Sheldon House Development

8 Cromwell Road, Teddington, London
TW11 9EJ

Energy & Sustainability Report

January 2022

CLIVE CHAPMAN
ARCHITECTS
SUSTAINABILITY CONSULTANTS

4 EEL PIE ISLAND
TWICKENHAM MIDDX
TW1 3DY
TELEPHONE 020 8891 4837
EMAIL INFO@CCAR.CO.UK
WEBSITE WWW.CCAR.CO.UK

CONTENTS

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 43.5-55.5m^{2}), 8 No. 2-bed flats (at 61-85m^{2}), and 3 No. 3-bed flats (at 86m^{2}). 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 CO_2 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 CO_2 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)	1
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.

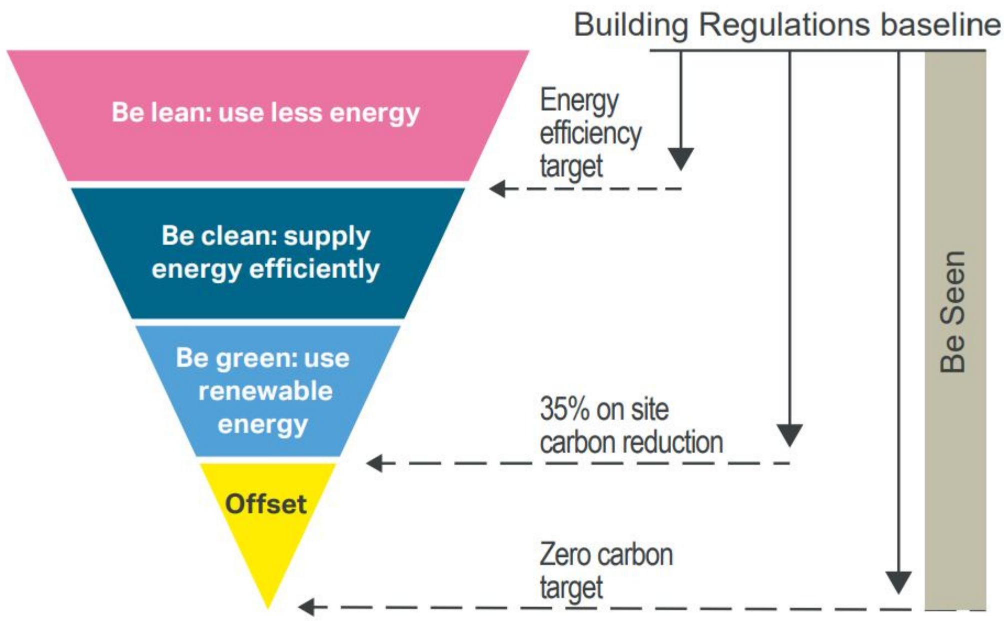
4.0 Energy Strategy

This section sets out the detailed analysis and results of the annual CO_2 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 CO_2 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.

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.

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 CO_2 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:

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 panels	The building has a flat green roof that can be used for photovoltaic panels. They will be angled to target best orientation. PV panels are a commonly used renewable technology and not prohibitively expensive.	Likely to be suitable for this site
Solar water heating panels	As above, the building has a sufficient flat roof that can be used for Solar Thermal tubes. However, the contribution of solar hot water towards the LBRUT 20% renewables requirement is significantly lower than the 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.	May be suitable for this site
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 development, it is not suitable for a communal biomass CHP. Micro biomass CHPs are not readily available on the open market and there are limited suppliers to the London area.	Rejected
Ground source heat pumps for heating - space and hot water	The site is likely suitable for a vertical borehole system, with the removal of the existing tower block and its subsequent foundations, with a level of ground works being required already.	Likely to be suitable for this site
Ground sourced inc. borehole cooling, either direct or via a chiller	There is no need of a mechanical cooling system.	Possibly suitable for this site

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/)

System	*Preliminary Assessment*	*Decision*
Air source heat pumps (ASHP) for heating - space and domestic hot water)	Air is an easily accessible means of heating especially with the use of a low temperature system such as under floor heating. As it runs on electricity, the system could use the energy generated from PV panels and it is preferred small-scale renewable tech.	Likely to be suitable for this site

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:

$$\frac{[(\text{target primary energy rate1} \times \text{floor area1}) + (\text{target primary energy rate2} \times \text{floor area2}) + (\text{target primary energy rate3} \times \text{floor area3}) + \ldots]}{(\text{floor area1} + \text{floor area2} + \text{floor area3} + \ldots)}$$

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 L1A, 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:	1.7 t/yr
DER:	23.29 $kgCO_2/yr/m^2$
TER:	13.14 $kgCO_2/yr/m^2$
%DER<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:	**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.

	'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 x 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 kWh/yr		
	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 CO_2 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 L1A, bettering the reduction target of 35%;
- Provides a portion of **35.88%** reduction in CO_2 emissions and CO_2 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 **101.31** 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: Clive Chapman Architects

For Non-Residential
Size of development (m2):

For Residential
Number of dwellings: 27

1 MINIMUM COMPLIANCE (RESIDENTIAL AND NON-RESIDENTIAL

Energy Assessment

Has an energy assessment been submitted that demonstrates the expected energy and carbon dioxide emissions saving from energy efficiency and renewable energy measures, including the feasibility of CHP/CCHP and community heating systems? If yes, please select TRUE. **TRUE**

Carbon Dioxide emissions reduction

What is the on site carbon dioxide emissions reduction against a Building Regulations Part L (2013) baseline: 45.05 %
Policy LP 22 B. and Draft London Plan Policy 9.2.5 require a 35% onsite reduction in CO_2 emissions beyond Building Regulations 2013.

What is the percentage reduction from efficiency measures alone: 35.88 %
Policy LP 22 C. and Draft London Plan Policy 9.2.6 require a 10% onsite reduction in CO2 emissions beyond Building Regulations 2013 from efficiency measures for residential and 15% for non-residential.

Percentage of **total** site CO2 emissions saved through renewable energy installation? 5.88 %

What is the total remaining carbon to be offset: 13.77 Tonne
Policy LP 22 B. and Draft London Plan Policy 9.2.4 require Major developments to achieve Zero Carbon after offsetting.

Are remaining emissions going to be offset through offset fund payment in accordance with current guidelines issued for the cost per tonne of CO2? **TRUE**

What is the total predicted cost of offset? 39244.5 £
The London Plan sets this as £95/tonne per year over 30 years, this should be updated based on As Build calculations.

1A MINIMUM POLICY COMPLIANCE (NON-RESIDENTIAL AND DOMESTIC REFURBISHMENT

Please check the Guidance Section of this SPD for the policy requirements

Environmental Rating of development:

Non-Residential new-build (100sqm or more)
BREEAM Level: **Please Select** — Have you attached a pre-assessment to support this? **Please Select:**
Excellent required under Policy LP22 A 3

Extensions and conversions for residential dwellings
BREEAM Domestic Refurbishment: **Please Select** — Have you attached a pre-assessment to support this? **Please Select:**
Excellent required under Policy LP22 A 4

Extensions and conversions for non-residential buildings
BREEAM Level: **Please Select** — Have you attached a pre-assessment to support this? **Please Select:**
Excellent required under Policy LP 22

Score awarded for Environmental Rating:
BREEAM: Good = *0*, Very Good = 4, Excellent = *8*, Outstanding = *16*

Subtotal 0

1B MINIMUM POLICY COMPLIANCE (RESIDENTIAL

Score

Water Usage

Internal water usage after gray/rainwater systems limited to 105 litres person per day. (Excluding an allowance 5 litres per person per day for external water consumption). Calculations using the water efficiency calculator for new dwellings have been submitted. — Score: *1* — **TRUE**
110l/p/d Required for new dwellings under Policy LP22 A 2 105l/p/d required under Draft London Plan Policy SI5

Subtotal 1

2. ENERGY USE AND POLLUTION

2.1 Need 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 Heat Generation

		Score	
b.	How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy **SI3)** Tick all heating and cooling systems that will be used in the development:		
	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	*4*	FALSE
	Site wide CHP network powered by gas	*3*	FALSE
	Communal heating and cooling powered by renewable energy	*2*	FALSE
	Communal heating and cooling powered by gas or electricity	*1*	FALSE
	Individual heating and cooling	*0*	TRUE
	See Draft London Plan SI3		

2.3 Pollution: Air, Noise and Light

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
	If yes, please refer to the biomass guidelines for the Borough of Richmond, please see guidance for supplementary 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.	Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity?	*3*	TRUE
	see Policy LP 10		
f.	Have you attached a Lighting Pollution Report?	*-*	

Subtotal 19

Please give any additional relevant comments to the Energy Use and Pollution Section below

With regards to air quality, though no specific 'mechanical' measures have been proposed to protect residents, the design follows passive 'natural' ventilation as a best practice measure. This is relevant 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' development scenarios, and no short term exceedance is expected. In terms of enhancing the soundscape, new boundary fencing/walls are to be provided to screen the railway, whilst increassed planting is used to act as a sound buffer.

