	ite CO2 emissions saved through renewable energy installation?		5.88 %	
_	-			
	aining carbon to be offset		13.77 Tonne	
Policy LP 22 B. and D	Oraft London Plan Policy 9.2.4 require Major developments to achieve Zero Carbon at	fter offsetting.		
Are remaining emission	ons going to be offset through offset fund payment in accordance with current guideli	ines issued for the cost per tonne of CO2?	TRUE	
		·		
What is the total predi	icted cost of offset? s this as £95/tonne per year over 30 years, this should be updated based on As Build	1 coloulations	39244.5 £	
The London Plan Sets	s triis as £95/torine per year over 50 years, triis snould be updated based on As Build	r Calculations.		
1A MINIMUM POLICY CO	OMPLIANCE (NON-RESIDENTIAL AND DOMESTIC REFURBISHMENT			
	Please check the Guidance Section of this SPD for the p	policy requirements		
Environmental Rating of deve	elopment:	<u> </u>		
Non-Residential new-build (100				
BREEAM Level	Please Select	Have you attached a pre-assessment to support this?		Please Select:
Excellent required under Policy Extensions and conversions for				
BREEAM Domestic R		Have you attached a pre-assessment to support this?		Please Select:
Excellent required under Policy	y LP22 A 4	, , , , , , , , , , , , , , , , , , , ,		
Extensions and conversions for				D
BREEAM Level Excellent required under Policy	Please Select	Have you attached a pre-assessment to support this?		Please Select:
Excellent required under 1 one	y Li 22			
Score awarded for En	· · · · · · · · · · · · · · · · · · ·		Subtotal 0	
BREEAM:	Good = 0, Very Good = 4, Excellent = 8, Outstanding = 16			
1B MINIMUM POLICY CO	OMPLIANCE (RESIDENTIAL)			
			Score	
Water Usage	ofter groutesing ator evertome limited to 105 litros person per day. (Evaluding an ellaur	ance E litros per person per day for external water		
	after gray/rainwater systems limited to 105 litres person per day. (Excluding an allowa ations using the water efficiency calculator for new dwellings have been submitted.	ance o intes per person per day for external water	1	TRUE
	new dwellings under Policy I P22 A 2 105l/p/d required under Draft London Plan Poli	icv SI5	•	

Subtotal 1

	ERGY USE AND POLLUTION			
	eed for Cooling	Score		
a.	How does the development incorporate cooling measures? Tick all that apply: Energy efficient design incorporating specific heat demand to less than or equal to 15 kWh/sqm		6	FALSE
	Reduce heat entering a building through providing/improving insulation and living roofs and walls		2	TRUE
	Reduce heat entering a building through shading		3	TRUE
	Exposed thermal mass and high ceilings		4	FALSE
	Passive ventilation		3	TRUE
	Mechanical ventilation with heat recovery		1	FALSE
	Active cooling systems, i.e. Air Conditioning Unit		0	FALSE
	See Draft London Plan SI4			
2.2 He	pat Generation			
b.	How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy S13) Tick all heating and			
	cooling systems that will be used in the development:	Score		
	Connection to existing heating or cooling networks powered by renewable energy		6	FALSE
	Connection to existing heating or cooling networks powered by gas or electricity		5	FALSE
	Site wide CHP network powered by renewable energy Site wide CHP network powered by gas		<i>4 3</i>	FALSE FALSE
	Communal heating and cooling powered by gas		2	FALSE
	Communal heating and cooling powered by gas or electricity		1	FALSE
	Individual heating and cooling		0	TRUE
	See Draft London Plan SI3			
	Illution: Air, Noise and Light			TOUT
a.	Does the development plan to implement reduction strategies for dust emissions from construction sites?		2	TRUE
b.	Does the development plan to include a biomass boiler?			FALSE
ъ.	If yes, please refer to the biomass guidelines for the Borough of Richmond, please see guidance for supplementary			IALUL
	information. If the proposed boiler is of a qualifying size, you may need to complete the information request form found on			
	the Richmond website.			
C.	Has an air quality impact assessment been provided			TRUE
	If yes, has 'Emissions Neutral' been achieved		1	TRUE
	If yes, have occupants of new development been protected from existing pollution		1	TRUE
	If no to any of the above are there any sensitive receptors as defined in Policy LP 10 present?		-1	FALSE
	see Policy LP 10			
d.	Please tick only one option below			
	Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site?		3	TRUE
	Has the development taken care to not create any new noise generation/transmission issues in its intended operation?		1	TRUE
			,	
	see Policy LP 10		•	
e	see Policy LP 10			
e.			3	TRUE
e. f.	see Policy LP 10 Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity?			
	see Policy LP 10 Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? see Policy LP 10	0	3	
f.	see Policy LP 10 Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? see Policy LP 10 Have you attached a Lighting Pollution Report?	Subto	3	
f. Please	see Policy LP 10 Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? see Policy LP 10 Have you attached a Lighting Pollution Report? e give any additional relevant comments to the Energy Use and Pollution Section below		3	
f. Please With re	Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? see Policy LP 10 Have you attached a Lighting Pollution Report? e give any additional relevant comments to the Energy Use and Pollution Section below egards to air quality, though no specific 'mechanical' measures have been proposed to protect residents, the design follows passive 'natural' ventilation as a best practice ment for this site as the results of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the process of the Air Quality Impact Assessment demonstrate nitrogen oxide and particulates concentrations are below the objective in the 'without' developing the Air Quality Impact Assessment demonstrates nitrogen oxide and particulates oxide and the 'without' developing the Air Quality Impact A	asure. This is ment scenarios	3 - tal 19	
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	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	BIODIVERSITY	
		imising the threat to biodiversity from new buildings, lighting, hard surfacing and people Does your development involve the loss of an ecological feature or habitat, including a loss of garden or other green space? (Indicate if yes) -2	FALSE
	a.	If so, please state how much in sqm? Osm	IALUE
	b.	Does your development involve the removal of any tree(s)? (Indicate if yes)	TRUE
		If so, has a tree report been provided in support of your application? (Indicate if yes)	TRUE
	c.	Does your development plan to add (and not remove) any tree(s) on site? (Indicate if yes)	FALSE
	٠.	2000 your development place to date for remove) any acception offer (managem year)	IALUL
	d.	Please indicate which features and/or habitats that your development will incorporate to improve on site biodiversity:	
		Pond, reedbed or extensive native planting 6 Area provided: 34 sqm	TRUE
		An extensive green roof 5 Area provided: 226 sqm An intensive green roof 4 Area provided: 0 sqm	TRUE FALSE
		Administrate great not 4 Area provided: Usym	TRUE
		Additional native and/or wildlife friendly planting to peripheral areas 3 Area provided: 405 sqm	TRUE
		Additional planting to peripheral areas 2 Area provided: sqm	FALSE
		A living wall 2 Area provided: sqm	FALSE
		Bat boxes 0.5 Bird boxes 0.5	TRUE TRUE
		But blokes U.5 Swift boxes U.5	TRUE
		Other 0.5	FALSE
	۵	Does your development use at least 70% of available roof plate as green/brown roof	Please Select:
	e.	Does your development use at least 70% of available roof plate as green/brown roof 1 Policy LP 17 requires 70%	i lease select.
		Subtotal 19.5	
		give any additional relevant comments to the Biodiversity Section below	
	The pro	posal will increase the area provided for landscaping and garden amenity by the removal of the existing frontage hardstanding for car parking, whilst placing a proportion of the new parking	
	within a	in undercroft. The new parking area will be permeable.	
,	5	FLOODING AND DRAINAGE	
.1	Mitigati a.	ing the risks of flooding and other impacts of climate change in the borough Is your site located in a high flood risk zone (Zone 3)? (Indicate if yes) -2	FALSE
	a.	is your site located in a riigh nlood risk zone (zone 3)? (iniciate it yes) -2 Have you submitted a Flood Risk Assessment? (Indicate if yes)	FALSE
		joe edunined a ribbe ribbi ribbi (maledon yeb)	
	b.	Which of the following measures of the drainage hierarchy are incorporated onto your site? (tick all that apply)	
		Store rainwater for later use 5	TRUE
		Use of infiltration techniques such as porous surfacing materials to allow drainage on-site Attenuets injunctor in page or propy water features.	TRUE
		Attenuate rainwater in ponds or open water features Store rainwater in tanks for gradual release to a watercourse 3	TRUE FALSE
		Sioner railwater in tains for gradual release to a watercourse Discharge railwater directly to watercourse 2	FALSE
		Discharge rainwater to surface water drain 1	TRUE
		Discharge rainwater to combined sewer 0	FALSE
		Have you submitted a Drainage Statement (Indicate if yes)	FALSE
	•	See Policy LP 21 and Draft London Plan SL 13 Please give the change in area of permeable surfacing which will result from your development proposal: 194 sqm	
	C.	Please give the change in area of permeable surfacing which will result from your development proposal: Please provide details of the permeable surfacing below please represent a loss in permeable area as a negative number	
		rease provide details of the permeasure surfacing delow please represent a loss in permeasure area as a regainer number Subtotal 13	
		give any additional relevant comments to the Flooding and Drainage Section below	
		velopment increases the permeable area with increased gardens/landscaping, together with a permeable parking area (resin bound gravel), all aiding natural drainage. A flat green roof is	
	all propo	osed providing additional attenuation.	
	6 0.4 Dead	IMPROVING RESOURCE EFFICIENCY	
	6.1 Red a.	duce waste generated and amount disposed of by landfill though increasing level of re-use and recycling Will demolition be required on your site prior to construction? [Points will only be awarded if 10% or greater of demolition waste is reused/recycled] 1	TRUE
	a.	I understand the required on your site prior to constitutions: It office will only be awarded in 10% of greater or demonstration waste is reuseuffectively.	INUE
		If so, what percentage of demolition waste will be reused in the new development?	
		What percentage of demolition waste will be recycled? 5 %	
	b.	Does your site have any contaminated land?	FALSE
		Have you submitted an assessment of the site contamination?	FALSE
		Are plans in place to remediate the contamination?	FALSE
		Have you submitted a remediation plan?	FALSE
		Are plans in place to include composting on site?	TRUE
	•	Will a waste management plan and facilities he in place in line with Paliay I P24	
	C.	Will a waste management plan and facilities be in place in line with Policy LP24	
	6.2 Red	ducing levels of water waste	
	a.	Will the following measures of water conservation be incorporated into the development? (Please tick all that apply):	
		Fitting of water efficient taps, shower heads etc	TRUE
		Use of water efficient A or B rated appliances 1 Rainwater harvesting for internal use 4	TRUE FALSE
		Rainwater harvesting for internal use 4 Greywater systems 4	FALSE
		Orlegwater systems Fit a water meter 1	TRUE
		Subtotal 4	
	Please	give any additional relevant comments to the Improving Resource Efficiency Section below	

