DEMOLITION OF EXISTING GARAGES AND ERECTION OF FIVE ONE-BED SINGLE-STOREY ALMSHOUSE DWELLINGS

AT

ST MARY'S GROVE GARAGES SITE, RICHMOND

Energy & Sustainability Report

June 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 and energy report for a proposed residential development at St Mary's Grove garage site, Richmond.

The proposed development is for 5 No. almshouse dwellings for the over 65s, comprising of 4 No. 1-bed / 2-person M4(3) wheelchair accessible units at $60m^2$, and 1 No. 1-bed, 2-person M4(2) accessible and adaptable unit at $50m^2$, together with provision of parking spaces, cycle / refuse / recycling storage and associated amenity space.

For new-build residential schemes of between 1 – 9 dwellings, the London Borough of Richmond upon Thames (LBRuT) requires a 35% reduction of carbon dioxide emissions (regulated) beyond Part L, as outlined within the Local Plan 2018 LP 22(B). This is to be demonstrated by an Energy Report, together with a submitted Sustainable Construction Checklist (June 2020). It is noted that a cash-in-lieu contribution to the Council's Carbon Offset fund would be sought in cases where it is not technically feasible to achieve this target.

Beyond the carbon emissions reduction, water conservation measures are required demonstrating a maximum water consumption of 110 litres per person per day, including an allowance of 5 litres or less per head per day for external water consumption. This is based on Part G2 of the Building Regulations and the Sustainability Construction Checklist (June 2020), Minimal Compliance 1B (LBRuT Local Plan 2018 Policy LP 22 & London Plan 2021 Policy S1 5).

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 London Borough of Richmond upon Thames will be expected to be assessed against the following seven checklist items:

2.2 SCC Assumptions and Compliance:

Category	Score
Minimum Policy Compliance 1B (Residential)	1
Energy Use and Pollution	25
Transport[1]	9
Biodiversity	18
Flooding and Drainage	13
Improving Resource Efficiency	6
Accessibility	4
TOTAL	**76**

An overall score achieved of **76 credits** will be achieving 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 **93.25 litres person per day on average per each new dwelling.**

4.0 Overheating Assessment

The London Plan overheating checklist (GLA Energy Assessment Guidance 2018 - Appendix 5) has been used to assess the risk of overheating in the almshouses. The impact of solar gain has been incorporated into the SAP analysis for compliance with Part L, and is in-line with the CIBSE TM59 Design methodology for the assessment of overheating risk in homes 2017.

In this case, the sample used follows the guidance principles and Plot 2 was assessed, being a typical layout and predominantly facing west. Following the overheating checklist, and results of the SAP assessment, the risk over solar overheating is minimised, with the maximum summer internal temperature of 21.29 °C being achieved. Refer to Overheating Assessment within the appendix.

5.0 Energy Efficiency Measures

This section sets out the detailed analysis and results of the annual CO_2 emission calculations of the proposed dwelling. The dwelling has been modelled using the Government Standard Assessment Procedure (SAP) 2012 to determine the impact of building services options and to investigate the use of renewable energy sources, their impact on emissions, and their approximate cost of installation. The reductions of CO_2 emissions achieved through the application of renewable energy technologies have been tested and calculated in accordance with London Borough of Richmond upon Thames' Sustainable Construction Checklist Guidance adopted in June 2020 (Appendix A).

1. Be Lean: reduce the energy demand through fabric efficiency measures
2. Be Clean: supply energy for space and water heating efficiently via small-scale renewable technology (air-source heat pumps)
3. Be Green: producing, storing and using renewable energy on-site through (PV arrays)
4. Be Seen: monitor, verify and report energy on-site

Note: That assumptions will need to be confirmed by an M&E Consultant and that any changes will have an impact on the SAP results and therefore the achieved reduction in CO_2 and % Renewables.

5.1 Suitable 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 three stages of application: use less energy, use renewable energy and supply energy efficiently. This hierarchy has been adopted for this project and various high efficiency communal services systems, and renewable energy systems have been investigated.