3. TRANSPORT

3.1 Provision for the safe efficient and sustainable movement of people and goods

a. Does your development provide opportunities for occupants to use innovative travel technologies? — TRUE

Please explain:

Secure bicyle storage has been provided for the flats and visitors, in-line with London Plan guidance, inclusive of larger bicycle bays. Plus 100% of the parking spaces will have active charging.

		Score	
b.	Does your development provide for 100% active provision for electric vehicle charging point(s) and have you successfully demonstrated that it would be able to operate satisfactorily in the future expectation of all vehicles being electrically powered?	*2*	TRUE
c.	**For major developments ONLY**: Has a Transport Assessment been produced for your development based on TfL's Best Practice Guidance?		
	If you have provided a Transport Assessment as part of your planning application, please tick here and move to Section 3 of this Checklist.	*5*	TRUE
	See policy LP44		
d.	**For smaller developments ONLY**: Have you provided a Transport Statement?	*5*	FALSE
e.	Does your development provide cycle storage? (Standard space requirements are set out in the Council's Parking Standards - Local Plan Appendix 3)	*2*	TRUE
	If so, for how many bicycles?	53	
	Is this shown on the site plans?		TRUE
	See Local Plan Appendix 3		
f.	Will the development create or improve links with local and wider transport networks? If yes, please provide details.	*2*	FALSE

Subtotal 9

Please give any additional relevant comments to the Transport Section below

4 BIODIVERSITY

4.1 Minimising the threat to biodiversity from new buildings, lighting, hard surfacing and people

a.	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
	If so, please state how much in sqm?			0 sqm	
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
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	TRUE
	An intensive green roof	4	Area provided:	0 sqm	FALSE
	Garden space	4	Area provided:	385 sqm	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			TRUE
	Bird boxes	0.5			TRUE
	Swift boxes	0.5			TRUE
	Other	0.5			FALSE
e.	Does your development use at least 70% of available roof plate as green/brown roof *Policy LP 17 requires 70%*	1			Please Select:

Subtotal 19.5

Please give any additional relevant comments to the Biodiversity Section below

The proposal 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 an undercroft. The new parking area will be permeable.

5 FLOODING AND DRAINAGE

5.1 Mitigating the risks of flooding and other impacts of climate change in the borough

a.	Is your site located in a high flood risk zone (Zone 3)? (Indicate if yes)	-2	FALSE
	Have you submitted a Flood Risk Assessment? (Indicate if yes)		FALSE
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	3	TRUE
	Attenuate rainwater in ponds or open water features	4	TRUE
	Store rainwater in tanks for gradual release to a watercourse	3	FALSE
	Discharge rainwater 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

c. Please give the change in area of permeable surfacing which will result from your development proposal: 194 sqm

Please provide details of the permeable surfacing below

please represent a loss in permeable area as a negative number

Subtotal 13

Please give any additional relevant comments to the Flooding and Drainage Section below

The development 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 proposed providing additional attenuation.

6 IMPROVING RESOURCE EFFICIENCY

6.1 Reduce waste generated and amount disposed of by landfill though increasing level of re-use and recycling

a.	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
	If so, what percentage of demolition waste will be reused in the new development?	5 %		
	What percentage of demolition waste will be recycled?	5 %		
b.	Does your site have any contaminated land?		1	FALSE
	Have you submitted an assessment of the site contamination?		2	FALSE
	Are plans in place to remediate the contamination?		2	FALSE
	Have you submitted a remediation plan?		1	FALSE
	Are plans in place to include composting on site?		1	TRUE
c.	Will a waste management plan and facilities be in place in line with Policy LP24	Yes		

6.2 Reducing 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	1	TRUE
	Use of water efficient A or B rated appliances	1	TRUE
	Rainwater harvesting for internal use	4	FALSE
	Greywater systems	4	FALSE
	Fit a water meter	1	TRUE

Subtotal 4

Please give any additional relevant comments to the Improving Resource Efficiency Section below

7 ACCESSIBILITY

7.1 Ensure flexible adaptable and long-term use of structures

a. **If the development is residential,** will it meet the requirements of the nationally described space standard for internal space and layout? *1* **TRUE**

If the standards are not met, in the space below, please provide details of the functionality of the internal space and layout

AND

b. **If the development is residential**, will it meet Building Regulation Requirement M4 (2) 'accessible and adaptable dwellings'? *2* **TRUE**

If this is not met, in the space below, please provide details of any accessibility measures included in the development.

For major residential developments, are 10% or more of the units in the development to Building Regulation Requirement M4 (3) 'wheelchair user dwellings'? *1* **TRUE**

OR

c. **If the development is non-residential,** does it comply with requirements included in Richmond's Local Plan LP1, LP28.B, LP30 & LP45 *2* **Please Select:**

Please provide details of the accessibility measures specified in the Local Plan that will be included in the development

Subtotal 4

Please give any additional relevant comments to the Design Standards and Accessibility Section below

11% Wheelchair dwellings M4(3) have been incorporated.

LBRUT Sustainable Construction Checklist- Scoring Matrix for *New Construction* **(Non-Residential and domestic refurb)** ***TOTAL*** ***69.5***

Score	Rating	Significance
84 or more	*A+*	Project strives to achieve highest standard in energy efficient sustainable development
75-83	*A*	Makes a major contribution towards achieving sustainable development in Richmond
56-74	*B*	Helps to significantly improve the Borough's stock of sustainable developments
40-55	*C*	Minimal effort to increase sustainability beyond general compliance
39 or less	*FAIL*	Does not comply with SPD Policy

LBRUT Sustainable Construction Checklist- Scoring Matrix for New Construction **Residential new-build**

Score	Rating	Significance
85 or more	A++	Project strives to achieve highest standard in energy efficient sustainable development
68-84	*A+*	Project strives to achieve higher standard in energy efficient sustainable development
59-67	*A*	Makes a major contribution towards achieving sustainable development in Richmond
39-58	*B*	Helps to significantly improve the Borough's stock of sustainable developments
24-38	*C*	Minimal effort to increase sustainability beyond general compliance
23 or less	*FAIL*	Does not comply with SPD Policy

Authorisation:

I herewith declare that I have filled in this form to the best of my knowledge

Signature ______________________________ **Date** ______________________

Appendix B - Building Regulations Part L1A Notional & Limited Tables

Table 1.1 Summary of notional dwelling 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 W/(m²·K)
Party walls	U = 0
Floors	U = 0.13 W/(m²·K)
Roofs	U = 0.11 W/(m²·K)
Opaque door (less than 30% glazed area)	U = 1.0 W/(m²·K)
Semi-glazed door (30–60% glazed area)	U = 1.0 W/(m²·K)
Windows and glazed doors with greater than 60% glazed area	U = 1.2 W/(m²·K) Frame factor = 0.7
Roof windows	U = 1.2 W/(m²·K), when in vertical position (for correction due to angle, see specification in SAP 10 Appendix R)
Rooflights	U = 1.7 W/(m²·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 × (0.2 + 0.051 $V^{2/3}$) 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 / 6.5 For flats: kWp = 40% of dwelling floor area / (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/(m²·K).