٤	nsure flexible adapt	table and long-	erm use of structures				
lf	the development is	residential, wil	it meet the requirements of the nationally described space standard for internal space and			1	
		If the standard	s are not met, in the space below, please provide details of the functionality of the internal	space and layout		I	
						İ	
16	the development is	recidential wil	it meet Building Regulation Requirement M4 (2) 'accessible and adaptable dwellings'?			2	
"	the development is		et, in the space below, please provide details of any accessibility measures included in the	development.		2	
						ı	
			lential developments, are 10% or more of the units in the development to Building Regulati	ion Requirement		1	
		M4 (3) 'wheel	hair user dwellings'?				
If	the development is	non-residentia	does it comply with requirements included in Richmond's Local Plan LP1, LP28.B, LP30	& LP45		2	Ple
	and doveropinone to		, asses it comply that requirements instauce in radiinstale 2004. Fig. 1, 21 20.0, 21 00 t	u 20		_	
		Please provid	details of the accessibility measures specified in the Local Plan that will be included in the	e development		•	
e aiv	e any additional relev	ant comments t	the Design Standards and Accessibility Section below			Subtotal	4
	e any additional relev elchair dwellings M4(3		the Design Standards and Accessibility Section below proporated.			Subtotal	4
						Subtotal	4
Whee	elchair dwellings M4(3) have been ind	orporated.	c refurb)			5
Whee	elchair dwellings M4(3) have been ind		c refurb)		Subtotal TOTAL 69.	5
Whee	inable Construction Score 84 or more	n Checklist- Sc. Rating A+	ring Matrix for New Construction (Non-Residential and domestic Significance Project strives to achieve highest standard in energy efficient sustainable development	c refurb)			5
Whee	inable Construction Score 84 or more 75-83	n Checklist- Score Rating A+ A	ring Matrix for New Construction (Non-Residential and domestic Significance Project strives to achieve highest standard in energy efficient sustainable development Makes a major contribution towards achieving sustainable development in Richmond	c refurb)			5
Whee	inable Construction Score 84 or more 75-83 56-74	n Checklist- Sca Rating A+ A B	ring Matrix for New Construction (Non-Residential and domestic 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	c refurb)			5
Whee	inable Construction Score 84 or more 75-83	n Checklist- Score Rating A+ A	ring Matrix for New Construction (Non-Residential and domestic 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 sustainablity beyond general compliance	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less	n Checklist- Sc Rating A+ A B C FAIL	ring Matrix for New Construction (Non-Residential and domestic 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less	n Checklist- Sc Rating A+ A B C FAIL	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less	n Checklist- Sc Rating A+ A B C FAIL	ring Matrix for New Construction (Non-Residential and domestic 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more	n Checklist- Sc. Rating A+ A B C FAIL n Checklist- Sc. Rating A+ A+ A B C FAIL	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more	n Checklist- Sc Rating A+ A B C FAIL n Checklist- Sc Rating A+ A	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher standard in energy efficient sustainable development	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A++ A+	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher standard in energy efficient sustainable development Makes a major contribution towards achieving sustainable development in Richmond	c refurb)			5
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Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58 24-38	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A A+ B C Rating A++ A+ A+ A+ B C C Rating A++ A+ A+ A+ A+ A+ B C C	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58	n Checklist- Sc Rating A+ B C FAIL n Checklist- Sc Rating A+ A+ A+ A+ B	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	e refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58 24-38	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A A+ B C Rating A++ A+ A+ A+ B C C Rating A++ A+ A+ A+ A+ A+ B C C	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58 24-38 23 or less	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A+ A B C FAIL Checklist- Sc.	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58 24-38 23 or less	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A+ A B C FAIL Checklist- Sc.	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	c refurb)			5
Susta	inable Construction Score 84 or more 75-83 56-74 40-55 39 or less inable Construction Score 85 or more 68-84 59-67 39-58 24-38 23 or less	n Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A+ A B C FAIL Checklist- Sc. Rating A++ A+ A B C FAIL Checklist- Sc.	ring Matrix for New Construction (Non-Residential and domestic 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 ring Matrix for New Construction Residential new-build Significance Project strives to achieve highest standard in energy efficient sustainable development Project strives to achieve higher 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	c refurb)	Date		5

Appendix B - Building Regulations Part L1A Notional & Limited Tables

Table 1.1 Summary of notional d	welling specification for new dwelling ⁽¹⁾
Element or system	Reference value for target setting
Opening areas (windows, roof windows, rooflights and doors)	Same as for actual dwelling not exceeding a total area of openings of 25% of total floor area $^{(2)}$
External walls including semi-exposed walls	$U = 0.18 \text{ W/(m}^2 \cdot \text{K)}$
Party walls	U = 0
Floors	$U = 0.13 \text{ W/(m}^2 \cdot \text{K)}$
Roofs	$U = 0.11 \text{ W/(m}^2 \cdot \text{K)}$
Opaque door (less than 30% glazed area)	$U = 1.0 \text{ W/(m}^2 \cdot \text{K)}$
Semi-glazed door (30–60% glazed area)	$U = 1.0 \text{ W/(m}^2 \cdot \text{K)}$
Windows and glazed doors with greater than 60% glazed area	$U = 1.2 \text{ W/(m}^2 \cdot \text{K)}$ Frame factor = 0.7
Roof windows	U = 1.2 W/($m^2 \cdot K$), when in vertical position (for correction due to angle, see specification in SAP 10 Appendix R)
Rooflights	U = 1.7 W/(m^2 -K), when in horizontal position (for correction due to angle, see specification in SAP 10 Appendix R)
Ventilation system	Natural ventilation with intermittent extract fans
Air permeability	5 m³/(h·m²) at 50 Pa
Main heating fuel (space and water)	Mains gas
Heating system	Boiler and radiators Central heating pump 2013 or later, in heated space Design flow temperature = 55 °C
Boiler	Efficiency, SEDBUK 2009 = 89.5%
Heating system controls	 Boiler interlock, ErP Class V Either: single storey dwelling in which the living area is greater than 70% of the total floor area: programmer and room thermostat any other dwelling: time and temperature zone control, thermostatic radiator valves
Hot water system	Heated by boiler (regular or combi as above) Separate time control for space and water heating
Wastewater heat recovery (WWHR)	All showers connected to WWHR, including showers over baths Instantaneous WWHR with 36% recovery efficiency utilisation of 0.98
Hot water cylinder	If cylinder, declared loss factor = $0.85 \times (0.2 + 0.051 \text{ V}^{2/3}) \text{ kWh/day}$ where V is the volume of the cylinder in litres
Lighting	Fixed lighting capacity (lm) = 185 × total floor area Efficacy of all fixed lighting = 80 lm/W
Air conditioning	None
Photovoltaic (PV) system	For houses: kWp = 40% of ground floor area, including unheated spaces \angle 6.5 For flats: kWp = 40% of dwelling floor area \angle (6.5 × number of storeys in block)
	System facing south-east or south-west

- NOTE:
 1. For a dwelling connected to an existing district heat network, an alternative notional building is used. See paragraph 1.8 and SAP 10.
 2. See SAP 10 for details.

Table 4.1 Limiting U-values for new fabric	elements and air permeability in new dwellings
Element type	Maximum U-value ⁽¹⁾ W/(m²·K)
All roof types ⁽²⁾	0.16
Wall ⁽²⁾	0.26
Floor	0.18
Party wall	0.20
Swimming pool basin ⁽³⁾	0.25
Window ⁽⁴⁾⁽⁵⁾	1.6
Rooflight ⁽⁶⁾⁽⁷⁾	2.2
Doors (including glazed doors)	1.6
Air permeability	8.0m³/(h·m²) @ 50Pa
	1.57m³/(h·m²) @ 4Pa

NOTES:

- 1. Area-weighted average values.
- 2. For dormer windows, 'roof' includes the roof parts of the windows and 'wall' includes the wall parts (cheeks).
- 3. The U-value of a swimming pool basin (walls and floor) calculated according to BS EN ISO 13370.
- 4. If performance requires thicker glass to be used, an equivalent window unit with standard thickness (6mm) glazing should be shown to meet the required standard.
- 5. Including roof windows and curtain walling.
- 6. U-values for rooflights or rooflight-and-kerb assemblies should be based on the developed surface area of the rooflight (U_d-values), which is often greater than the area of the roof opening. Further guidance on U_d-values is given in the Building Research Establishment's BR 443 and the National Association of Rooflight Manufacturers' Technical Document NTD02.
- 7. The limiting value for rooflights also applies to kerbs that are supplied as part of a single rooflight-and-kerb assembly sourced from the same supplier and for which the supplier can provide a combined U_d -value for the assembly. An upstand built on site should not exceed a U-value of 0.35W/(m^2 -K).

Appendix C - SAP Worksheets - Improved Scenario



Property Reference	SH		Issued on Date	17/11/2022		
Assessment Reference	Unit 1 - Improved		Prop 1	Type Ref	Flats	
Property	Sheldon House, 8, Cromwe	ell Road, Teddington, London, TW11	9EJ			
SAP Rating		70 C	DER	6.99	TER	12.72
Environmental		94 A	% DER <ter< td=""><td>45.05</td><td></td><td></td></ter<>	45.05		
CO ₂ Emissions (t/year)		0.51	DFEE	52.21	TFEE	35.86
Compliance Check		See BREL	% DFEE < TFEE	-45.57		
% DPER < TPER		-10.79	DPER	74.92	TPER	67.62
Assessor Details	Mr. Andrew Gilbert				Assessor ID	U888-0001
Client	RHP					

SAP 10 WORKSHEET FOR New Build (As Designed) CALCULATION OF DWELLING EMISSIONS FOR REGULATI	ONS COMPLIANO	CE	2022)							
1. Overall dwelling characteristics						Chana				
Ground floor Total floor area TFA = $(1a)+(1b)+(1c)+(1d)+(1e)$	e)(1n)	8	6.0000		Area (m2) 86.0000	•	/ height (m) 2.5000	(2b) =	Volume (m3) 215.0000	
Dwelling volume	, , ,				(3	a)+(3b)+(3c)+	(3d)+(3e)	(3n) =	215.0000	
2. Ventilation rate									2 man hawa	
Number of open chimneys								0 * 80 =	<pre>3 per hour 0.0000</pre>	
Number of open flues Number of chimneys / flues attached to closed Number of flues attached to solid fuel boiler	fire							0 * 20 = 0 * 10 = 0 * 20 =	0.0000	(6c)
Number of flues attached to other heater Number of blocked chimneys								0 * 35 = 0 * 20 =	0.0000 0.0000 0.0000	(6e)
Number of intermittent extract fans Number of passive vents Number of flueless gas fires								2 * 10 = 0 * 10 = 0 * 40 =	20.0000 0.0000 0.0000	(7b)
Infiltration due to chimneys, flues and fans	= (6a)+(6b)-	+(6c)+(6d)+(6e)+(6f)+(5g)+(7a)+(3	7b)+(7c) =		20.0000	Air change / (5) =	0.0930	(8)
Pressure test Pressure Test Method Measured/design AP50								В	Yes lower Door 8.0000	
Infiltration rate Number of sides sheltered									0.4930 2	(18) (19)
Shelter factor Infiltration rate adjusted to include shelter	factor					(20) = 1 - (21)		(19)] = x (20) =	0.8500 0.4191	
Jan Feb Mar Wind speed 5.1000 5.0000 4.9000	Apr 4.4000	May 4.3000	Jun 3.8000	Jul 3.8000	Aug 3.7000	Sep 4.0000	Oct 4.3000	Nov 4.5000	Dec 4.7000	
Wind factor 1.2750 1.2500 1.2250 Adj infilt rate 0.5343 0.5238 0.5134	1.1000 0.4610	1.0750 0.4505	0.9500 0.3981	0.9500 0.3981	0.9250 0.3876	1.0000 0.4191	1.0750 0.4505	1.1250 0.4715	1.1750 0.4924	
Effective ac 0.6427 0.6372 0.6318	0.6062	0.6015	0.5792	0.5792	0.5751	0.5878	0.6015	0.6111	0.6212	
3. Heat losses and heat loss parameter								_		
Element Opening Type 1 (Uw = 1.20)	Gross m2	Openings m2	Net.	m2	U-value W/m2K 1.1450	A x U W/K 17.2901		-value kJ/m2K	A x K kJ/K	
Opening Type 2 (Uw = 1.20) Heatloss Floor 1			6. 86.	1000 1000	1.1450 0.1300	6.9847 11.1800		0.0000	9460.0000	(27) (28a)
External Wall 1 External Wall 2	22.0000	9.9400	12.	9600	0.1800	2.1708	1	4.0000	168.8400	(29a)
External Wall 3	5.1500 10.5600	5.1600		1500 1000	0.1800 0.1800	0.9270 0.9720		4.0000 4.0000	72.1000 75.6000	(29a)