Further information, specification and information on renewables considered appropriate for the development is provided in Appendix F. This includes considerations for monitoring of energy demand and use as well as CO2 emissions and offset to ensure planning commitments are delivered (plus display Energy Certificate (DEC) and reporting to the Mayor for at least five years via an online portal to enable the GLA to identify good practice and report on the operational performance of new development in London. (London Plan 2021, Policy SI 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 below 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 dwellings have flat green roofs that can be used for photovoltaic panels. They will be marginally tilted 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	As above, the building has a sufficient flat roof that can be used for	May be

heating panels	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.	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 suitable for an individual, vertical system, with circa 5 boreholes of 75m depth at the centre of the plot, in front of each unit, and away from neighbouring residential buildings. The boring via a water/auger system would generate very minimal noise disturbance and unlikely take more than 5 days.	Likely to be suitable for this site
Ground source inc. borehole cooling, either direct or via a chiller	There is no need of a mechanical cooling system.	Rejected

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. However, following concerns from neighbours during the public consultation, a GSHP system is the preferred choice.	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. These 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

5.2 Renewable Energy Technologies: Options, Calculations and Results

Options have been modelled using the approved by the Government NHER SAP 2012 to calculate the energy use of the property and predict the reduction of CO_2 emissions achieved through the application of renewable energy technologies.

The SAP Assessment looks into the energy performance of one individual unit, considered the 'worst' case scenario given its orientation and proportions of exposed areas to the elements. The demonstration for compliance on the chosen unit will ensure other dwellings could only score better.

Note: In most assessment situations the Base Case is set by the 'Limiting U-values for new fabric elements and air permeability in new dwellings', as outlined in Building Regulations Part L1A: Conservation and fuel and power – Volume 1 Dwellings 2021 edition. This is the threshold of compliance which is to be improved upon by the specification of more efficient fabric U-values and the introduction of renewable technologies. This is typically due to the unknown fabric construction at the planning application stage of a project. In this case the building performance has already been evaluated using a Base Case with U-values related to 'Limiting' values (refer to Approved Document L1A Table 4.1). The results are documented in Appendix B. Then further improvements have been assessed to achieve the enhanced LBRuT requirements with the addition of energy efficiency measures and renewables, refer to Appendix C.

5.3 Calculations – SAP CO_2 Emission Data

Option	Specification	DER/TER Variance LBRUT TARGET -35% (minimum)	% reduction through renewables
Base Case	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 - Radiators - No PV panels - Passive (natural) cross-ventilation - 100% energy efficient lighting	**44.54%** Not compliant	**0.0%** Not compliant

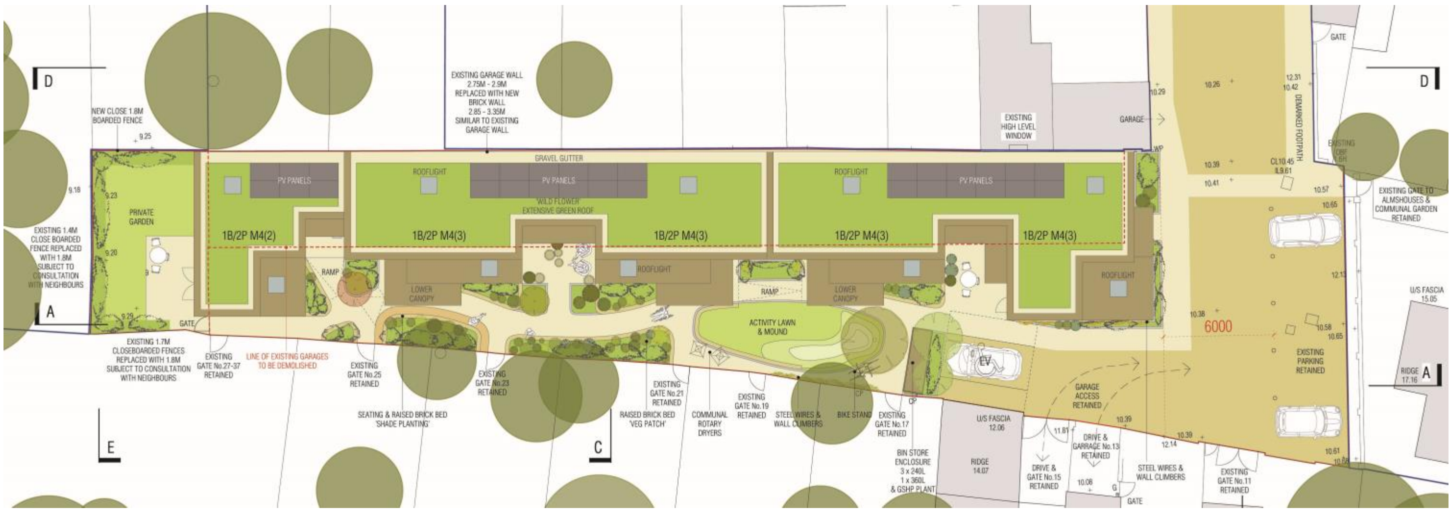
Improved Case	U-values in accordance with B.Regs Part L1A 2021 Edition – Notional dwelling specification for new dwelling (Table 1.1). Plus low carbon / renewable measures to reach LBRuT carbon reduction targets. - Roof U = 0.11 W/m²K - External walls U = 0.17 W/m²K - Floor U = 0.13 W/m²K - Windows (double-glazed) U = 0.79 W/m²K - Front door (solid) U = 1.0 W/m²K - Thermal bridging: standard psi values - Air permeability 5.0 m³/hrm² - Ground Source Heat Pump – Individual vertical system - 120L water storage cylinder per unit - Underfloor heating - 6 x 350kW PV panels per unit - Triple glazed windows & rooflights - Enhanced wall insulation - Passive (natural) cross-ventilation - 100% energy efficient lighting	-70.28% Compliant	41.74% Compliant