Appendix C - SAP Worksheets - Improved Scenario

Full SAP Calculation Printout

Property Reference	SH	Issued on Date	17/11/2022
Assessment Reference	Unit 1 - Improved	Prop Type Ref	Flats
Property	Sheldon House, 8 , Cromwell Road, Teddington, London, TW11 9EJ		

SAP Rating	70 C	DER	6.99	TER	12.72
Environmental	94 A	% DER<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) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	86.0000 (1b)	x	2.5000 (2b)	=	215.0000 (1b) -
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

		m3 per hour
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 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (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 m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Opening Type 1 (Uw = 1.20)			15.1000	1.1450	17.2901			(27)
Opening Type 2 (Uw = 1.20)			6.1000	1.1450	6.9847			(27)
Heatloss Floor 1			86.0000	0.1300	11.1800	110.0000	9460.0000	(28a)
External Wall 1	22.0000	9.9400	12.0600	0.1800	2.1708	14.0000	168.8400	(29a)
External Wall 2	5.1500		5.1500	0.1800	0.9270	14.0000	72.1000	(29a)
External Wall 3	10.5600	5.1600	5.4000	0.1800	0.9720	14.0000	75.6000	(29a)
External Wall 4	15.1700	4.5200	10.6500	0.1800	1.9170	14.0000	149.1000	(29a)
External Wall 5	3.8700	1.5800	2.2900	0.1800	0.4122	14.0000	32.0600	(29a)

Total net area of external elements Aum(A, m2)	142.7500					(31)
Fabric heat loss, W/K = Sum (A x U)	(26)...(30) + (32) =		41.8538			(33)
Party Wall 1	11.5700	0.0000	0.0000	20.0000	231.4000	(32)
Party Wall 2	4.2500	0.0000	0.0000	20.0000	85.0000	(32)
Party Wall 3	17.1200	0.0000	0.0000	20.0000	342.4000	(32)
Party Wall 4	16.0600	0.0000	0.0000	20.0000	321.2000	(32)
Party Floor 1	55.5700			40.0000	2222.8000	(32d)
Party Ceiling 1	86.0000			30.0000	2580.0000	(32b)
Internal Wall 1	22.2500			9.0000	200.2500	(32c)
Internal Wall 2	5.2500			9.0000	47.2500	(32c)
Internal Wall 3	10.0000			9.0000	90.0000	(32c)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16078.0000	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		186.9535	(35)
Thermal bridges (Default value 0.200 * total exposed area)		28.5500	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	70.4038	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	45.6028	45.2095	44.8240	43.0134	42.6747	41.0977	41.0977	40.8056	41.7051	42.6747	43.3600	44.0764	(38)
Heat transfer coeff	116.0066	115.6133	115.2279	113.4172	113.0785	111.5015	111.5015	111.2094	112.1089	113.0785	113.7638	114.4802	(39)
Average = Sum(39)m / 12 =												113.4156	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3489	1.3443	1.3399	1.3188	1.3149	1.2965	1.2965	1.2931	1.3036	1.3149	1.3228	1.3312	(40)
HLP (average)												1.3188	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

---

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.5669	(42)
Hot water usage for mixer showers	67.2585	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 usage 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 for other uses	40.9178	39.4299	37.9420	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178	(42c)
Average daily hot water use (litres/day)												126.1389	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	137.2229	134.2929	130.7246	125.2985	120.8922	116.1550	114.3344	117.8873	121.6344	126.6076	132.1173	136.8670	(44)
Energy conte	217.3276	191.2313	200.9188	171.5274	162.7441	142.8262	138.2776	145.9691	149.9874	171.8053	188.2253	214.3007	(45)
Energy content (annual)										Total = Sum(45)m =		2095.1407	
Distribution loss (46)m = 0.15 x (45)m	32.5991	28.6847	30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	32.1451	(46)
Water storage loss:													
Store volume												120.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1330	(48)
Temperature factor from Table 2b												0.7930	(49)
Enter (49) or (54) in (55)												1.6914	(55)
Total storage loss	52.4349	47.3605	52.4349	50.7434	52.4349	50.7434	52.4349	52.4349	50.7434	52.4349	50.7434	52.4349	(56)
If cylinder contains dedicated solar storage	52.4349	47.3605	52.4349	50.7434	52.4349	50.7434	52.4349	52.4349	50.7434	52.4349	50.7434	52.4349	(57)
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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	269.7625	238.5918	253.3537	222.2708	215.1790	193.5696	190.7125	198.4040	200.7308	224.2402	238.9687	266.7356	(62)
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	-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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
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	(63d)
Output from w/h	269.7625	238.5918	253.3537	222.2708	215.1790	193.5696	190.7125	198.4040	200.7308	224.2402	238.9687	266.7356	(64)
								Total per year (kWh/year) = Sum(64)m =				2712.5191	(64)
12Total per year (kWh/year)												2713	(64)
Electric shower(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)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	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 gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	117.6626	130.2693	117.6626	121.5847	117.6626	121.5847	117.6626	117.6626	121.5847	117.6626	121.5847	117.6626	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	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)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)