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Total net area Fabric heat los Party Wall 1 Party Wall 2 Party Wall 3 Party Wall 4 Party Floor 1 Party Ceiling 1 Internal Wall 2 Internal Wall 3	ss, W/K = S					11 4 17 16 55 86 22 5	.7500 (26)(.5700 .2500 .1200 .0600 .5700 .0000 .2500 .2500	30) + (32) = 0.0000 0.0000 0.0000 0.0000	= 41.85: 0.00(0.00(0.00(0.00(90 2 90 2 90 2 90 2 4 3	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 9.0000 9.0000 9.0000	231.4000 85.0000 342.4000 321.2000 2222.8000 2580.0000 47.2500 90.0000	(32) (32) (32) (32d) (32b) (32c) (32c)
Heat capacity (Thermal mass pa Thermal bridges Point Thermal b Total fabric he	arameter (T s (Default oridges	MP = Cm /)			(28).	(30) + (33	2) + (32a). 33) + (36)	(36a) =	16078.0000 186.9535 28.5500 0.0000 70.4038	(35) (36)
Ventilation hea	Jan 45.6028	culated mo Feb 45.2095	nthly (38)m Mar 44.8240	= 0.33 x (Apr 43.0134	25)m x (5) May 42.6747	Jun 41.0977	Jul 41.0977	Aug 40.8056	Sep 41.7051	Oct 42.6747	Nov 43.3600	Dec 44.0764	(38)
Heat transfer of Average = Sum(3	116.0066	115.6133	115.2279	113.4172	113.0785	111.5015	111.5015	111.2094	112.1089	113.0785	113.7638	114.4802 113.4156	
HLP HLP (average)	Jan 1.3489	Feb 1.3443	Mar 1.3399	Apr 1.3188	May 1.3149	Jun 1.2965	Jul 1.2965	Aug 1.2931	Sep 1.3036	0ct 1.3149	Nov 1.3228	Dec 1.3312 1.3188	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4 Natan baatir													
Assumed occupar Hot water usage	e for mixer 67.2585	66.2478	64.7749	61.9568	59.8771	57.5579	56.2396	57.7013	59.3037	61.7938	64.6725	2.5669 67.0008	
Hot water usage	e for baths 29.0466	28.6152	28.0077	26.8877	26.0490	25.1190	24.6166	25.2199	25.8767	26.8718	28.0149	28.9484	(42b)
Hot water usage Average daily h	40.9178	39.4299	37.9420 /day)	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178 126.1389	
,	Jan	Feb	Mar	Ann	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	(- /
Daily hot water	r use			Apr	-			Aug	·				
Energy content		134.2929 191.2313	130.7246 200.9188	125.2985 171.5274	120.8922 162.7441	116.1550 142.8262	114.3344 138.2776	117.8873 145.9691	121.6344 149.9874	126.6076 171.8053 Total = S	132.1173 188.2253 um(45)m =	136.8670 214.3007 2095.1407	(45)
Distribution lo	32.5991	= 0.15 x (28.6847	45)m 30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	32.1451	(46)
Store volume a) If manufact Temperature f Enter (49) or (Total storage 1	factor from (54) in (55	Table 2b	actor is kno	own (kWh/d	ay):							120.0000 2.1330 0.7930 1.6914	(48) (49)
If cylinder cor	52.4349 ntains dedi	47.3605 cated sola	52.4349 r storage	50.7434	52.4349	50.7434	52.4349	52.4349	50.7434	52.4349	50.7434	52.4349	(56)
Primary loss Combi loss	52.4349 0.0000 0.0000	47.3605 0.0000 0.0000	52.4349 0.0000 0.0000	50.7434 0.0000 0.0000	52.4349 0.0000 0.0000	50.7434 0.0000 0.0000	52.4349 0.0000 0.0000	52.4349 0.0000 0.0000	50.7434 0.0000 0.0000	52.4349 0.0000 0.0000	50.7434 0.0000 0.0000	52.4349 0.0000 0.0000	(59)
Total heat requ						193.5696	190.7125	198.4040	200.7308	224.2402	238.9687	266.7356	
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter Solar input	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	
FGHRS Output from w/h	0.0000 n	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
12Total per yea	269.7625 ar (kWh/yea	238.5918 r)	253.3537	222.2708	215.1790	193.5696	190.7125	198.4040 Total pe	200.7308 er year (kWl	224.2402 h/year) = S	238.9687 um(64)m =	266.7356 2712.5191 2713	
Electric shower		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
Heat gains from	n water hea	ting, kWh/	month	Tot	al Energy u	sed by inst	antaneous e	lectric show	wer(s) (kWh,	/year) = Su	m(64a)m =	0.0000	(64a)
	114.2093	101.4728	108.7534	97.6276	96.0603	88.0844	87.9252	90.4826	90.4655	99.0732	103.1797	113.2029	(65)
5. Internal gai	ins (see Ta	ble 5 and	5a)										
Metabolic gains		, Watts							Can	0.54	No	Do-	
(66)m Lighting gains	Jan 128.3459 (calculate	Feb 128.3459 d in Appen	Mar 128.3459 dix L, equa	Apr 128.3459 tion L9 or	May 128.3459 L9a), also	Jun 128.3459 see Table 5	Jul 128.3459	Aug 128.3459	Sep 128.3459	0ct 128.3459	Nov 128.3459	Dec 128.3459	(66)
Appliances gair	117.6626	130.2693	117.6626	121.5847	117.6626	121.5847	117.6626 le 5	117.6626	121.5847	117.6626	121.5847	117.6626	(67)
Cooking gains (231.5234	233.9259	227.8717	214.9831	198.7134	183.4223	173.2069	170.8044	176.8586	189.7472	206.0168	221.3080	(68)
Pumps, fans Losses e.g. eva	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	
	, (- J V	, (/									

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Water heating	-102.6768		-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	(71)
	153.5072	151.0012	146.1739	135.5939	129.1133	122.3395	118.1790	121.6165	125.6466	133.1629	143.3051	152.1544	(72)
「otal internal	564.1969	576.7002	553.2120	533.6654	506.9931	488.8502	470.5522	471.5872	485.5936	502.0764	532.4104	552.6288	(73)
. Solar gains	s												
[Jan]				rea m2	Solar flux Table 6a W/m2	Speci	g fic data Table 6b	Specific or Tab		Acce fact Table	or	Gains W	
Northeast Southeast South			15.1 4.5 1.5	200	11.2829 36.7938 46.7521	 	0.6300 0.6300 0.6300	 0 0	.7000 .7000 .7000	0.54 0.54 0.54	00 00	36.5152 35.6442 15.8319	(77)
Solar gains Total gains	87.9913 652.1882	160.9716 737.6717	250.0166 803.2286	360.1880 893.8533	449.8165 956.8097	467.0613 955.9116	441.7595 912.3118	371.6938 843.2810	287.6303 773.2239	185.9041 687.9805	107.4053 639.8156	74.0044 626.6331	
. Mean interr emperature du Utilisation fa	uring heatin	g periods	in the livi	ng area froi	n Table 9,	Th1 (C)						21.0000	(85)
au alpha atil living ar	Jan 38.4988 3.5666	Feb 38.6297 3.5753	Mar 38.7590 3.5839	Apr 39.3777 3.6252	May 39.4957 3.6330	Jun 40.0543 3.6703	Jul 40.0543 3.6703	Aug 40.1595 3.6773	Sep 39.8373 3.6558	Oct 39.4957 3.6330	Nov 39.2578 3.6172	Dec 39.0121 3.6008	
.c.r rivilig di	0.9862	0.9776	0.9610	0.9145	0.8196	0.6596	0.5108	0.5646	0.7854	0.9354	0.9771	0.9880	(86)
Living Non living 24 / 16 24 / 9	19.4680 18.4233 0 26	19.6388 18.5947 0	19.9079 18.8617 0 0	20.2910 19.2428 0 0	20.6142 19.5370 0 0	20.8221 19.7126 0 0	20.8882 19.7512 0 0	20.8761 19.7490 0 0	20.7281 19.6455 0	20.3159 19.2762 0 0	19.8406 18.8090 0	19.4519 18.4182 0	
., 9 MIT Th 2 util rest of h	5 20.8601 19.8027	28 20.2291 19.8063	31 20.3815 19.8097	0 20.2910 19.8261	0 20.6142 19.8292	0 20.8221 19.8436	0 20.8882 19.8436	0 20.8761 19.8462	0 20.7281 19.8380	0 20.3159 19.8292	8 19.9746 19.8230	31 20.1232 19.8165	
MIT 2 Living area fr	0.9827 19.6767 raction	0.9719 19.1201	0.9506 19.2728	0.8906 19.2428	0.7682 19.5370	0.5682 19.7126	0.3883 19.7512	0.4405 19.7490		0.9123 19.2762 Living are		0.9850 19.0246 0.4012	(90) (91)
MIT Temperature ac adjusted MIT	20.1514 djustment 20.1514	19.5650 19.5650	19.7176 19.7176	19.6633 19.6633	19.9691 19.9691	20.1577	20.2073	20.2012	20.0798	19.6933 19.6933	19.3469 19.3469	19.4653 0.0000 19.4653	
3. Space heati													
Utilisation Useful gains Ext temp.	Jan 0.9839 641.6590 4.3000	Feb 0.9705 715.9254 4.9000	Mar 0.9496 762.7487 6.5000	Apr 0.8867 792.5624 8.9000	May 0.7751 741.5798 11.7000	Jun 0.5947 568.5238 14.6000	Jul 0.4284 390.8404 16.6000	Aug 0.4807 405.4046 16.4000	Sep 0.7260 561.3833 14.1000	Oct 0.9090 625.3782 10.6000	Nov 0.9667 618.5012 7.1000	Dec 0.9839 616.5365 4.2000	(95)
Heat loss rate Space heating	1838.8695	1695.4640	1523.0320	1220.7450	935.0609	619.6926	402.2194	422.7253	670.3889	1028.2559	1393.2481	1747.5750	(97)
Space heating	890.7246 requirement kWh				143.9499	0.0000	0.0000	0.0000	0.0000	299.7411	557.8178	841.4926 4265.9181	
Solar heating Space heating		0.0000 n - total	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
Space heating Space heating	890.7246 requirement	658.2500 after sol	565.6508 ar contribu	308.2914 tion - tota	143.9499 l per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	299.7411 (98c	557.8178) / (4) =	841.4926 4265.9181 49.6037	
			l heating s	ystems, inc	luding micr	o-CHP						0.0000	(201)
Pa. Energy records of specification of specification of specification of specification of the	pace heat fr pace heat fr main space main space	om seconda om main sy heating sy heating sy	ry/suppleme stem(s) stem 1 (in stem 2 (in	ntary system %) %)	m (labie ii	,						1.0000 221.5970 0.0000 0.0000	(206) (207)
Pa. Energy reconstruction of specificiency of efficiency of efficiency of efficiency of	pace heat fr pace heat fr main space main space secondary/s	om seconda om main sy heating sy heating sy upplementa Feb	ry/suppleme stem(s) stem 1 (in stem 2 (in	ntary system %) %)	May	Jun	Jul	Aug	Sep	0ct	Nov	221.5970 0.0000	(206) (207)
Fraction of specification of specificati	pace heat fr pace heat fr main space main space secondary/s Jan requirement 890.7246	om seconda om main sy heating sy heating sy upplementa Feb 658.2500	ry/suppleme stem(s) stem 1 (in stem 2 (in ry heating Mar 565.6508	ntary system %) %) system, % Apr 308.2914	·	Jun 0.0000	Jul 0.0000	Aug 0.0000	Sep 0.0000	0ct 299.7411	Nov 557.8178	221.5970 0.0000 0.0000	(206 (207 (208
Pa. Energy reconstruction of specificiency of efficiency o	pace heat fr pace heat fr main space main space secondary/s Jan requirement 890.7246 efficiency 221.5970	om seconda om main sy heating sy heating sy upplementa Feb 658.2500 (main heat 221.5970	ry/suppleme stem(s) stem 1 (in stem 2 (in ry heating Mar 565.6508 ing system 221.5970	ntary system %) %) system, % Apr 308.2914	May			_				221.5970 0.0000 0.0000 Dec	(206 (207 (208 (98)
Pa. Energy reconstruction of specificiency of efficiency of efficiency of efficiency of	pace heat fr pace heat fr main space main space secondary/s Jan requirement 890.7246 efficiency 221.5970 fuel (main 401.9569	om seconda om main sy heating sy heating sy upplementa Feb 658.2500 (main heat 221.5970 heating sy 297.0482	ry/suppleme stem(s) stem 1 (in stem 2 (in ry heating Mar 565.6508 ing system 221.5970 stem) 255.2610	%) %) %) system, % Apr 308.2914 1) 221.5970 139.1225	May 143.9499	0.0000	0.0000	0.0000	0.0000	299.7411	557.8178	221.5970 0.0000 0.0000 Dec 841.4926	(206 (207 (208 (98) (210