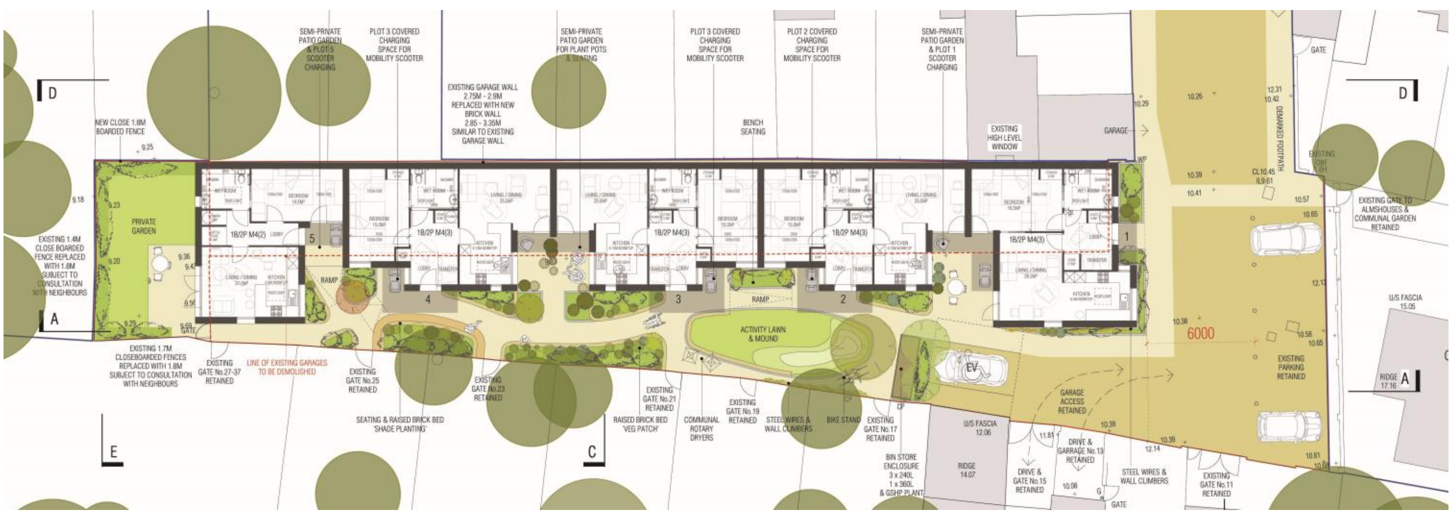
	Total $kgCO_2$/yr	
	Base Case Limiting U-values	Improved Case to achieve 35% reduction over Part L of the Building Regulations
Space Heating	1203.88	466.31
Secondary Heating	0	0
Hot Water Heating	445.64	705.41
Fixed Electrical	15.57	15.57
Lighting	141.63	143.7
Appliances	17.01	17.01
Cooking	2.78	2.78
Less amount of renewables	0	-828.86
TOTAL	**1826.51**	**521.92**
DER/TER Variance % reduction overall[1]	**44.54%**	**-70.28%**
% reduction through energy efficiency measures[2]	0%	28.54%
% reduction through renewables[3]	0%	41.74%

[1] This is the total % reduction in $kgCO_2$/year over Part L of the Building Regulations.
[2] This is the total % reduction in $kgCO_2$/year achieved through energy efficiency measures – This is based on the Improved Case but without PV renewables (1023.10 Total $kgCO_2$/yr).
[3] This is the total % reduction in $kgCO_2$/year achieved through the incorporation of renewable energy installations.

The numbers refer to one dwelling only – worst case scenario Plot 2 out of 5 No. total dwellings.