Losses e.g. evaporation (negative values) (Table 5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	-102.6768	-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 gains (Table 5)	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)
Total internal gains	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)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	15.1000	11.2829	0.6300	0.7000	0.5400	36.5152	(75)
Southeast	4.5200	36.7938	0.6300	0.7000	0.5400	35.6442	(77)
South	1.5800	46.7521	0.6300	0.7000	0.5400	15.8319	(78)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	87.9913	160.9716	250.0166	360.1880	449.8165	467.0613	441.7595	371.6938	287.6303	185.9041	107.4053	74.0044	(83)
Total gains	652.1882	737.6717	803.2286	893.8533	956.8097	955.9116	912.3118	843.2810	773.2239	687.9805	639.8156	626.6331	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	38.4988	38.6297	38.7590	39.3777	39.4957	40.0543	40.0543	40.1595	39.8373	39.4957	39.2578	39.0121	
alpha	3.5666	3.5753	3.5839	3.6252	3.6330	3.6703	3.6703	3.6773	3.6558	3.6330	3.6172	3.6008	
util living area	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	19.4680	19.6388	19.9079	20.2910	20.6142	20.8221	20.8882	20.8761	20.7281	20.3159	19.8406	19.4519	
Non living	18.4233	18.5947	18.8617	19.2428	19.5370	19.7126	19.7512	19.7490	19.6455	19.2762	18.8090	18.4182	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	26	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	5	28	31	0	0	0	0	0	0	0	8	31	
MIT	20.8601	20.2291	20.3815	20.2910	20.6142	20.8221	20.8882	20.8761	20.7281	20.3159	19.9746	20.1232	(87)
Th 2	19.8027	19.8063	19.8097	19.8261	19.8292	19.8436	19.8436	19.8462	19.8380	19.8292	19.8230	19.8165	(88)
util rest of house	0.9827	0.9719	0.9506	0.8906	0.7682	0.5682	0.3883	0.4405	0.7079	0.9123	0.9702	0.9850	(89)
MIT 2	19.6767	19.1201	19.2728	19.2428	19.5370	19.7126	19.7512	19.7490	19.6455	19.2762	18.9263	19.0246	(90)
Living area fraction											fLA = Living area / (4) =	0.4012	(91)
MIT	20.1514	19.5650	19.7176	19.6633	19.9691	20.1577	20.2073	20.2012	20.0798	19.6933	19.3469	19.4653	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.1514	19.5650	19.7176	19.6633	19.9691	20.1577	20.2073	20.2012	20.0798	19.6933	19.3469	19.4653	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9839	0.9705	0.9496	0.8867	0.7751	0.5947	0.4284	0.4807	0.7260	0.9090	0.9667	0.9839	(94)
Useful gains	641.6590	715.9254	762.7487	792.5624	741.5798	568.5238	390.8404	405.4046	561.3833	625.3782	618.5012	616.5365	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	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 kWh	890.7246	658.2500	565.6508	308.2914	143.9499	0.0000	0.0000	0.0000	0.0000	299.7411	557.8178	841.4926	(98a)
Space heating requirement - total per year (kWh/year)												4265.9181	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	890.7246	658.2500	565.6508	308.2914	143.9499	0.0000	0.0000	0.0000	0.0000	299.7411	557.8178	841.4926	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												4265.9181	
Space heating per m2											(98c) / (4) =	49.6037	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	221.5970	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	890.7246	658.2500	565.6508	308.2914	143.9499	0.0000	0.0000	0.0000	0.0000	299.7411	557.8178	841.4926	(98)
Space heating efficiency (main heating system 1)	221.5970	221.5970	221.5970	221.5970	221.5970	0.0000	0.0000	0.0000	0.0000	221.5970	221.5970	221.5970	(210)
Space heating fuel (main heating system)	401.9569	297.0482	255.2610	139.1225	64.9602	0.0000	0.0000	0.0000	0.0000	135.2640	251.7262	379.7400	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	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 system 2)	0.0000	0.0000	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	269.7625	238.5918	253.3537	222.2708	215.1790	193.5696	190.7125	198.4040	200.7308	224.2402	238.9687	266.7356	(64)
Efficiency of water heater												106.8983	(216)
(217)m	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	106.8983	(217)
Fuel for water heating, kWh/month	252.3542	223.1950	237.0043	207.9273	201.2931	181.0782	178.4055	185.6007	187.7773	209.7696	223.5476	249.5227	(219)
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	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	27.7631	22.2726	20.0540	14.6924	11.3488	9.2721	10.3528	13.4569	17.4792	22.9337	25.9036	28.5347	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-12.5031	-22.0534	-40.2170	-54.8239	-66.1078	-62.6325	-61.3113	-53.5875	-41.0407	-28.0137	-14.8774	-10.2023	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(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-electric generators (Appendix M) (negative quantity)													
(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 generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)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	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-1.5794	-4.3643	-11.7797	-23.8001	-37.8855	-42.1995	-41.0571	-31.4487	-19.2377	-7.7340	-2.4199	-1.1720	(233b)
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	(234b)
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	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(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	1925.0790	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	106.8983	
Water heating fuel used	2537.4755	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	224.0640	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-692.0484	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3994.5700	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1925.0790	0.1553	298.8751	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2537.4755	0.1409	357.5959	(264)
Space and water heating			656.4710	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	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	-224.6780	0.1190	-26.7273	
Total			-88.0626	(269)
Total CO2, kg/year			600.7478	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			6.9900	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1925.0790	1.5748	3031.5647	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2537.4755	1.5211	3859.7390	(278)
Space and water heating			6891.3037	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	224.0640	1.5338	343.6768	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-467.3705	1.4848	-693.9695	
PV Unit electricity exported	-224.6780	0.4362	-98.0122	
Total			-791.9816	(283)
Total Primary energy kWh/year			6442.9989	(286)
Dwelling Primary energy Rate (DPER)			74.9200	(287)

```
-------------------------------------------------------------------------------------------------


-------------------------------------------------------------------------------------------------
SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------


-------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
-------------------------------------------------------------------------------------------------
                                                                                                Area        Storey height              Volume
                                                                                                (m2)             (m)                   (m3)
Ground floor                                                                                 86.0000 (1b)    x      2.5000 (2b)    =     215.0000 (1b) -
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
-------------------------------------------------------------------------------------------------
                                                                                                                                    m3 per hour

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                                                                                       3 * 10 =      30.0000 (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) =            30.0000 / (5) =       0.1395 (8)
Pressure test                                                                                                                             Yes
Pressure Test Method                                                                                                              Blower Door
Measured/design AP50                                                                                                                   5.0000 (17)
Infiltration rate                                                                                                                      0.3895 (18)
Number of sides sheltered                                                                                                                   2 (19)

Shelter factor                                                                                      (20) = 1  -  [0.075 x (19)]  =       0.8500 (20)
Infiltration rate adjusted to include shelter factor                                                     (21) = (18) x (20)  =       0.3311 (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
                 0.4222     0.4139     0.4056     0.3642     0.3559     0.3145     0.3145     0.3063     0.3311     0.3559     0.3725     0.3890 (22b)
Effective ac     0.5891     0.5856     0.5823     0.5663     0.5633     0.5495     0.5495     0.5469     0.5548     0.5633     0.5694     0.5757 (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
TER Opening Type (Uw = 1.20)                                               21.2000         1.1450        24.2748                                  (27)
Heatloss Floor 1                                                           86.0000         0.1300        11.1800                                  (28a)
External Wall 1                             22.0000         9.9400         12.0600         0.1800         2.1708                                  (29a)
External Wall 2                              5.1500                         5.1500         0.1800         0.9270                                  (29a)
External Wall 3                             10.5600         5.1600          5.4000         0.1800         0.9720                                  (29a)
External Wall 4                             15.1700         4.5200         10.6500         0.1800         1.9170                                  (29a)
External Wall 5                              3.8700         1.5800          2.2900         0.1800         0.4122                                  (29a)
Total net area of external elements Aum(A, m2)                            142.7500                                                                (31)
Fabric heat loss, W/K = Sum (A x U)                                             (26)...(30) + (32) =      41.8538                                  (33)
Party Wall 1                                                               11.5700         0.0000         0.0000                                  (32)
Party Wall 2                                                                4.2500         0.0000         0.0000                                  (32)
Party Wall 3                                                               17.1200         0.0000         0.0000                                  (32)
Party Wall 4                                                               16.0600         0.0000         0.0000                                  (32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                    196.9535 (35)
Thermal bridges (User defined value 0.050 * total exposed area)                                                                        7.1375 (36)
Point Thermal bridges                                                                                                   (36a) =       0.0000
Total fabric heat loss                                                                                      (33) + (36) + (36a) =      48.9913 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m          41.7973    41.5518    41.3111    40.1809    39.9694    38.9849    38.9849    38.8026    39.3641    39.9694    40.3972    40.8444 (38)
Heat transfer coeff
               90.7886    90.5431    90.3024    89.1722    88.9607    87.9763    87.9763    87.7939    88.3554    88.9607    89.3885    89.8357 (39)
Average = Sum(39)m / 12 =                                                                                                             89.1711
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0557	1.0528	1.0500	1.0369	1.0344	1.0230	1.0230	1.0209	1.0274	1.0344	1.0394	1.0446	(40)
HLP (average)												1.0369	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.5669	(42)
Hot water usage for mixer showers	67.2585	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 usage 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 for other uses	40.9178	39.4299	37.9420	36.4541	34.9661	33.4782	33.4782	34.9661	36.4541	37.9420	39.4299	40.9178	(42c)
Average daily hot water use (litres/day)												126.1389	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	137.2229	134.2929	130.7246	125.2985	120.8922	116.1550	114.3344	117.8873	121.6344	126.6076	132.1173	136.8670	(44)
Energy conte	217.3276	191.2313	200.9188	171.5274	162.7441	142.8262	138.2776	145.9691	149.9874	171.8053	188.2253	214.3007	(45)
Energy content (annual)											Total = Sum(45)m =	2095.1407	
Distribution loss (46)m = 0.15 x (45)m	32.5991	28.6847	30.1378	25.7291	24.4116	21.4239	20.7416	21.8954	22.4981	25.7708	28.2338	32.1451	(46)
Water storage loss:													
Store volume												150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3938	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7527	(55)
Total storage loss	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 contains dedicated solar 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	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi 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	(61)
Total heat required for water heating calculated for each month	263.9225	233.3170	247.5137	216.6192	209.3390	187.9180	184.8725	192.5640	195.0792	218.4002	233.3171	260.8956	(62)
WWHRS	-30.7478	-27.1936	-28.4756	-23.5789	-21.9747	-18.8039	-17.6257	-18.7431	-19.4552	-22.9356	-25.9832	-30.1784	(63a)
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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
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	(63d)
Output from w/h	233.1747	206.1234	219.0382	193.0403	187.3643	169.1141	167.2469	173.8209	175.6240	195.4646	207.3339	230.7172	(64)
									Total per year (kWh/year) = Sum(64)m =			2358.0625	(64)
12Total per year (kWh/year)												2358	(64)
Electric shower(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)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	109.5373	97.2530	104.0814	93.1063	91.3883	83.5632	83.2532	85.8107	85.9443	94.4012	98.6584	108.5309	(65)

5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	128.3459	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	117.6626	130.2693	117.6626	121.5847	117.6626	121.5847	117.6626	117.6626	121.5847	117.6626	121.5847	117.6626	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	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)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	35.8346	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-102.6768	-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 gains (Table 5)	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 gains	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

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	15.1000	11.2829	0.6300	0.7000	0.5400	36.5152	(75)
Southeast	4.5200	36.7938	0.6300	0.7000	0.5400	35.6442	(77)
South	1.5800	46.7521	0.6300	0.7000	0.5400	15.8319	(78)

Solar gains	87.9913	160.9716	250.0166	360.1880	449.8165	467.0613	441.7595	371.6938	287.6303	185.9041	107.4053	74.0044	(83)
Total gains	648.9087	734.3922	799.9491	890.5738	953.5301	949.6320	906.0322	837.0014	766.9444	684.7010	636.5361	623.3536	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	51.8237	51.9642	52.1027	52.7631	52.8885	53.4803	53.4803	53.5914	53.2508	52.8885	52.6354	52.3734	
alpha	4.4549	4.4643	4.4735	4.5175	4.5259	4.5654	4.5654	4.5728	4.5501	4.5259	4.5090	4.4916	
util living area	0.9868	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	(87)
Th 2	20.0372	20.0395	20.0419	20.0527	20.0547	20.0642	20.0642	20.0660	20.0606	20.0547	20.0506	20.0463	(88)
util rest of house	0.9836	0.9704	0.9426	0.8608	0.7050	0.4948	0.3348	0.3815	0.6423	0.8921	0.9685	0.9861	(89)
MIT 2	18.4859	18.7472	19.1206	19.6037	19.9148	20.0428	20.0615	20.0610	19.9933	19.6007	18.9848	18.4551	(90)
Living area fraction									fLA = Living area / (4) =			0.4012	(91)
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	(92)
Temperature adjustment												0.0000	
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 heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9787	0.9639	0.9353	0.8587	0.7183	0.5233	0.3698	0.4182	0.6668	0.8897	0.9624	0.9817	(94)
Useful gains	635.0729	707.8906	748.2125	764.7611	684.9411	496.9555	335.0600	350.0430	511.4324	609.1708	612.6279	611.9480	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1330.7048	1294.4204	1177.4560	988.5727	763.7115	511.4058	337.3993	354.0732	553.0549	834.3752	1100.4180	1323.0022	(97)
Space heating kWh	517.5501	394.1480	319.3571	161.1444	58.6052	0.0000	0.0000	0.0000	0.0000	167.5521	351.2089	529.0243	(98a)
Space heating requirement - total per year (kWh/year)												2498.5902	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	517.5501	394.1480	319.3571	161.1444	58.6052	0.0000	0.0000	0.0000	0.0000	167.5521	351.2089	529.0243	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2498.5902	
Space heating per m2											(98c) / (4) =	29.0534	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	92.3000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	517.5501	394.1480	319.3571	161.1444	58.6052	0.0000	0.0000	0.0000	0.0000	167.5521	351.2089	529.0243	(98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)	560.7260	427.0293	345.9991	174.5876	63.4943	0.0000	0.0000	0.0000	0.0000	181.5299	380.5080	573.1574	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	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 system 2)	0.0000	0.0000	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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	233.1747	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 water heater												79.8000	(216)
(217)m	85.7946	85.4892	84.9043	83.6576	81.7747	79.8000	79.8000	79.8000	79.8000	83.7162	85.2318	85.8594	(217)
Fuel for water heating, kWh/month	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 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	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	24.4480	19.6131	17.6594	12.9380	9.9937	8.1649	9.1166	11.8501	15.3921	20.1953	22.8105	25.1274	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (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 turbines (Appendix M) (negative quantity) (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-electric generators (Appendix M) (negative quantity) (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 generated by micro-CHP (Appendix N) (negative if net generation) (235c)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	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (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 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	(234b)
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	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(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	2707.0316 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	79.8000
Water heating fuel used	2835.6133 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
Total electricity for the above, kWh/year	86.0000 (231)
Electricity for lighting (calculated in Appendix L)	197.3090 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-850.1531 (233)
Wind generation	0.0000 (234)
Hydro-electric generation (Appendix N)	0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)	0.0000 (235)
Appendix Q - special features	
Energy saved or generated	-0.0000 (236)
Energy used	0.0000 (237)
Total delivered energy for all uses	4975.8009 (238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	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			0.0000 (373)
Water heating (other fuel)	2835.6133	0.2100	595.4788 (264)
Space and water heating			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	-473.8209	0.1334	-63.1951
PV Unit electricity exported	-376.3322	0.1252	-47.1237
Total			-110.3188 (269)
Total CO2, kg/year			1094.0437 (272)
Target Carbon Dioxide Emission Rate (TER)			12.7200 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	2707.0316	1.1300	3058.9458 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2835.6133	1.1300	3204.2430 (278)
Space and water heating			6263.1888 (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			5815.6183 (286)
Target Primary Energy Rate (TPER)			67.6200 (287)

;

Appendix D - SAP Worksheets – Baseline (limiting) Scenario

Full SAP Calculation Printout

elmhurst energy

Property Reference	SH	Issued on Date	17/11/2022
Assessment Reference	Unit 1 - Limiting	Prop Type 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	-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 (m2)		Storey height (m)		Volume (m3)
Ground floor	86.0000 (1b)	x	2.5000 (2b)	=	215.0000 (1b) -
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

		m3 per hour
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 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (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 m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K 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)