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Space heating fuel (main heating system 0.0000 0.0000	1 2) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	, ,
Water heating	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Water heating requirement		045 4700	102 5505	400 7405	400 4040	200 7200		222 2527	066 7056	(5.1)
Efficiency of water heater	3.3537 222.2708	215.1790	193.5696	190.7125	198.4040	200.7308	224.2402	238.9687	266.7356 106.8983	(216)
(217)m 106.8983 106.8983 10 Fuel for water heating, kWh/month	06.8983 106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	(217)
252.3542 223.1950 23 Space cooling fuel requirement	37.0043 207.9273	201.2931	181.0782	178.4055	185.6007	187.7773	209.7696	223.5476	249.5227	(219)
(221)m 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	
	0.0540 14.6924	11.3488	9.2721	10.3528	13.4569	17.4792	22.9337	25.9036	28.5347	` '
(233a)m -12.5031 -22.0534 -4	0.2170 -54.8239	-66.1078	-62.6325	-61.3113	-53.5875	-41.0407	-28.0137	-14.8774	-10.2023	(233a)
	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric (235a)m 0.0000 0.0000	generators (Append 0.0000 0.0000	neg) (neg 0.0000	ative quant 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity gen (235c)m 0.0000 0.0000	nerated by micro-CHF 0.0000 0.0000	O.0000	N) (negati 0.0000	ve if net g 0.0000	generation) 0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix			-42.1995	-41.0571	-31.4487	-19.2377	-7.7340	-2.4199	-1.1720	, ,
Electricity generated by wind turbines				0.0000	0.0000	0.0000	0.0000	0.0000		(234b)
Electricity generated by hydro-electric	generators (Append	dix M) (neg	ative quant	ity)		0.0000				, ,
Electricity used or net electricity gen	,		, , ,		,		0.0000	0.0000		(235b)
(235d)m 0.0000 0.0000 Annual totals kWh/year	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)
Space heating fuel - main system 1 Space heating fuel - main system 2									1925.0790 0.0000	
Space heating fuel - secondary Efficiency of water heater									0.0000 106.8983	(215)
Water heating fuel used Space cooling fuel									2537.4755 0.0000	
-									0.0000	(221)
Electricity for pumps and fans: Total electricity for the above, kWh/ye									0.0000	
Electricity for lighting (calculated in	Appendix L)								224.0640	(232)
<pre>Energy saving/generation technologies (PV generation</pre>	Appendices M ,N and	d Q)							-692.0484	(233)
Wind generation Hydro-electric generation (Appendix N)									0.0000 0.0000	
Electricity generated - Micro CHP (Appe	endix N)								0.0000	
Appendix Q - special features Energy saved or generated									-0.0000	
Energy used Total delivered energy for all uses									0.0000 3994.5700	
12a. Carbon dioxide emissions - Individ	lual heating systems	s including	micro-CHP							
					Energy kWh/year		ion factor kg CO2/kWh	k	Emissions g CO2/year	
Space heating - main system 1 Total CO2 associated with community sys	toms				1925.0790		0.1553		298.8751	(261)
Water heating (other fuel)	Cellis				2537.4755		0.1409		357.5959	(264)
Space and water heating Pumps, fans and electric keep-hot					0.0000		0.0000		656.4710 0.0000	(267)
Energy for lighting					224.0640		0.1443		32.3394	(268)
Energy saving/generation technologies PV Unit electricity used in dwelling					-467.3705		0.1312		-61.3353	
PV Unit electricity exported Total					-224.6780		0.1190		-26.7273 -88.0626	
Total CO2, kg/year Dwelling Carbon Dioxide Emission Rate ('DED'								600.7478	(272)
bweiling carbon bloxide Lillission Race (DER)								0.9900	(2/3)
13a. Primary energy - Individual heatin	ng systems including	g micro-CHP								
						Primary ene	rgy factor	Prim	ary energy	
Space heating - main system 1					kWh/year 1925.0790	ı	kg CO2/kWh 1.5748		kWh/year 3031.5647	
Total CO2 associated with community sys Water heating (other fuel)	tems				2537.4755		1.5211		0.0000 3859.7390	(473)
Space and water heating									6891.3037	(279)
Pumps, fans and electric keep-hot Energy for lighting					0.0000 224.0640		0.0000 1.5338		0.0000 343.6768	
Energy saving/generation technologies										
PV Unit electricity used in dwelling PV Unit electricity exported					-467.3705 -224.6780		1.4848 0.4362		-693.9695 -98.0122	
Total Total Primary energy kWh/year									-791.9816 6442.9989	(283)
Dwelling Primary energy Rate (DPER)									74.9200	

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SAP 10 WORKSHEE			esigned)	(Version 10	.2, February								
1. Overall dwell	ling chara	cteristics											
								Area (m2)	Store	y height (m)		Volume (m3)	
Ground floor Total floor area Dwelling volume		a)+(1b)+(1c)+(1d)+(1e)	(1n)	8	36.0000		86.0000	(1b) x Ba)+(3b)+(3c)+	2.5000 (3d)+(3e)	. ,	215.0000 ((215.0000 (4)
2. Ventilation	rate												
Number of once	ahi wa awa											3 per hour	(6-)
Number of open of open of open of open of open of open of chimm. Number of flues Number of flues Number of block Number of intern. Number of passi Number of flueld	flues eys / flues attached attached ed chimneys mittent ex ve vents	to solid fu to other he s tract fans	el boiler	ire							0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 3 * 10 = 0 * 10 = 0 * 40 =	0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (0.0000 (6b) 6c) 6d) 6e) 6f) 7a)
Infiltration du Pressure test Pressure Test M Measured/design Infiltration ra Number of sides	ethod AP50 te	eys, flues	and fans	= (6a)+(6b)	+(6c)+(6d)+((6e)+(6f)+(6g)+(7a)+(7	/b)+(7c) =		30.0000	Air changes / (5) = Bl	o per hour 0.1395 (Yes Lower Door 5.0000 (0.3895 (2 (17) 18)
Shelter factor Infiltration ra	te adjuste	d to includ	e shelter f	actor					(20) = 1 - (21		(19)] = x (20) =	0.8500 (0.3311 (
Wind speed Wind factor Adj infilt rate	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 (1.1750 (
Effective ac	0.4222 0.5891	0.4139 0.5856	0.4056 0.5823	0.3642 0.5663	0.3559 0.5633	0.3145 0.5495	0.3145 0.5495	0.3063 0.5469	0.3311 0.5548	0.3559 0.5633	0.3725 0.5694	0.3890 (0.5757 (
3. Heat losses	and hoat le												
Element				Gross	Openings	 Net	 Area	U-value	Α×U		-value	ΑxΚ	
TER Opening Type Heatloss Floor: External Wall 1 External Wall 2 External Wall 3 External Wall 4 External Wall 5 Total net area	1	,		m2 22.0000 5.1500 10.5600 15.1700 3.8700	9.9400 5.1600 4.5200 1.5800	86. 12. 5. 5.	m2 2000 0000 0600 1500 4000 6500 2900 7500	W/m2K 1.1450 0.1300 0.1800 0.1800 0.1800 0.1800	W/K 24.2748 11.1800 2.1708 0.9270 0.9720 1.9170 0.4122		kJ/m2K	((((27) 28a) 29a) 29a) 29a) 29a) 29a)
Fabric heat loss Party Wall 1 Party Wall 2 Party Wall 3 Party Wall 4			,			11. 4. 17.		(0) + (32) 0.0000 0.0000 0.0000 0.0000	= 41.8538 0.0000 0.0000 0.0000 0.0000			(((33) 32) 32) 32) 32)
Thermal mass par Thermal bridges Point Thermal br Total fabric hea	(User def: ridges				area)				(33) + (36)	(36a) = + (36a) =	196.9535 (7.1375 (0.0000 48.9913 (36)
Ventilation hear (38)m Heat transfer co	Jan 41.7973	culated mon Feb 41.5518	thly (38)m Mar 41.3111	= 0.33 x (2 Apr 40.1809	5)m x (5) May 39.9694	Jun 38.9849	Jul 38.9849	Aug 38.8026	Sep 39.3641	Oct 39.9694	Nov 40.3972	Dec 40.8444 ([38]
Average = Sum(3	90.7886	90.5431	90.3024	89.1722	88.9607	87.9763	87.9763	87.7939	88.3554	88.9607	89.3885	89.8357 (89.1711	39)

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HLP	Jan 1.0557	Feb 1.0528	Mar 1.0500	Apr 1.0369	May 1.0344	Jun 1.0230	Jul 1.0230	Aug 1.0209	Sep 1.0274	0ct 1.0344	Nov 1.0394	Dec 1.0446	(40)
HLP (average) Days in mont	31	28	31	30	31	30	31	31	30	31	30	1.0369 31	
4. Water heat													
Assumed occupa												2.5669	(42)
Hot water usag		r showers 66.2478	64.7749	61.9568	59.8771	57.5579	56.2396	57.7013	59.3037	61.7938	64.6725	67.0008	(42a)
Hot water usag	ge for bath: 29.0466	s 28.6152	28.0077	26.8877	26.0490	25.1190	24.6166	25.2199	25.8767	26.8718	28.0149	28.9484	(42b)
Hot water usage Average daily	40.9178	39.4299	37.9420 /day)	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178 126.1389	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Energy conte	137.2229 217.3276	134.2929 191.2313	130.7246 200.9188	125.2985 171.5274	120.8922 162.7441	116.1550 142.8262	114.3344 138.2776	117.8873 145.9691	121.6344 149.9874	126.6076 171.8053	132.1173 188.2253	136.8670 214.3007	
Energy content Distribution		= 0.15 x (- 28.6847	45)m 30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	2095.1407 32.1451	(46)
Water storage Store volume		2010017	3011370	231,7232	2220	221.1233	2017.120	22.055.	227.302	2317700	2012330	150.0000	
a) If manufac Temperature Enter (49) or	factor from (54) in (55)	m Table 2b	actor is kn	own (kWh/d	lay):							1.3938 0.5400 0.7527	(48) (49)
Total storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder co	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	
Primary loss Combi loss	23.2624 0.0000	21.0112 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	
Total heat red	263.9225 -30.7478	233.3170 -27.1936	247.5137 -28.4756	216.6192 -23.5789	209.3390 -21.9747	187.9180 -18.8039	184.8725 -17.6257	192.5640 -18.7431	195.0792 -19.4552	218.4002 -22.9356	233.3171 -25.9832	260.8956 -30.1784	
PV diverter	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000	-0.0000 0.0000	-0.0000	(63b)
Solar input FGHRS Output from w	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	
output ITom w	233.1747	206.1234	219.0382	193.0403	187.3643	169.1141	167.2469	173.8209 Total n	175.6240 er year (kw	195.4646 h/vear) = S	207.3339 Sum(64)m =	230.7172 2358.0625	
12Total per ye Electric showe		ar)							, (····	, , ,	(/		(64)
	0.0000	0.0000	0.0000	0.0000 Tot	0.0000 al Energy u	0.0000 sed by inst	0.0000 antaneous e	0.0000 lectric sho	0.0000 wer(s) (kWh	0.0000 /year) = Su	0.0000 m(64a)m =	0.0000 0.0000	
Heat gains fro	om water he 109.5373	ating, kWh/ 97.2530	month 104.0814	93.1063	91.3883	83.5632	83.2532	85.8107	85.9443	94.4012	98.6584	108.5309	(65)
5. Internal ga													
Metabolic gair	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	>
(66)m Lighting gains	•							128.3459	128.3459	128.3459	128.3459	128.3459	
Appliances gas				uation L13				117.6626	121.5847	117.6626	121.5847	117.6626	, ,
Cooking gains								170.8044	176.8586	189.7472	206.0168	221.3080	, ,
Pumps, fans	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	
Losses e.g. ev	-102.6768	-102.6768	-102.6768		-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	(71)
Water heating	147.2276	144.7217	139.8944	129.3143	122.8338	116.0600	111.8995	115.3369	119.3670	126.8833	137.0255	145.8749	(72)
Total internal	560.9174	573.4206	549.9325	530.3858	503.7136	482.5707	464.2727	465.3076	479.3140	498.7969	529.1308	549.3492	(73)
6. Solar gains													
gains													
[Jan]			А	rea m2	Solar flux Table 6a W/m2	Speci	g fic data Table 6b	Specific or Tab		Acce fact Table	or	Gains W	
Northeast			15.1		11.2829		0.6300		.7000	0.54		36.5152	
Southeast South			4.5	200 800	36.7938 46.7521		0.6300 0.6300	0	.7000 .7000	0.54 0.54	.00	35.6442 15.8319	(77)
Solar gains Total gains	87.9913 648.9087	160.9716 734.3922	250.0166 799.9491	360.1880 890.5738	449.8165 953.5301	467.0613 949.6320	441.7595 906.0322	371.6938 837.0014	287.6303 766.9444	185.9041 684.7010	107.4053 636.5361	74.0044 623.3536	
. Jeun Builla	5.5.5007	, , , , , , , , , , , ,		550.5750		2.2.0320	200.0322	057.0014	, 50. 2444	554.7010	050.5501	0_0.000	(37)