```
Total net area of external elements Aum(A, m2)                                 142.7500                                                         (31)
Fabric heat loss, W/K = Sum (A x U)                                                  (26)...(30) + (32) =     56.6027                           (33)
Party Wall 1                                                                    11.5700        0.0000        0.0000       20.0000       231.4000 (32)
Party Wall 2                                                                     4.2500        0.0000        0.0000       20.0000        85.0000 (32)
Party Wall 3                                                                    17.1200        0.0000        0.0000       20.0000       342.4000 (32)
Party Wall 4                                                                    16.0600        0.0000        0.0000       20.0000       321.2000 (32)
Party Floor 1                                                                   55.5700                                   40.0000      2222.8000 (32d)
Party Ceiling 1                                                                 86.0000                                   30.0000      2580.0000 (32b)
Internal Wall 1                                                                 22.2500                                    9.0000       200.2500 (32c)
Internal Wall 2                                                                  5.2500                                    9.0000        47.2500 (32c)
Internal Wall 3                                                                 10.0000                                    9.0000        90.0000 (32c)

Heat capacity Cm = Sum(A x k)                                                  (28)...(30) + (32) + (32a)...(32e) =  16078.0000 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                       186.9535 (35)
Thermal bridges (Default value 0.200 * total exposed area)                                                               28.5500 (36)
Point Thermal bridges                                                                                        (36a) =      0.0000
Total fabric heat loss                                                                          (33) + (36) + (36a) =    85.1527 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m          45.6028    45.2095    44.8240    43.0134    42.6747    41.0977    41.0977    40.8056    41.7051    42.6747    43.3600    44.0764 (38)
Heat transfer coeff
              130.7555   130.3622   129.9767   128.1661   127.8274   126.2504   126.2504   125.9583   126.8578   127.8274   128.5127   129.2291 (39)
Average = Sum(39)m / 12 =                                                                                                       128.1645

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP             1.5204     1.5158     1.5114     1.4903     1.4864     1.4680     1.4680     1.4646     1.4751     1.4864     1.4943     1.5027 (40)
HLP (average)                                                                                                                     1.4903
Days in mont        31         28         31         30         31         30         31         31         30         31         30         31