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	_												
7. Mean inter						TI 4 (0)						24 2222	(05)
Temperature du Utilisation fa	actor for ga	ains for li	ving area,	ni1,m (see T	able 9a)							21.0000	(85)
tau alpha	Jan 51.8237 4.4549	Feb 51.9642 4.4643	Mar 52.1027 4.4735	Apr 52.7631 4.5175	May 52.8885 4.5259	Jun 53.4803 4.5654	Jul 53.4803 4.5654	Aug 53.5914 4.5728	Sep 53.2508 4.5501	0ct 52.8885 4.5259	Nov 52.6354 4.5090	Dec 52.3734 4.4916	
util living a		0.9762	0.9540	0.8877	0.7566	0.5694	0.4222	0.4734	0.7153	0.9179	0.9755	0.9889	(86)
MIT	19.6606	19.8663	20.1636	20.5570	20.8372	20.9657	20.9929	20.9883	20.9060	20.5441	20.0460	19.6312	
Th 2 util rest of h		20.0395	20.0419	20.0527	20.0547	20.0642 0.4948	20.0642	20.0660	20.0606	20.0547 0.8921	20.0506	20.0463	
MIT 2 Living area fo	0.9836 18.4859 raction	0.9704 18.7472	0.9426 19.1206	0.8608 19.6037	19.9148	20.0428	0.3348 20.0615	0.3815 20.0610	0.6423 19.9933 fLA =	19.6007 Living are	0.9685 18.9848 a / (4) =	0.9861 18.4551 0.4012	(90)
MIT Temperature ad	18.9572	19.1962	19.5390	19.9861	20.2848	20.4130	20.4351	20.4330	20.3594	19.9791	19.4105	18.9269 0.0000	1 1
adjusted MIT	18.9572	19.1962	19.5390	19.9861	20.2848	20.4130	20.4351	20.4330	20.3594	19.9791	19.4105	18.9269	(93)
8. Space heat:													
Utilisation Useful gains Ext temp.	Jan 0.9787 635.0729 4.3000	Feb 0.9639 707.8906 4.9000	Mar 0.9353 748.2125 6.5000	Apr 0.8587 764.7611 8.9000	May 0.7183 684.9411 11.7000	Jun 0.5233 496.9555 14.6000	Jul 0.3698 335.0600 16.6000	Aug 0.4182 350.0430 16.4000	Sep 0.6668 511.4324 14.1000	Oct 0.8897 609.1708 10.6000	Nov 0.9624 612.6279 7.1000	Dec 0.9817 611.9480 4.2000	(95)
Heat loss rate	e W	1294.4204		988.5727	763.7115	511.4058	337.3993	354.0732	553.0549		1100.4180	1323.0022	` '
Space heating		394.1480	319.3571	161.1444	58.6052	0.0000	0.0000	0.0000	0.0000	167.5521	351.2089	529.0243	` ,
Space heating Solar heating	kWh		,	,	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	2498.5902	(00h)
Solar heating Space heating		0.0000 on - total	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(980)
Space heating Space heating		394.1480 t after sol	319.3571 Lar contribu	161.1444 ution - total	58.6052 per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	167.5521	351.2089) / (4) =	529.0243 2498.5902 29.0534	
9a. Energy rec	quirements - pace heat fr	- Individua rom seconda	al heating s ary/suppleme		uding micr	o-CHP						0.0000 1.0000	(201) (202)
Efficiency of Efficiency of Efficiency of	main space main space	heating sy heating sy	stem 1 (in stem 2 (in	%)								92.3000 0.0000	(206) (207) (208)
Space heating	Jan requirement	Feb t	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Space heating					58.6052	0.0000	0.0000	0.0000	0.0000	167.5521	351.2089	529.0243	` '
Space heating				92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	
Space heating					63.4943	0.0000	0.0000	0.0000	0.0000	181.5299	380.5080	573.1574	
Space heating		0.0000 heating sy 0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	, ,
Space heating	0.0000 fuel (secon 0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	` ,
Water heating	0,000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(223)
Water heating	requirement 233.1747	t 206.1234	219.0382	193.0403	187.3643	169.1141	167.2469	173.8209	175.6240	195.4646	207.3339	230.7172	(64)
Efficiency of (217)m	85.7946	85.4892	84.9043	83.6576	81.7747	79.8000	79.8000	79.8000	79.8000	83.7162	85.2318	79.8000 85.8594	
Fuel for water	271.7824	241.1104	257.9825	230.7504	229.1226	211.9225	209.5825	217.8207	220.0802	233.4849	243.2590	268.7153	(219)
Space cooling (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Pumps and Fa Lighting	7.3041 24.4480	6.5973 19.6131	7.3041 17.6594	7.0685 12.9380	7.3041 9.9937	7.0685 8.1649	7.3041 9.1166	7.3041 11.8501	7.0685 15.3921	7.3041 20.1953	7.0685 22.8105	7.3041 25.1274	
Electricity go (233a)m Electricity go	-18.9129	-28.2844	-43.0944	-51.4489	-58.1214	-55.2109	-54.5272	-50.1516	-42.9215	-33.6242	-21.3564	-16.1671	(233a)
(234a)m Electricity ge	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 itv)	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
(235a)m Electricity us	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 reneration)	0.0000	0.0000	0.0000	0.0000	(235a)
(235c)m Electricity ge	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
	cheracea by	. vs (Appell											
(233b)m Electricity ge	-6.2713 enerated by	-13.5296	-27.5355	-42.3260	-56.9353	-57.5752 ity)	-56.9097	-47.7471	-34.4198	-19.6730	-8.4745	-4.9353	(233b)
	enerated by 0.0000	-13.5296 wind turbi 0.0000	-27.5355 Ines (Append 0.0000	-42.3260 Hix M) (negat 0.0000	-56.9353 ive quanti: 0.0000	0.0000	0.0000	-47.7471 0.0000	-34.4198 0.0000	-19.6730 0.0000	-8.4745 0.0000	-4.9353 0.0000	, ,

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Electricity used or net electricity generated by micro-CHP (Appendix N) (negative (235d)m 0.0000 0.0000 0.0000 0.0000 0.0000	if net generation) 0.0000 0.0000	0.0000 0.0000	0.0000 0.0000 (235d)
Annual totals kWh/year Space heating fuel - main system 1 Space heating fuel - main system 2 Space heating fuel - secondary	0.0000	0.0000	2707.0316 (211) 0.0000 (213) 0.0000 (215)
Efficiency of water heater Water heating fuel used Space cooling fuel			79.8000 2835.6133 (219) 0.0000 (221)
Electricity for pumps and fans: Total electricity for the above, kWh/year Electricity for lighting (calculated in Appendix L)			86.0000 (231) 197.3090 (232)
Energy saving/generation technologies (Appendices M ,N and Q) PV generation Wind generation Hydro-electric generation (Appendix N) Electricity generated - Micro CHP (Appendix N) Appendix Q - special features			-850.1531 (233) 0.0000 (234) 0.0000 (235a) 0.0000 (235)
Energy saved or generated Energy used Total delivered energy for all uses			-0.0000 (236) 0.0000 (237) 4975.8009 (238)
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP			
The colonia contact control of the colonia systems including macro cin			
	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2707.0316	0.2100	568.4766 (261)
Total CO2 associated with community systems Water heating (other fuel)	2835.6133	0.2100	0.0000 (373) 595.4788 (264)
Space and water heating	2833.0133	0.2100	1163.9554 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	197.3090	0.1443	28.4778 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling PV Unit electricity exported	-473.8209 -376.3322	0.1334 0.1252	-63.1951 -47.1237
Total	-370.3322	0.1232	-110.3188 (269)
Total CO2, kg/year Target Carbon Dioxide Emission Rate (TER)			1094.0437 (272) 12.7200 (273)
13a. Primary energy - Individual heating systems including micro-CHP			
		imary energy factor	Primary energy
Constitution with sustain 4	kWh/year	kg CO2/kWh	kWh/year
Space heating - main system 1 Total CO2 associated with community systems	2707.0316	1.1300	3058.9458 (275) 0.0000 (473)
Water heating (other fuel)	2835.6133	1.1300	3204.2430 (278)
Space and water heating Pumps, fans and electric keep-hot	86.0000	1.5128	6263.1888 (279) 130.1008 (281)
Energy for lighting	197.3090	1.5338	302.6392 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-473.8209	1.4929	-707.3467
PV Unit electricity exported Total	-376.3322	0.4596	-172.9638 -880.3105 (283)
Total Primary energy kWh/year			5815.6183 (286)
Target Primary Energy Rate (TPER)			67.6200 (287)

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Appendix D - SAP Worksheets — Baseline (limiting) Scenario



Property Reference	SH				Issued on Date	17/11/2022
Assessment Reference	Unit 1 - Limiting		Prop Type	e Ref	Flats	
Property	Sheldon House, 8 , Cromwell Road,	Teddington, London, TW11 9EJ				
SAP Rating		79 C	DER	23.29	TER	13.14
Environmental		80 C	% DER <ter< td=""><td>-77.25</td><td></td><td></td></ter<>	-77.25		
CO ₂ Emissions (t/year)		1.7	DFEE	61.04	TFEE	35.86
Compliance Check		See BREL	% DFEE < TFEE	-70.19		
% DPER < TPER		-83.32	DPER	128.07	TPER	69.86
Assessor Details	Mr. Andrew Gilbert				Assessor ID	U888-0001
Client	RHP					

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3) Ground floor (m3) x 2.5000 (2b) = 215.0000 (1b)
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3)
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3)
1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3)
1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3)
1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3)
(m2) (m3)
Total floor area TFA = $(1a)+(1b)+(1c)+(1d)+(1e)(1n)$ 86.0000 (4)
Dwelling volume $(3a)+(3b)+(3c)+(3d)+(3e)(3n) = 215.0000 (5)$
2. Ventilation rate
Number of open chimneys $0*80 = 0.0000 (6a)$
Number of open flues $0 * 20 = 0.0000 (6b)$ Number of chimneys / flues attached to closed fire $0 * 10 = 0.0000 (6c)$
Number of flues attached to solid fuel boiler 0 * 20 = 0.0000 (6d) Number of flues attached to other heater 0 * 35 = 0.0000 (6e) Number of blocked chimneys 0 * 20 = 0.0000 (6f)
Number of intermittent extract fans $2 * 10 = 20.0000 (7a)$ Number of passive vents $0 * 10 = 0.0000 (7b)$ Number of flueless gas fires $0 * 40 = 0.0000 (7c)$
Air changes per hour Infiltration due to chimneys, flues and fans = $(6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c)$ = $20.0000 / (5) = 0.0930 (8)$
Pressure test Yes Pressure Test Method Blower Door Measured/design AP50 8.0000 (17)
Infiltration rate 0.4930 (18) Number of sides sheltered 2 (19)
Shelter factor $(20) = 1 - [0.075 \times (19)] = 0.8500 (20)$ Infiltration rate adjusted to include shelter factor $(21) = (18) \times (20) = 0.4191 (21)$
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Wind speed 5.1000 5.0000 4.9000 4.4000 4.3000 3.8000 3.8000 3.7000 4.0000 4.3000 4.5000 4.7000 (22)
Wind factor 1.2750 1.2500 1.2250 1.1000 1.0750 0.9500 0.9500 0.9250 1.0000 1.0750 1.1250 1.1750 (22a) Adj infilt rate 0.5343 0.5238 0.5134 0.4610 0.4505 0.3981 0.3981 0.3876 0.4191 0.4505 0.4715 0.4924 (22b)
Effective ac 0.6427 0.6372 0.6318 0.6062 0.6015 0.5792 0.5792 0.5751 0.5878 0.6015 0.6111 0.6212 (25)
3. Heat losses and heat loss parameter
Element Gross Openings NetArea U-value A x U K-value A x K m2 m2 m2 W/m2K W/K kJ/m2K kJ/K Opening Type 1 (Uw = 1.60) 15.1000 1.5038 22.7068 (27)
Opening Type 2 (Uw = 1.60) 6.1000 1.5038 9.1729 (27) Heatloss Floor 1 86.0000 0.1800 15.4800 110.0000 9460.0000 (28a)
External Wall 1 22.0000 9.9400 12.0600 0.2600 3.1356 14.0000 168.8400 (29a) External Wall 2 5.1500 5.1500 0.2600 1.3390 14.0000 72.1000 (29a)
External Wall 3 10.5600 5.1600 5.4000 0.2600 1.4040 14.0000 75.6000 (29a) External Wall 4 15.1700 4.5200 10.6500 0.2600 2.7690 14.0000 149.1000 (29a) External Wall 5 3.8700 1.5800 2.2900 0.2600 0.5954 14.0000 32.0600 (29a)