-----------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                 2.5669 (42)
Hot water usage for mixer showers
               67.2585    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 usage 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 for other uses
               40.9178    39.4299    37.9420    36.4541    34.9661    33.4782    33.4782    34.9661    36.4541    37.9420    39.4299    40.9178 (42c)
Average daily hot water use (litres/day)                                                                                        126.1389 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
              137.2229   134.2929   130.7246   125.2985   120.8922   116.1550   114.3344   117.8873   121.6344   126.6076   132.1173   136.8670 (44)
Energy conte  217.3276   191.2313   200.9188   171.5274   162.7441   142.8262   138.2776   145.9691   149.9874   171.8053   188.2253   214.3007 (45)
Energy content (annual)                                                                                 Total = Sum(45)m =     2095.1407
Distribution loss  (46)m = 0.15 x (45)m
               32.5991    28.6847    30.1378    25.7291    24.4116    21.4239    20.7416    21.8954    22.4981    25.7708    28.2338    32.1451 (46)
Water storage loss:
Total storage 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 (56)
If cylinder contains dedicated solar 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 (57)
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     50.9589    46.0274    50.9589    49.3151    50.9589    49.3151    50.9589    50.9589    49.3151    50.9589    49.3151    50.9589 (61)
Total heat required for water heating calculated for each month
              268.2865   237.2587   251.8777   220.8424   213.7030   192.1412   189.2365   196.9280   199.3024   222.7642   237.5404   265.2596 (62)
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     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     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63c)
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 (63d)
Output from w/h
              268.2865   237.2587   251.8777   220.8424   213.7030   192.1412   189.2365   196.9280   199.3024   222.7642   237.5404   265.2596 (64)
                                                                                     Total per year (kWh/year) = Sum(64)m =    2695.1407 (64)
12Total per year (kWh/year)                                                                                                         2695 (64)
Electric shower(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)
                                                       Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =     0.0000 (64a)
Heat gains from water heating, kWh/month
               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 gains (see Table 5 and 5a)
-----------------------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m         128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              117.6626   130.2693   117.6626   121.5847   117.6626   121.5847   117.6626   117.6626   121.5847   117.6626   121.5847   117.6626 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              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)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346 (69)
Pumps, fans     3.0000     3.0000     3.0000     3.0000     3.0000     0.0000     0.0000     0.0000     0.0000     3.0000     3.0000     3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
             -102.6768  -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 gains (Table 5)
              114.2489   111.7429   106.9156    96.3356    89.8550    83.0812    78.9207    82.3582    86.3883    93.9046   104.0468   112.8961 (72)
Total internal gains
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	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]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	15.1000	11.2829	0.6300	0.7000	0.5400	36.5152	(75)
Southeast	4.5200	36.7938	0.6300	0.7000	0.5400	35.6442	(77)
South	1.5800	46.7521	0.6300	0.7000	0.5400	15.8319	(78)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	87.9913	160.9716	250.0166	360.1880	449.8165	467.0613	441.7595	371.6938	287.6303	185.9041	107.4053	74.0044	(83)
Total gains	615.9299	701.4134	766.9703	857.5950	920.5514	916.6533	873.0535	804.0227	733.9656	651.7222	603.5573	590.3748	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	34.1562	34.2592	34.3608	34.8463	34.9386	35.3750	35.3750	35.4571	35.2056	34.9386	34.7523	34.5596	
alpha	3.2771	3.2839	3.2907	3.3231	3.3292	3.3583	3.3583	3.3638	3.3470	3.3292	3.3168	3.3040	
util living area	0.9886	0.9816	0.9686	0.9324	0.8561	0.7198	0.5774	0.6327	0.8326	0.9502	0.9817	0.9901	(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	(87)
Th 2	20.2398	20.2421	20.2443	20.2548	20.2568	20.2660	20.2660	20.2677	20.2625	20.2568	20.2528	20.2487	(88)
util rest of house	0.9870	0.9790	0.9637	0.9211	0.8304	0.6676	0.4986	0.5560	0.7936	0.9399	0.9786	0.9887	(89)
MIT 2	18.5561	18.7327	19.0208	19.4412	19.8071	20.0618	20.1443	20.1325	19.9539	19.4899	18.9693	18.5447	(90)
Living area fraction									fLA = Living area / (4) =			0.4012	(91)
MIT	18.7273	18.9125	19.2155	19.6565	20.0474	20.3237	20.4208	20.4043	20.2021	19.7057	19.1575	18.7122	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7273	18.9125	19.2155	19.6565	20.0474	20.3237	20.4208	20.4043	20.2021	19.7057	19.1575	18.7122	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9827	0.9730	0.9555	0.9105	0.8222	0.6720	0.5161	0.5713	0.7900	0.9305	0.9728	0.9849	(94)
Useful gains	605.2524	682.4592	732.8422	780.8046	756.9013	615.9893	450.5476	459.3243	579.8395	606.4503	587.1255	581.4320	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1886.4481	1826.7041	1652.7214	1378.6245	1067.0232	722.6229	482.3832	504.3755	774.0939	1163.9520	1549.5466	1875.3959	(97)
Space heating kWh	953.2095	768.9326	684.3902	430.4303	230.7307	0.0000	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091	(98a)
Space heating requirement - total per year (kWh/year)												5138.1270	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	953.2095	768.9326	684.3902	430.4303	230.7307	0.0000	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												5138.1270	
Space heating per m2										(98c) / (4) =		59.7457	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	83.8000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	953.2095	768.9326	684.3902	430.4303	230.7307	0.0000	0.0000	0.0000	0.0000	414.7813	692.9432	962.7091	(98)
Space heating efficiency (main heating system 1)	83.8000	83.8000	83.8000	83.8000	83.8000	0.0000	0.0000	0.0000	0.0000	83.8000	83.8000	83.8000	(210)
Space heating fuel (main heating system)	1137.4816	917.5806	816.6947	513.6400	275.3350	0.0000	0.0000	0.0000	0.0000	494.9657	826.9012	1148.8176	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	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 system 2)	0.0000	0.0000	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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	268.2865	237.2587	251.8777	220.8424	213.7030	192.1412	189.2365	196.9280	199.3024	222.7642	237.5404	265.2596	(64)
Efficiency of water heater												80.2000	(216)

```
(217)m         86.7567    86.6101    86.3101    85.6844    84.4458    80.2000    80.2000    80.2000    80.2000    85.5930    86.4339    86.7896 (217)
Fuel for water heating, kWh/month
              309.2401   273.9389   291.8287   257.7395   253.0652   239.5776   235.9557   245.5462   248.5068   260.2598   274.8232   305.6351 (219)
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 (221)
Pumps and Fa    7.3041     6.5973     7.3041     7.0685     7.3041     7.0685     7.3041     7.3041     7.0685     7.3041     7.0685     7.3041 (231)
Lighting       27.7631    22.2726    20.0540    14.6924    11.3488     9.2721    10.3528    13.4569    17.4792    22.9337    25.9036    28.5347 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)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 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(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-electric generators (Appendix M) (negative quantity)
(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 generated by micro-CHP (Appendix N) (negative if net generation)
(235c)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 (235c)
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 (233b)
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 (234b)
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 (235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(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                                                                                                   6131.4165 (211)
Space heating fuel - main system 2                                                                                                      0.0000 (213)
Space heating fuel - secondary                                                                                                          0.0000 (215)
Efficiency of water heater                                                                                                             80.2000
Water heating fuel used                                                                                                              3196.1168 (219)
Space cooling fuel                                                                                                                      0.0000 (221)

Electricity for pumps and fans:
   central heating pump                                                                                                                41.0000 (230c)
   main heating flue fan                                                                                                               45.0000 (230e)
Total electricity for the above, kWh/year                                                                                              86.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                   224.0640 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                           0.0000 (233)
Wind generation                                                                                                                         0.0000 (234)
Hydro-electric generation (Appendix N)                                                                                                  0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                                                          0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                                              -0.0000 (236)
Energy used                                                                                                                             0.0000 (237)
Total delivered energy for all uses                                                                                                  9637.5973 (238)


----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                            Energy       Emission factor            Emissions
                                                                                          kWh/year            kg CO2/kWh          kg CO2/year
Space heating - main system 1                                                            6131.4165                0.2100            1287.5975 (261)
Total CO2 associated with community systems                                                                                            0.0000 (373)
Water heating (other fuel)                                                               3196.1168                0.2100             671.1845 (264)
Space and water heating                                                                                                             1958.7820 (265)
Pumps, fans and electric keep-hot                                                          86.0000                0.1387              11.9293 (267)
Energy for lighting                                                                       224.0640                0.1443              32.3394 (268)
Total CO2, kg/year                                                                                                                  2003.0506 (272)
Dwelling Carbon Dioxide Emission Rate (DER)                                                                                           23.2900 (273)


----------------------------------------------------------------------------------------------------
13a. Primary energy - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                            Energy Primary energy factor       Primary energy
                                                                                          kWh/year            kg CO2/kWh             kWh/year
Space heating - main system 1                                                            6131.4165                1.1300            6928.5006 (275)
Total CO2 associated with community systems                                                                                            0.0000 (473)
Water heating (other fuel)                                                               3196.1168                1.1300            3611.6120 (278)
Space and water heating                                                                                                            10540.1127 (279)
Pumps, fans and electric keep-hot                                                          86.0000                1.5128             130.1008 (281)
Energy for lighting                                                                       224.0640                1.5338             343.6768 (282)
Total Primary energy kWh/year                                                                                                      11013.8903 (286)
Dwelling Primary energy Rate (DPER)                                                                                                  128.0700 (287)


----------------------------------------------------------------------------------------------------


----------------------------------------------------------------------------------------------------
SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS
----------------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------------


----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
```