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Total net area Fabric heat lo Party Wall 1 Party Wall 2 Party Wall 3 Party Wall 4 Party Floor 1 Party Ceiling Internal Wall Internal Wall	ss, W/K = S 1 1 2					11 4 17 16 55 86 22 5	.7500 (26)(.5700 .2500 .1200 .0600 .5700 .0000 .2500 .2500	30) + (32) 0.0000 0.0000 0.0000 0.0000	= 56.60 0.00 0.00 0.00 0.00	00 2 00 2 00 2 00 2	10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 9.0000 9.0000 9.0000	231.4000 85.0000 342.4000 321.2000 2222.8000 2580.0000 200.2500 47.2500 90.0000	(32) (32) (32) (32d) (32b) (32c) (32c)
Heat capacity Thermal mass p Thermal bridge Point Thermal Total fabric h	arameter (T s (Default bridges	MP = Cm /	,)			(28).	(30) + (3	2) + (32a). 33) + (36)	(36a) =	16078.0000 186.9535 28.5500 0.0000 85.1527	(35) (36)
Ventilation he	Jan 45.6028	culated mo Feb 45.2095	nthly (38)m Mar 44.8240	= 0.33 x () Apr 43.0134	25)m x (5) May 42.6747	Jun 41.0977	Jul 41.0977	Aug 40.8056	Sep 41.7051	Oct 42.6747	Nov 43.3600	Dec 44.0764	(38)
Heat transfer Average = Sum(130.7555	130.3622	129.9767	128.1661	127.8274	126.2504	126.2504	125.9583	126.8578	127.8274	128.5127	129.2291 128.1645	(39)
HLP HLP (average)	Jan 1.5204	Feb 1.5158	Mar 1.5114	Apr 1.4903	May 1.4864	Jun 1.4680	Jul 1.4680	Aug 1.4646	Sep 1.4751	0ct 1.4864	Nov 1.4943	Dec 1.5027 1.4903	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Uston bosti													
4. Water heati Assumed occupa												2.5669	(42)
Hot water usag	67.2585	66.2478	64.7749	61.9568	59.8771	57.5579	56.2396	57.7013	59.3037	61.7938	64.6725	67.0008	
Hot water usag	29.0466	28.6152	28.0077	26.8877	26.0490	25.1190	24.6166	25.2199	25.8767	26.8718	28.0149	28.9484	(42b)
Hot water usag Average daily	40.9178	39.4299	37.9420 /day)	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178 126.1389	
Daily hot wate	Jan r use	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Energy conte Energy content	137.2229 217.3276 (annual)	134.2929 191.2313	130.7246 200.9188	125.2985 171.5274	120.8922 162.7441	116.1550 142.8262	114.3344 138.2776	117.8873 145.9691	121.6344 149.9874	126.6076 171.8053 Total = S	132.1173 188.2253 Sum(45)m =	136.8670 214.3007 2095.1407	
Distribution 1 Water storage	32.5991 loss:	= 0.15 x (28.6847	45)m 30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	32.1451	(46)
Total storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder co Primary loss	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000 0.0000	
Combi loss Total heat req	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	
WWHRS	268.2865 0.0000	237.2587	251.8777 0.0000	220.8424	213.7030	192.1412 0.0000	189.2365 0.0000	196.9280 0.0000	199.3024 0.0000	222.7642 0.0000	237.5404	265.2596 0.0000	
PV diverter	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63b)
Solar input FGHRS	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	. ,
Output from w/ 12Total per ye	268.2865	237.2587	251.8777	220.8424	213.7030	192.1412	189.2365	196.9280 Total p	199.3024 er year (kW	222.7642 h/year) = S	237.5404 Sum(64)m =	265.2596 2695.1407 2695	
Electric showe	r(s) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
Heat gains fro						sed by inst						0.0000	
	85.0011	75.0912	79.5452	69.3616	66.8521	59.8185	58.7170	61.2745	62.1996	69.8650	74.9137	83.9947	(65)
5. Internal ga	ins (see Ta	ble 5 and											
Metabolic gain			Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
(66)m Lighting gains	128.3459 (calculate	128.3459 d in Appen	128.3459 dix L, equa	128.3459 tion L9 or	128.3459 L9a), also	128.3459 see Table 5	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	
Appliances gai			endix L, equ		or L13a), a			117.6626	121.5847	117.6626	121.5847	117.6626	
Cooking gains								170.8044	176.8586	189.7472	206.0168	221.3080	
Pumps, fans Losses e.g. ev					35.8346 3.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	(70)
	-102.6768 gains (Tabl	-102.6768 .e 5)	-102.6768	-102.6768			-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	` '
Total internal		111.7429	106.9156	96.3356	89.8550	83.0812	78.9207	82.3582	86.3883	93.9046	104.0468	112.8961	(72)

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527.9386 540.4419 516.9537 497.4071 470.7348 449.5919 431.2939 432.3289 446.3353 465.8181 496.1521 516.3705 (73)

6. Solar gain	 S												
[Jan]			Α	.rea m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab		Acce fact Table	or	Gains W	
Northeast Southeast South			15.1 4.5 1.5	200 800	11.2829 36.7938 46.7521		0.6300 0.6300 0.6300	0 0	.7000 .7000 .7000	0.54 0.54	00	36.5152 (7 35.6442 (7 15.8319 (7	77)
Solar gains Total gains	87.9913 615.9299	160.9716 701.4134	250.0166 766.9703	360.1880 857.5950	449.8165 920.5514	467.0613 916.6533	441.7595 873.0535	371.6938 804.0227	287.6303 733.9656	185.9041 651.7222	107.4053 603.5573	74.0044 (8 590.3748 (8	
7. Mean inter	nal tempera	 ture (heati	 ng season)										
Temperature du Utilisation fa	uring heati	ng periods	in the livi	ng area fro								21.0000 (8	85)
tau alpha	Jan 34.1562 3.2771	Feb 34.2592 3.2839	Mar 34.3608 3.2907	Apr 34.8463 3.3231	May 34.9386 3.3292	Jun 35.3750 3.3583	Jul 35.3750 3.3583	Aug 35.4571 3.3638	Sep 35.2056 3.3470	0ct 34.9386 3.3292	Nov 34.7523 3.3168	Dec 34.5596 3.3040	
util living a	rea 0.9886	0.9816	0.9686	0.9324	0.8561	0.7198	0.5774	0.6327	0.8326	0.9502	0.9817	0.9901 (8	86)
MIT	18.9829	19.1810	19.5061	19.9780	20.4060	20.7148	20.8336	20.8100	20.5726	20.0277	19.4385	18.9622 (8	,
Th 2 util rest of I	20.2398	20.2421	20.2443	20.2548	20.2568	20.2660	20.2660	20.2677	20.2625	20.2568	20.2528	20.2487 (8	
MIT 2	0.9870 18.5561	0.9790 18.7327	0.9637 19.0208	0.9211 19.4412	0.8304 19.8071	0.6676 20.0618	0.4986 20.1443	0.5560 20.1325	0.7936 19.9539	0.9399 19.4899	0.9786 18.9693	0.9887 (8 18.5447 (9	
Living area f MIT	raction 18.7273	18.9125	19.2155	19.6565	20.0474	20.3237	20.4208	20.4043	fLA = 20.2021	Living are 19.7057	a / (4) = 19.1575	0.4012 (9 18.7122 (9	
Temperature a adjusted MIT	djustment 18.7273	18.9125	19.2155	19.6565	20.0474	20.3237	20.4208	20.4043	20.2021	19.7057	19.1575	0.0000 18.7122 (9	93)
3. Space heat:													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Jtilisation Jseful gains Ext temp.	0.9827 605.2524 4.3000	0.9730 682.4592 4.9000	0.9555 732.8422 6.5000	0.9105 780.8046 8.9000	0.8222 756.9013 11.7000	0.6720 615.9893 14.6000	0.5161 450.5476 16.6000	0.5713 459.3243 16.4000	0.7900 579.8395 14.1000	0.9305 606.4503 10.6000	0.9728 587.1255 7.1000	0.9849 (9 581.4320 (9 4.2000 (9	95)
Heat loss rate		1826.7041	1652.7214	1378.6245	1067.0232	722.6229	482.3832	504.3755	774.0939	1163.9520	1549.5466	1875.3959 (9	97)
Space heating	953.2095	768.9326 t - total p	684.3902 er year (kW	430.4303 h/year)	230.7307	0.0000	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091 (9 5138.1270	98a
Solar heating Solar heating	0.0000	0.0000 on - total	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (9 0.0000	98b
Space heating Space heating	953.2095		684.3902 ar contribu			0.0000 (kWh/vear)	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091 (9 5138.1270	98c
Space heating		c u. cc. 301	u. coc. 100		iz per yeur	(, yea.)				(98c) / (4) =	59.7457 (9	99)
9a. Energy re					luding micr								
Fraction of specification of specificati	pace heat fi pace heat fi main space main space	rom seconda rom main sy heating sy heating sy	ry/suppleme stem(s) stem 1 (in stem 2 (in	ntary syste %) %)								0.0000 (2 1.0000 (2 83.8000 (2 0.0000 (2	202 206 207
,	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Space heating			684.3902	430.4303	230.7307	0.0000	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091 (9	98)
Space heating		(main heat 83.8000			83.8000	0.0000	0.0000	0.0000	0.0000	83.8000	83.8000	83.8000 (2	
pace heating				513.6400	275.3350	0.0000	0.0000	0.0000	0.0000	494.9657		1148.8176 (2	
pace heating					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (2	
pace heating				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (2	
pace heating			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (2	

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(217)m 86.7567 86.6101 86.3101 85.6844 84.4458 80.2000 80.2000 Fuel for water heating, kWh/month	80.2000	80.2000	85.5930	86.4339	86.7896 (21	7)
309.2401 273.9389 291.8287 257.7395 253.0652 239.5776 235.9557 Space cooling fuel requirement	245.5462	248.5068	260.2598	274.8232	305.6351 (21))
(221)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Pumps and Fa 7.3041 6.5973 7.3041 7.0685 7.3041 7.0685 7.3041			0.0000 7.3041	0.0000 7.0685	0.0000 (22 7.3041 (23	
Lighting 27.7631 22.2726 20.0540 14.6924 11.3488 9.2721 10.3528 Electricity generated by PVs (Appendix M) (negative quantity)			22.9337	25.9036	28.5347 (23	
(233a)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by wind turbines (Appendix M) (negative quantity)	0.0000	0.0000	0.0000	0.0000	0.0000 (23	3a)
(234a)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by hydro-electric generators (Appendix M) (negative quantity)	0.0000	0.0000	0.0000	0.0000	0.0000 (23	↓a)
(235a)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000		0.0000	0.0000	0.0000	0.0000 (23	ia)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net (235c)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000		0.0000	0.0000	0.0000	0.0000 (23	ic)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (23	3b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (23	ŧb)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000		0.0000	0.0000	0.0000	0.0000 (23	ib)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net (235d)m 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000		0.0000	0.0000	0.0000	0.0000 (23	id)
Annual totals kWh/year Space heating fuel - main system 1					6131.4165 (21	
Space heating fuel - main system 2 Space heating fuel - secondary					0.0000 (21 0.0000 (21	
Efficiency of water heater Water heating fuel used					80.2000 3196.1168 (21	
Space cooling fuel					0.0000 (22	.)
Electricity for pumps and fans: central heating pump					41.0000 (23	
main heating flue fan Total electricity for the above, kWh/year					45.0000 (23 86.0000 (23	1)
Electricity for lighting (calculated in Appendix L)					224.0640 (23	<u>!</u>)
Energy saving/generation technologies (Appendices M ,N and Q) PV generation					0.0000 (23	
Wind generation Hydro-electric generation (Appendix N)					0.0000 (23 0.0000 (23	ā)
Electricity generated - Micro CHP (Appendix N) Appendix Q - special features					0.0000 (23	•
Energy saved or generated Energy used					-0.0000 (23 0.0000 (23	7)
Total delivered energy for all uses					9637.5973 (23	3)
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP						
	Energy kWh/year		ion factor kg CO2/kWh	k	Emissions g CO2/year	
Space heating - main system 1 Total CO2 associated with community systems	6131.4165		0.2100	,	1287.5975 (26 0.0000 (37	
Water heating (other fuel) Space and water heating	3196.1168		0.2100		671.1845 (26 1958.7820 (26	4)
Pumps, fans and electric keep-hot Energy for lighting	86.0000 224.0640		0.1387 0.1443		11.9293 (26 32.3394 (26	7)
Total CO2, kg/year Dwelling Carbon Dioxide Emission Rate (DER)	224.0040		0.1443		2003.0506 (27	2)
pweiling Carbon ploxide Emission Rate (DER)					23.2900 (27	٠)
13a. Primary energy - Individual heating systems including micro-CHP						
	kWh/year		kg CO2/kWh	Prim	ary energy kWh/year	
Space heating - main system 1 Total CO2 associated with community systems	6131.4165		1.1300		6928.5006 (27 0.0000 (47	3)
Water heating (other fuel) Space and water heating	3196.1168		1.1300		3611.6120 (27 10540.1127 (27	9)
Pumps, fans and electric keep-hot Energy for lighting	86.0000 224.0640		1.5128 1.5338		130.1008 (28 343.6768 (28	2)
Total Primary energy kWh/year Dwelling Primary energy Rate (DPER)					11013.8903 (28 128.0700 (28	
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)						
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF TARGET EMISSIONS						
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)						
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF TARGET EMISSIONS						

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1. Overall dwelling characteristics



Ground floor Total floor area Dwelling volume	n TFA = (1a)+(1b)+(1c)+(1d)+(1e)	(1n)	8	6.0000		Area (m2) 86.0000		ey height (m) 2.5000 (-(3d)+(3e).		Volume (m3) 215.0000 (215.0000	(4)
2. Ventilation r	ate												
Number of open of Number of open f Number of chimne Number of flues Number of flues Number of blocke Number of intern Number of passi Number of fluele	Flues Eys / flues attached t attached t ed chimneys mittent ext ve vents	o solid fu o other hea	el boiler	ire							m3 0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 3 * 10 = 0 * 10 = 0 * 40 =	9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 (9.0000 ((6b) (6c) (6d) (6e) (6f) (7a) (7b)
Infiltration due Pressure test Pressure Test Me Measured/design Infiltration rat Number of sides	ethod AP50 ce	ys, flues a	and fans	= (6a)+(6b)	+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7	b)+(7c) =		30.0000		0.1395 (Yes ower Door 5.0000 (0.3895 ((17)
Shelter factor Infiltration rat	e adjusted	to include	e shelter f	actor					(20) = 1 - (21	[0.075 x L) = (18) x		0.8500 (0.3311 (
Wind speed Wind factor Adj infilt rate	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 (1.1750 (
Effective ac	0.4222 0.5891	0.4139 0.5856	0.4056 0.5823	0.3642 0.5663	0.3559 0.5633	0.3145 0.5495	0.3145 0.5495	0.3063 0.5469	0.3311 0.5548	0.3559 0.5633	0.3725 0.5694	0.3890 (0.5757 (1
3. Heat losses a Element TER Opening Type Heatloss Floor 1 External Wall 1 External Wall 2 External Wall 3 External Wall 4 External Wall 4	e (Uw = 1.2	ss parameto	er		Openings m2 9.9400 5.1600 4.5200 1.5800	Net. 21. 86. 12. 5. 10.	Area m2 2000 0000 00600 1500 4000 6500 2900	U-value W/m2K 1.1450 0.1300 0.1800 0.1800 0.1800 0.1800 0.1800	A x l W/k 24.274 11.1806 2.1708 0.9276 0.9726 1.9176 0.4122	k 3 3 3 3 3	-value kJ/m2K		(27) (28a) (29a) (29a) (29a) (29a) (29a)
Total net area of Fabric heat loss Party Wall 1 Party Wall 2 Party Wall 3 Party Wall 4			Aum(A, m2)			4. 17.		0) + (32) 0.0000 0.0000 0.0000 0.0000	= 41.8538 0.0000 0.0000 0.0000))			(31) (33) (32) (32) (32) (32)
Thermal mass par Thermal bridges Point Thermal br Total fabric hea	(User defi idges				area)						(36a) =	196.9535 (7.1375 (0.0000	(36)
Ventilation heat									(33	3) + (36) +	+ (36a) =	48.9913	(37)
(38)m Heat transfer co Average = Sum(39	: loss calc Jan 41.7973 Deff 90.7886	ulated mon [*] Feb 41.5518 90.5431	thly (38)m Mar 41.3111 90.3024	= 0.33 x (2 Apr 40.1809 89.1722	5)m x (5) May 39.9694 88.9607	Jun 38.9849 87.9763	Jul 38.9849 87.9763	Aug 38.8026 87.7939	Sep 39.3641 88.3554	Oct 39.9694 88.9607	Nov 40.3972 89.3885	Dec 40.8444 89.8357 89.1711	(38)
(38)m Heat transfer co	: loss calc Jan 41.7973 Deff 90.7886	Feb 41.5518	Mar 41.3111	Apr 40.1809	May 39.9694	38.9849	38.9849	38.8026	Sep 39.3641	Oct 39.9694	Nov 40.3972	Dec 40.8444 ((38) (39)
(38)m Heat transfer co Average = Sum(39	loss calc Jan 41.7973 peff 90.7886 D)m / 12 =	Feb 41.5518 90.5431 Feb	Mar 41.3111 90.3024 Mar	Apr 40.1809 89.1722 Apr	May 39.9694 88.9607	38.9849 87.9763 Jun	38.9849 87.9763 Jul	38.8026 87.7939 Aug	Sep 39.3641 88.3554	Oct 39.9694 88.9607	Nov 40.3972 89.3885	Dec 40.8444 (89.8357 (89.1711	(38) (39)
(38)m Heat transfer co Average = Sum(39 HLP HLP (average) Days in mont	loss calc Jan 41.7973 peff 90.7886 9)m / 12 = Jan 1.0557 31	Feb 41.5518 90.5431 Feb 1.0528 28	Mar 41.3111 90.3024 Mar 1.0500 31 (kWh/year)	Apr 40.1809 89.1722 Apr 1.0369 30	May 39.9694 88.9607 May 1.0344	38.9849 87.9763 Jun 1.0230 30	38.9849 87.9763 Jul 1.0230 31	38.8026 87.7939 Aug 1.0209 31	Sep 39.3641 88.3554 Sep 1.0274	Oct 39.9694 88.9607 Oct 1.0344	Nov 40.3972 89.3885 Nov 1.0394	Dec 40.8444 (89.8357 (89.1711 Dec 1.0446 (1.0369	(38) (39) (40)
(38)m Heat transfer co Average = Sum(39 HLP HLP (average) Days in mont 4. Water heating	loss calc Jan 41.7973 seff 90.7886 9)m / 12 = Jan 1.0557 31 g energy re- y or mixer 67.2585	Feb 41.5518 90.5431 Feb 1.0528 28	Mar 41.3111 90.3024 Mar 1.0500 31 (kWh/year)	Apr 40.1809 89.1722 Apr 1.0369 30	May 39.9694 88.9607 May 1.0344 31	38.9849 87.9763 Jun 1.0230 30	38.9849 87.9763 Jul 1.0230 31	38.8026 87.7939 Aug 1.0209 31	Sep 39.3641 88.3554 Sep 1.0274	Oct 39.9694 88.9607 Oct 1.0344	Nov 40.3972 89.3885 Nov 1.0394	Dec 40.8444 (89.8357 (89.1711) Dec 1.0446 (1.0369) 31	(38) (39) (40) (42) (42a)

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Average daily	40.9178 hot water u	39.4299 use (litres/	37.9420 /day)	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178 126.1389	
Daily hot wate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Energy conte	137.2229 217.3276	134.2929 191.2313	130.7246 200.9188	125.2985 171.5274	120.8922 162.7441	116.1550 142.8262	114.3344 138.2776	117.8873 145.9691	121.6344 149.9874	126.6076 171.8053 Total = S	132.1173 188.2253	136.8670 214.3007 2095.1407	(45)
Distribution 1	loss (46)m 32.5991	= 0.15 x (4 28.6847	45)m 30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	32.1451	
Water storage Total storage		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder co		icated solar	r storage		0.0000			0.0000	0.0000				, ,
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss Total heat red						49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	, ,
WWHRS	268.2865 -30.7478	237.2587 -27.1936	251.8777 -28.4756	220.8424 -23.5789	213.7030 -21.9747	192.1412 -18.8039	189.2365 -17.6257	196.9280 -18.7431	199.3024 -19.4552	222.7642 -22.9356	237.5404 -25.9832	265.2596 -30.1784	1 1
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	
Solar input FGHRS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	
Output from w/	h 237.5387	210.0651	223.4022	197.2635	191.7283	173.3373	171.6109	178.1849 Total p	179.8472 er year (kW	199.8286 h/year) = S	211.5571 um(64)m =	235.0812 2409.4451	
12Total per ye Electric showe		ar)										2409	(64)
	0.0000	0.0000	0.0000	0.0000 Tot	0.0000 al Energy u	0.0000 sed by inst	0.0000 antaneous e	0.0000 lectric sho	0.0000 wer(s) (kWh	0.0000 /year) = Su	0.0000 m(64a)m =	0.0000 0.0000	
Heat gains fro	m water hea 85.0011	ating, kWh/n 75.0912	nonth 79.5452	69.3616	66.8521	59.8185	58.7170	61.2745	62.1996	69.8650	74.9137	83.9947	(65)
	83.0011	73.0312	79.3432	09.3010	00.8321	39.8183	38.7170	01.2743	02.1990	09.8030	74.9137	83.3347	(03)
5. Internal ga		able 5 and 5	5a)										
Metabolic gair	rs (Table 5)												
(66)m	Jan 128.3459	Feb 128.3459	Mar 128.3459	Apr 128.3459	May 128.3459	Jun 128.3459	Jul 128.3459	Aug 128.3459	Sep 128.3459	Oct 128.3459	Nov 128.3459	Dec 128.3459	(66)
Lighting gains	(calculate	ed in Append	dix L, equa [.]	tion L9 or	L9a), also	see Table 5							
Appliances gai								117.6626	121.5847	117.6626	121.5847	117.6626	, ,
Cooking gains	231.5234 (calculated	233.9259 d in Appendi	227.8717 ix L. equat:	214.9831 ion L15 or	198.7134 L15a), also	183.4223 see Table	173.2069 5	170.8044	176.8586	189.7472	206.0168	221.3080	(68)
Pumps, fans	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 0.0000	35.8346 3.0000	35.8346 3.0000	35.8346 3.0000	
Losses e.g. ev	aporation ((negative va	alues) (Tab	le 5)									
Water heating	-102.6768 gains (Tabl		-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	-102.6768	(71)
Total internal	114.2489 gains	111.7429	106.9156	96.3356	89.8550	83.0812	78.9207	82.3582	86.3883	93.9046	104.0468	112.8961	(72)
	527.9386	540.4419	516.9537	497.4071	470.7348	449.5919	431.2939	432.3289	446.3353	465.8181	496.1521	516.3705	(73)
6. Solar gains													
[Jan]			A	rea m2	Solar flux Table 6a W/m2		g fic data Table 6b	Specific or Tab		Acce fact Table	or	Gains W	
Northeast			15.1	 900	11.2829		0.6300		.7000	0.54	90	36.5152	(75)
Southeast South			4.5 1.5		36.7938 46.7521		0.6300 0.6300		.7000 .7000	0.54 0.54		35.6442 15.8319	
													()
Solar gains Total gains	87.9913 615.9299	160.9716 701.4134	250.0166 766.9703	360.1880 857.5950	449.8165 920.5514	467.0613 916.6533	441.7595 873.0535	371.6938 804.0227	287.6303 733.9656	185.9041 651.7222	107.4053 603.5573	74.0044 590.3748	` '
7. Mean interr	nal temperat	ture (heatir	ng season)										
Temperature du Utilisation fa	actor for ga	ains for liv	/ing area, i	ni1,m (see	Table 9a)		77	A	6 m m	0-4	New	21.0000	(85)
tau alpha	Jan 51.8237 4.4549	Feb 51.9642 4.4643	Mar 52.1027 4.4735	Apr 52.7631 4.5175	May 52.8885 4.5259	Jun 53.4803 4.5654	Jul 53.4803 4.5654	Aug 53.5914 4.5728	Sep 53.2508 4.5501	0ct 52.8885 4.5259	Nov 52.6354 4.5090	Dec 52.3734 4.4916	
util living ar	rea 0.9892	0.9798	0.9600	0.8988	0.7728	0.5868	0.4373	0.4913	0.7366	0.9293	0.9798	0.9910	(86)
MIT Th 2	19.6131 20.0372	19.8210 20.0395	20.1225 20.0419	20.5267 20.0527	20.8218 20.0547	20.9613 20.0642	20.9918 20.0642	20.9864 20.0660	20.8938 20.0606	20.5090 20.0547	20.0006 20.0506	19.5831 20.0463	
util rest of h	0.9865 18.4258	0.9748 18.6905	0.9498 19.0705	0.8737 19.5695	0.7222 19.9002	0.5110 20.0398	0.3472 20.0610	0.3966 20.0601	0.6644 19.9835	0.9061 19.5607	0.9739 18.9283	0.9887 18.3941	
Living area fr MIT	action 18.9021	19.1440	19.4925	19.9535	20.2699	20.4095	20.4344	20.4317	fLA = 20.3487	Living are 19.9411	a / (4) = 19.3585	0.4012 18.8711	
Temperature ad	ljustment											0.0000	
adjusted MIT	18.9021	19.1440	19.4925	19.9535	20.2699	20.4095	20.4344	20.4317	20.3487	19.9411	19.3585	18.8711	(93)