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	86.0000 (1b)	x	2.5000 (2b)	=	215.0000	(1b) -
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

		m3 per hour	
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	3 * 10 =	30.0000	(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) =	30.0000 / (5) =	0.1395	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3895	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3311	(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	0.4222	0.4139	0.4056	0.3642	0.3559	0.3145	0.3145	0.3063	0.3311	0.3559	0.3725	0.3890	(22b)
Effective ac	0.5891	0.5856	0.5823	0.5663	0.5633	0.5495	0.5495	0.5469	0.5548	0.5633	0.5694	0.5757	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			21.2000	1.1450	24.2748			(27)
Heatloss Floor 1			86.0000	0.1300	11.1800			(28a)
External Wall 1	22.0000	9.9400	12.0600	0.1800	2.1708			(29a)
External Wall 2	5.1500		5.1500	0.1800	0.9270			(29a)
External Wall 3	10.5600	5.1600	5.4000	0.1800	0.9720			(29a)
External Wall 4	15.1700	4.5200	10.6500	0.1800	1.9170			(29a)
External Wall 5	3.8700	1.5800	2.2900	0.1800	0.4122			(29a)
Total net area of external elements Aum(A, m2)			142.7500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		41.8538			(33)
Party Wall 1			11.5700	0.0000	0.0000			(32)
Party Wall 2			4.2500	0.0000	0.0000			(32)
Party Wall 3			17.1200	0.0000	0.0000			(32)
Party Wall 4			16.0600	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		196.9535	(35)
Thermal bridges (User defined value 0.050 * total exposed area)		7.1375	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	48.9913	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	41.7973	41.5518	41.3111	40.1809	39.9694	38.9849	38.9849	38.8026	39.3641	39.9694	40.3972	40.8444	(38)
Heat transfer coeff	90.7886	90.5431	90.3024	89.1722	88.9607	87.9763	87.9763	87.7939	88.3554	88.9607	89.3885	89.8357	(39)
Average = Sum(39)m / 12 =												89.1711	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0557	1.0528	1.0500	1.0369	1.0344	1.0230	1.0230	1.0209	1.0274	1.0344	1.0394	1.0446	(40)
HLP (average)												1.0369	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.5669	(42)
Hot water usage for mixer showers	67.2585	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 usage 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 for other uses													

```
                   40.9178    39.4299    37.9420    36.4541    34.9661    33.4782    33.4782    34.9661    36.4541    37.9420    39.4299    40.9178 (42c)
Average daily hot water use (litres/day)                                                                                                     126.1389 (43)

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
                  137.2229   134.2929   130.7246   125.2985   120.8922   116.1550   114.3344   117.8873   121.6344   126.6076   132.1173   136.8670 (44)
Energy conte      217.3276   191.2313   200.9188   171.5274   162.7441   142.8262   138.2776   145.9691   149.9874   171.8053   188.2253   214.3007 (45)
Energy content (annual)                                                                                        Total = Sum(45)m =   2095.1407
Distribution loss  (46)m = 0.15 x (45)m
                   32.5991    28.6847    30.1378    25.7291    24.4116    21.4239    20.7416    21.8954    22.4981    25.7708    28.2338    32.1451 (46)
Water storage loss:
Total storage 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 (56)
If cylinder contains dedicated solar 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 (57)
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         50.9589    46.0274    50.9589    49.3151    50.9589    49.3151    50.9589    50.9589    49.3151    50.9589    49.3151    50.9589 (61)
Total heat required for water heating calculated for each month
                  268.2865   237.2587   251.8777   220.8424   213.7030   192.1412   189.2365   196.9280   199.3024   222.7642   237.5404   265.2596 (62)
WWHRS             -30.7478   -27.1936   -28.4756   -23.5789   -21.9747   -18.8039   -17.6257   -18.7431   -19.4552   -22.9356   -25.9832   -30.1784 (63a)
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         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63c)
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 (63d)
Output from w/h
                  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)
                                                                                     Total per year (kWh/year) = Sum(64)m =   2409.4451 (64)
12Total per year (kWh/year)                                                                                                          2409 (64)
Electric shower(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)
                                                Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =     0.0000 (64a)
Heat gains from water heating, kWh/month
                   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 gains (see Table 5 and 5a)
-------------------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m             128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459   128.3459 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                  117.6626   130.2693   117.6626   121.5847   117.6626   121.5847   117.6626   117.6626   121.5847   117.6626   121.5847   117.6626 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
                  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)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                   35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346    35.8346 (69)
Pumps, fans         3.0000     3.0000     3.0000     3.0000     3.0000     0.0000     0.0000     0.0000     0.0000     3.0000     3.0000     3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
                 -102.6768  -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 gains (Table 5)
                  114.2489   111.7429   106.9156    96.3356    89.8550    83.0812    78.9207    82.3582    86.3883    93.9046   104.0468   112.8961 (72)
Total internal gains
                  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]                                         Area          Solar flux                g                FF             Access                Gains
                                                m2            Table 6a    Specific data      Specific data             factor                    W
                                                                  W/m2      or Table 6b        or Table 6c           Table 6d
-------------------------------------------------------------------------------------------------
Northeast                                  15.1000             11.2829           0.6300           0.7000             0.5400              36.5152 (75)
Southeast                                   4.5200             36.7938           0.6300           0.7000             0.5400              35.6442 (77)
South                                       1.5800             46.7521           0.6300           0.7000             0.5400              15.8319 (78)
-------------------------------------------------------------------------------------------------

Solar gains        87.9913   160.9716   250.0166   360.1880   449.8165   467.0613   441.7595   371.6938   287.6303   185.9041   107.4053    74.0044 (83)
Total gains       615.9299   701.4134   766.9703   857.5950   920.5514   916.6533   873.0535   804.0227   733.9656   651.7222   603.5573   590.3748 (84)



-------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
-------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                            21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau                51.8237    51.9642    52.1027    52.7631    52.8885    53.4803    53.4803    53.5914    53.2508    52.8885    52.6354    52.3734
alpha               4.4549     4.4643     4.4735     4.5175     4.5259     4.5654     4.5654     4.5728     4.5501     4.5259     4.5090     4.4916
util living area
                    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                19.6131    19.8210    20.1225    20.5267    20.8218    20.9613    20.9918    20.9864    20.8938    20.5090    20.0006    19.5831 (87)
Th 2               20.0372    20.0395    20.0419    20.0527    20.0547    20.0642    20.0642    20.0660    20.0606    20.0547    20.0506    20.0463 (88)
util rest of house
                    0.9865     0.9748     0.9498     0.8737     0.7222     0.5110     0.3472     0.3966     0.6644     0.9061     0.9739     0.9887 (89)
MIT 2              18.4258    18.6905    19.0705    19.5695    19.9002    20.0398    20.0610    20.0601    19.9835    19.5607    18.9283    18.3941 (90)
Living area fraction                                                                                 fLA = Living area / (4) =      0.4012 (91)
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 (92)
Temperature adjustment                                                                                                             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)
```

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9821	0.9688	0.9427	0.8707	0.7345	0.5397	0.3833	0.4344	0.6880	0.9028	0.9683	0.9848	(94)
Useful gains	604.9200	679.5323	723.0213	746.7457	676.1518	494.7553	334.6284	349.2612	504.9413	588.3704	584.4201	581.4244	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	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	334.9754	172.0207	64.1575	0.0000	0.0000	0.0000	0.0000	180.5091	368.1701	548.0047	(98a)
Space heating requirement - total per year (kWh/year)												2614.1307	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	536.2628	410.0305	334.9754	172.0207	64.1575	0.0000	0.0000	0.0000	0.0000	180.5091	368.1701	548.0047	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2614.1307	
Space heating per m2											(98c) / (4) =	30.3969	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	92.4000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	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 heating system 1)	92.4000	92.4000	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 system)	580.3710	443.7559	362.5274	186.1696	69.4345	0.0000	0.0000	0.0000	0.0000	195.3561	398.4525	593.0787	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	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 system 2)	0.0000	0.0000	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												80.3000	(216)
(217)m	86.0703	85.7876	85.2472	84.0893	82.2961	80.3000	80.3000	80.3000	80.3000	84.1641	85.5562	86.1308	(217)
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	(219)
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	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	24.4480	19.6131	17.6594	12.9380	9.9937	8.1649	9.1166	11.8501	15.3921	20.1953	22.8105	25.1274	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(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 turbines (Appendix M) (negative quantity)													
(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-electric generators (Appendix M) (negative quantity)													
(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 generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)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	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(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 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	(234b)
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	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(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	2829.1458	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	80.3000	
Water heating fuel used	2883.5522	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	197.3090	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-850.1531	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)

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

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions 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 kWh/year	Primary energy factor kg CO2/kWh	Primary energy 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)

;

Appendix E - Water Calculator

Water Efficiency Calculator for New Dwellings (V1f - Aug 2010)

Project Details

Adress/Reference	Sheldon House, 8 Cromwell Road, Teddington	Case Reference	SH - Unit 6
Number of Bedrooms	1	Occupancy for Calculation Purposes	2

Appliance/Useage Details

Taps (Excluding Kitchen Taps)

Tap Fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
Tap 1	5.00	1	5.00
			0.00
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		1	
Total Flow (l/s)			5.00
Maximum Flow (l/s)			5.00
Average Flow (l/s)			5.00
Weighted Average Flow (l/s)			3.50
Flow for Calculation (l/s)			**5.00**

Showers

Shower fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
Shower 1	8.00	1	8.00
			0.00
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		1	
Total Flow (l/s)			8.00
Maximum Flow (l/s)			8.00
Average Flow (l/s)			8.00
Weighted Average Flow (l/s)			5.60
Flow for Calculation (l/s)			**8.00**

Baths

Bath Type	Capacity to Overflow	Quantity (No.)	Total per Fitting type
Bath 1	170.00	1	170.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		1	
Total Capacity (l)			170.00
Maximum Capacity (l)			170.00
Average Capacity (l)			170.00
Weighted Average Capacity (l)			119.00
Capacity for Calculation (l)			**170.00**

WCs

WC Type	Full Flush Volume	Part Flush Volume	Quantity (No)
WC 1	4.00	2.60	1
Total number of fittings			**1**
Average effective flushing volume			**N/a**

Dishwashers

Dishwasher Type	L per Place Setting	Quantity (No.)	Total per Fitting type
Dish 1	1.25	1	1.25
			0.00
Total No. of Fittings (No.)		1	
Total Consumption (l)			1.25
Maximum Consumption (l)			1.25
Average Consumption (l/s)			1.25
Weighted Average Consumption (l)			0.88
Consumption for Calculation (l/s)			**1.25**

Washing Machines

Washing Machine Type	L per Kg Dry Load	Quantity (No.)	Total per Fitting type
Wash 1	8.17	1	8.17
			0.00
Total No. of Fittings (No.)		1	
Total Consumption (l)			8.17
Maximum Consumption (l)			8.17
Average Consumption (l/s)			8.17
Weighted Average Consumption (l)			5.72
Consumption for Calculation (l/s)			**8.17**

Kitchen Taps

Tap Fitting Type	Flow Rate Litres/Min	Quantity (No.)	Total per Fitting type
Tap 2	6.00	1	6.00
			0.00
			0.00
Total No. of Fittings (No.)		1	
Total Flow (l/s)			6.00
Maximum Flow (l/s)			6.00
Average Flow (l/s)			6.00
Weighted Average Flow (l/s)			4.20
Flow for Calculation (l/s)			**6.00**

Other Fittings

Waste Disposal Y/N	
Water softner	
Consumption beyond 4% l/p/d	

Use of grey water and harvested rainwater

Total Grey water from WHB taps (l)	
Total Availble Grey Water Supply (l)	107.32
Possible Demand (l)	61.39
Grey/Rain Installed Capacity (l)	
Figure for Calculation lit/person/day	0.00

Water Use Assessment

Installation Type	Unit	Capacity/ Flow Rate	Use Factor	Fixed use (l/p/day)	**Total Use (l/p/day)**
WC Single Flush	Volume (l)	0.00	4.42	0.00	0.00
WC Dual Flush	Full Flush (l)	4.00	1.46	0.00	5.84
	Pt Flush (l)	2.60	2.96	0.00	7.70
WC's (Multiple)	Volume (l)	0.00	4.42	0.00	0.00
Taps Exc. Kitchen	Flow Rate	5.00	1.58	1.58	9.48
Bath (shower present)	(l/s)	170.00	0.11	0.00	18.70
Shower (bath present)	(l/s)	8.00	4.37	0.00	34.96
Bath Only	(l)	0.00	0.50	0.00	0.00
Shower Only	(l/s)	0.00	5.60	0.00	0.00
Kitchen Taps	(l/s)	6.00	0.44	10.36	13.00
Washing Machines	(l/kgdry)	8.17	2.10	0.00	17.16
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	(l/s)	0.00	1.00	0.00	0.00
Total Calculated Water Use (l/p/day)					**111.33**
Grey/RainWater Reused (l)					0.00
Normalisation Factor	(Factor)				0.91
Total Consumption CSH (l/p/day)					**101.31**
External Water Use Allowance (l)					5.00
Total Comsumption Part G (l/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 1 – 4.55kW$_p$ rating and can provide between 750 and 3,000kWh per year. From the DTI (domestic field trial performance analysis) domestic systems contribute on average 43% of the electrical load. Depending on the system, the efficiency of PVs range up to 15%.

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.

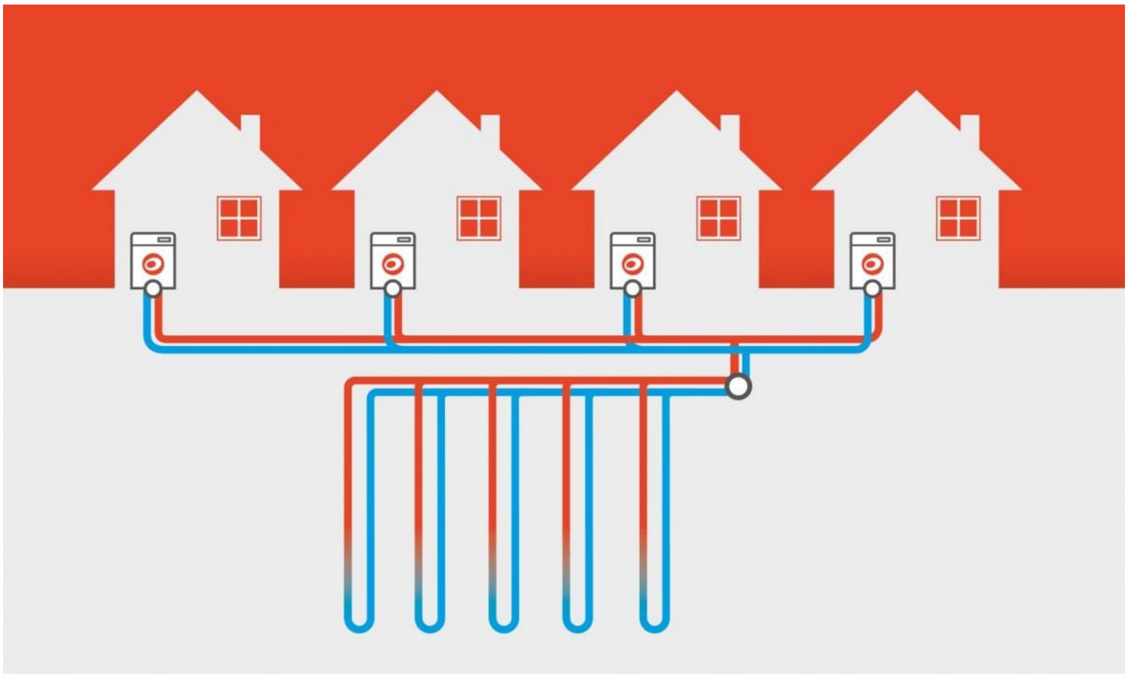
Ground Source Heat Pumps – Vertical System:

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.