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8. Space heating requirement											
Jan Feb Utilisation 0.9821 0.9688 Useful gains 604.9200 679.5323 Ext temp. 4.3000 4.9000 Heat loss rate W	Mar 0.9427 723.0213 6.5000	Apr 0.8707 746.7457 8.9000	May 0.7345 676.1518 11.7000	Jun 0.5397 494.7553 14.6000	Jul 0.3833 334.6284 16.6000	Aug 0.4344 349.2612 16.4000	Sep 0.6880 504.9413 14.1000	Oct 0.9028 588.3704 10.6000	Nov 0.9683 584.4201 7.1000	Dec 0.9848 581.4244 4.2000	(95)
1325.7034 1289.6966	1173.2570	985.6633	762.3849	511.0956	337.3371	353.9617	552.1023	830.9901	1095.7675	1317.9899	(97)
Space heating kWh 536.2628 410.0305 Space heating requirement - total p Solar heating kWh		172.0207 'year)	64.1575	0.0000	0.0000	0.0000	0.0000	180.5091	368.1701	548.0047 2614.1307	(98a)
0.0000 0.0000 Solar heating contribution - total Space heating kWh	0.0000 per year (kWh	0.0000 n/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
536.2628 410.0305		172.0207	64.1575	0.0000	0.0000	0.0000	0.0000	180.5091	368.1701	548.0047	(98c)
Space heating requirement after sol Space heating per m2	iar contributi	.on - total	per year	(KWII/ year')				(98c) / (4) =	2614.1307 30.3969	(99)
9a. Energy requirements - Individua											
Fraction of space heat from secondary Fraction of space heat from main systemiciency of main space heating systemiciency of main space heating systemiciency of secondary/supplementary.	ystem(s) ystem 1 (in %) ystem 2 (in %)		(Table 11							0.0000 1.0000 92.4000 0.0000 0.0000	(202) (206) (207)
Jan Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Space heating requirement 536.2628 410.0305	334.9754	172.0207	64.1575	0.0000	0.0000	0.0000	0.0000	180.5091	368.1701	548.0047	(98)
Space heating efficiency (main heat 92.4000 92.4000	ting system 1) 92.4000	92.4000	92.4000	0.0000	0.0000	0.0000	0.0000	92.4000	92.4000	92.4000	(210)
Space heating fuel (main heating sy 580.3710 443.7559	, ,	186.1696	69.4345	0.0000	0.0000	0.0000	0.0000	195.3561	398.4525	593.0787	(211)
Space heating efficiency (main heat 0.0000 0.0000	ting system 2) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating sy 0.0000 0.0000	ystem 2) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary) 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating Water heating requirement 237.5387 210.0651	223.4022	197.2635	191.7283	173.3373	171.6109	178.1849	179.8472	199.8286	211.5571	235.0812	(64)
Efficiency of water heater (217)m 86.0703 85.7876	85.2472	84.0893	82.2961	80.3000	80.3000	80.3000	80.3000	84.1641	85.5562	80.3000 86.1308	(216)
Fuel for water heating, kWh/month 275.9822 244.8666	262.0638	234.5882	232.9739	215.8622	213.7121	221.8990	223.9691	237.4273	247.2727	272.9351	
Space cooling fuel requirement (221)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Pumps and Fa 7.3041 6.5973 Lighting 24.4480 19.6131	7.3041 17.6594	7.0685 12.9380	7.3041 9.9937	7.0685 8.1649	7.3041 9.1166	7.3041 11.8501	7.0685 15.3921	7.3041 20.1953	7.0685 22.8105	7.3041 25.1274	(231)
Electricity generated by PVs (Apper (233a)m -18.9129 -28.2844	-43.0944	-51.4489	-58.1214	-55.2109	-54.5272	-50.1516	-42.9215	-33.6242	-21.3564	-16.1671	(233a)
Electricity generated by wind turbit (234a)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-elec (235a)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity (235c)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	ve if net ge 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Apper (233b)m -6.2713 -13.5296	-27.5355	-42.3260	-56.9353	-57.5752	-56.9097	-47.7471	-34.4198	-19.6730	-8.4745	-4.9353	(233b)
Electricity generated by wind turbit (234b)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-elect (235b)m 0.0000 0.0000 Electricity used or net electricity	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
(235d)m 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)
Annual totals kWh/year Space heating fuel - main system 1 Space heating fuel - main system 2 Space heating fuel - secondary Efficiency of water heater Water heating fuel used										2829.1458 0.0000 0.0000 80.3000 2883.5522	(213) (215) (219)
Space cooling fuel Electricity for pumps and fans:	ulb /voan									0.0000	
Total electricity for the above, kur Electricity for lighting (calculate	ed in Appendix	ŕ	0)							86.0000 197.3090	
Energy saving/generation technologi PV generation Wind generation Hydro-electric generation (Appendian Electricity generated - Micro CHP (x N)	n and, אי es	Q)							-850.1531 0.0000 0.0000 0.0000	(234) (235a)
Appendix Q - special features Energy saved or generated	(whhelings is)									-0.0000	, ,

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Energy used 0.0000 (237)
Total delivered energy for all uses 5145.8539 (238)

12a. Carbon dioxide emissions - Individual heating systems including			
	Energy	Emission factor	Emissions
	kWh/year	kg CO2/kWh	kg CO2/year
Space heating - main system 1	2829.1458	0.2100	594.1206 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2883.5522	0.2100	605.5460 (264)
Space and water heating			1199.6666 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	197.3090	0.1443	28.4778 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-473.8209	0.1334	-63.1951
PV Unit electricity exported	-376.3322	0.1252	-47.1237
Total			-110.3188 (269)
Total CO2, kg/year			1129.7548 (272)
Target Carbon Dioxide Emission Rate (TER)			13.1400 (273)
13a. Primary energy - Individual heating systems including micro-CHP			
	Energy Pr	imary energy factor	Primary energy
	kWh/year	kg CO2/kWh	kWh/year
Space heating - main system 1	2829.1458	1.1300	3196.9347 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2883.5522	1.1300	3258.4140 (278)
Space and water heating			6455.3487 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	197.3090	1.5338	302.6392 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-473.8209	1.4929	-707.3467
PV Unit electricity exported	-376.3322	0.4596	-172.9638
Total			-880.3105 (283)
Total Primary energy kWh/year			6007.7782 (286)
Target Primary Energy Rate (TPER)			69.8600 (287)
, , ,			(- ,

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Appendix E - Water Calculator

Water Efficiency Calculator for New Dwellings (V1f - Aug 2010) **Project Details** Adress/Reference SH - Unit 6 Sheldon House, 8 Cromwell Road, Teddington Case Reference Number of Bedrooms Occupancy for Calculation Purposes Appliance/Useage Details Taps (Excluding Kitchen Taps) **Showers** Quantity Tap Fitting Type Flow Rate Total per Shower fitting Flow Rate Quantity Total per Litres/Min Fitting type Fitting type (No.) Litres/Min (No.) Type Tap 1 5.00 Shower 1 8.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 Total No. of Fittings (No.) Total No. of Fittings (No.) Total Flow (I/s) 5.00 Total Flow (I/s) 8.00 Maximum Flow (I/s) 5.00 Maximum Flow (I/s) 8.00 Average Flow (I/s) 5.00 Average Flow (I/s) 8.00 Weighted Average Flow (I/s) 3.50 Weighted Average Flow (I/s) 5.60 Flow for Calculation (I/s) 5.00 Flow for Calculation (I/s) 8.00 **Baths** WCs Part Flush Quantity Full Flush **Bath Type** Capacity to Quantity Total per Fitting type Overflow (No.) **WC Type** Volume Volume (No) Bath 1 170.00 170.00 WC 1 4.00 2 60 0.00 0.00 0.00 Total No. of Fittings (No.) Total Capacity (I) 170.00 Total number of fittings Maximum Capacity (I) 170.00 Average effective flushing volume N/a Average Capacity (I) 170.00 Weighted Average Capacity (I) 119.00 Capacity for Calculation (I) 170.00 **Washing Machines** Dishwashers Dishwasher Type L per Place Quantity Washing Machine Quantity Total per Total per L per Kq Fitting type Dry Load Setting (No.) (No.) Fitting type Type 1.25 Wash 1 8.17 Dish 1 1.25 0.00 0.00 Total No. of Fittings (No.) Total No. of Fittings (No.) Total Consumption (I) **Total Consumption (I)** 8.17 Maximum Consumption (I) 1.25 Maximum Consumption (I) 8.17 1.25 Average Consumption (I/s) Average Consumption (I/s) 8.17 Weighted Average Consumption (I) 0.88 Weighted Average Consumption (I) 5.72 Consumption for Calculation (I/s) 1.25 Consumption for Calculation (I/s) Other Fittings Kitchen Taps **Tap Fitting Type** Flow Rate Quantity Waste Disposal Y/N Total per Litres/Min (No.) Fitting type 6.00 Consumption beyond 4% I/p/d Tap 2 6.00 0.00 Use of grey water and harvested rainwater 0.00 Total No. of Fittings (No.) Total Grey water from WHB taps (I) Total Flow (I/s) 6.00 Maximum Flow (I/s) 6.00 Total Availble Grey Water Supply (I) 107.32 Possible Demand (I) Average Flow (I/s) 6.00 61.39 Weighted Average Flow (I/s) 4.20 Grey/Rain Installed Capacity (I) Flow for Calculation (I/s) Figure for Calculation lit/person/day 0.00 6.00 **Water Use Assessment** Fixed use Total Use Installation Type Capacity/ Use Factor Flow Rate (l/p/day) (I/p/day) WC Single Flush Volume (I) 0.00 WC Dual Flush Full Flush (I) 4.00 1.46 0.00 5.84 Pt Flush (I) 2.96 0.00 WC's (Multiple) Volume (I) 0.00 4.42 0.00 0.00 Taps Exc. Kitchen Flow Rate 5.00 1.58 9.48 Bath (shower present) 70.00 0.11 (l/s) 0.00 18.70 Shower (bath present) (l/s) 8.00 4.37 0.00 34.96 Bath Only 0.00 0.50 0.00 0.00 (l) Shower Only (l/s) 0.00 5.60 0.00 0.00 Kitchen Taps 0.44 (l/s) 6.00 10.36 13.00 Washing Machines (l/kgdry) 8.17 0.00 Dishwashers (l/place) 1.25 3.60 0.00 4.50 Waste Disposal (l/s) 0.00 3.08 0.00 0.00 . Water Softner 0.00 (l/s) 0.00 Total Calculated Water Use (I/p/day) 111.33 Grey/RainWater Reused (I) 0.00 Normalisation Factor 0.91 Total Consumption CSH (I/p/day) 101.31 External Water Use Allowance (I) Total Comsumption Part G (I/p/day) 106.31 Assesment Result **PASS**

Appendix F - 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 the panels could be placed on a pitch between 30-40°. Currently this report anticipates an angle of no more than 15° for the flat green roof and 35° for the hipped roofs.

Typical domestic systems range from $I-4.55 kW_P$ 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 I.5%.





Fig. 3 & 4 PV Panels mounted on green flat roof

Fully installed the costs for roof mounted systems varies according the number of panels in an array, A standard 3.5kW_p domestic system costs on average £5,500, where cost factors in the array configuration, i.e. 3 panels providing approximately 1kWp cost on average £3,900 or 20 panels delivering 6kWp for larger developments would cost on average £9,100.

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.

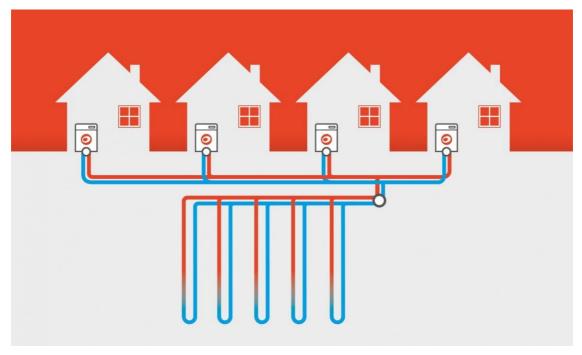
Ground Source Heat Pumps – Vertical System:

A ground source heat pump is a renewable heating system that extracts low-temperature solar energy stored in the ground or water using pipework within boreholes and compresses this energy into a higher temperature. A ground source heat pump provides a building with 100% of its heating and hot water all year round.

Heat naturally flows from warmer to cooler places. A ground source heat pump exploits these physics by circulating a cold fluid through ground array pipework in the ground or water. It absorbs low-grade surrounding energy from external heat sources, such as rock, soil, lakes and streams. The ground source heat pump then compresses and condenses this free energy to a higher temperature, and transfers it to the property's heating and hot water system.

Having surrendered the absorbed energy from the ground to the heat pump, the fluid continues its circuit back to the submerged pipework to commence the cycle all over again.

Ground source heat pumps keep residents affordably warm all year round. By installing heat pumps, social housing providers can tackle fuel poverty and reduce household heating bills – relieving tenants of the 'heat or eat' ultimatum.



Ground source heat pumps can be combined with smart controls to enhance comfort and savings for tenants. By using smart controls that learn a household's heating preferences and building heat physics, tenants can avoid the peaks of grid strain and shift the heat pump's power consumption to the times when the grid can best accommodate it – when there is lower carbon and lower-cost electricity. The heat pump will turn on when there is extra electrical capacity, and turn off when the grid is under strain from peak electricity times.

Ground source heat pumps have far more potential to participate in load shifting initiatives than air source variants, as the ground is a very stable temperature heat source. A ground source heat pump can be run at the same efficiency any time of day or night.

The grid generally generates excess power overnight, and some of the variable tariffs can go negative. When that happens, people actually get paid for running their heating.