Proposed Roof Plan, Floor Plans and Front Elevation:





5.4 Conclusion

The proposal gives an opportunity to provide a new residential development of 5 No. almshouses for the over 65s, in a single-storey terrace, appropriate to the scale of the site and the neighbouring buildings, improving the long term sustainability of the site. Much attention has been given by the applicant, The Richmond Charities, and their consultants to reduce 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 Photovoltaic Panels (PVs) for energy generation and combined Ground Source Heat Pumps (GSHPs) for space and water heating will be appropriate and practical strategy to meet the energy-efficiency and carbon reduction targets set by the council for the small scale residential developments. This report demonstrates compliance with the required standards and policies set out by LBRuT adopting the London Plan listed below:

- Can achieve the LBRuT requirement to reduce the carbon dioxide emissions by at least **-70.28%** over Building Regulations Part L1A 2010, 2013 edition, 2016 revision;
- Provides a **41.74%** reduction of predicted carbon emissions through the use of small-scale renewable energy technologies (in this case PVs);
- Provides a portion of **28.54%** reduction in CO_2 emissions and CO_2 sequestration through the provision of energy efficiency measures alone (though inclusive of the GSHPs);
- Achieves an **A+** rating assessed against the LBRUT Sustainable Construction Checklist 2020
- Achieves an overall SAP Rating of **A [93]**;
- Achieves the higher standard of water consumption efficiency of **93.25** litres person per day per one new dwelling;
- Solar overheating is minimised with a mean internal temperature of **21.29°C** being achieved.

6.0 Appendices

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): St Mary's Grove Garage Site

Application No. (if known): N/A

Address (include. postcode): St Mary's Grove Garage Site, Richmond

Completed by: Clive Chapman Architects

For Non-Residential
Size of development (m2):

For Residential
Number of dwellings: 5

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: 70.28 %
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: 28.54 %
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? 41.74 %

What is the total remaining carbon to be offset: 0.503 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? **FALSE**

What is the total predicted cost of offset? £
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?
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?
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?
Excellent required under Policy LP 22

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

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. *1*
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:

	Score
Energy efficient design incorporating specific heat demand to less than or equal to 15 kWh/sqm	*6*
Reduce heat entering a building through providing/improving insulation and living roofs and walls	*2*
Reduce heat entering a building through shading	*3*
Exposed thermal mass and high ceilings	*4*
Passive ventilation	*3*
Mechanical ventilation with heat recovery	*1*
Active cooling systems, i.e. Air Conditioning Unit	*0*

See Draft London Plan SI4

2.2 Heat Generation

b. How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy **SI3)** Tick all heating and cooling systems that will be used in the development:

	Score
Connection to existing heating or cooling networks powered by renewable energy	*6*
Connection to existing heating or cooling networks powered by gas or electricity	*5*
Site wide CHP network powered by renewable energy	*4*
Site wide CHP network powered by gas	*3*
Communal heating and cooling powered by renewable energy	*2*
Communal heating and cooling powered by gas or electricity	*1*
Individual heating and cooling	*0*

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*

b. Does the development plan to include a biomass boiler?
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
If yes, has 'Emissions Neutral' been achieved *1*
If yes, have occupants of new development been protected from existing pollution *1*
If no to any of the above are there any sensitive receptors as defined in Policy LP 10 present? *-1*
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*
Has the development taken care to not create any new noise generation/transmission issues in its intended operation? *1*
see Policy LP 10

e. Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? *3*
see Policy LP 10

f. Have you attached a Lighting Pollution Report? *-*

Subtotal 25

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' cross ventilation as a best practice measure. Openable windows and rooflights are provided.

3. TRANSPORT

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

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

Please explain:

As the scheme is for over 65s, and that an internal bike survey has been carried, the proposed residents will not be using bicycles in comparison to a general needs residential scheme. However, standards have been followed for 'specific older person housing' as set out in the London Plan.

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*

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*
See policy LP44

d. **For smaller developments ONLY**: Have you provided a Transport Statement? *5*

e. Does your development provide cycle storage? (Standard space requirements are set out in the Council's Parking Standards - Local Plan Appendix 3) *2*
If so, for how many bicycles? **2**
Is this shown on the site plans?
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*

Subtotal 9

Please give any additional relevant comments to the Transport Section below

The site will be near zero parking due to its highly sustainable location, though a disabled bay and two visitor bays are provided, that will have charging facilities.

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

If so, please state how much in sqm? 7.5 sqm

b. Does your development involve the removal of any tree(s)? (Indicate if yes)

If so, has a tree report been provided in support of your application? (Indicate if yes)

c. Does your development plan to add (and not remove) any tree(s) on site? (Indicate if yes)

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:	47	sqm
An extensive green roof	*5*	Area provided:	166	sqm
An intensive green roof	*4*	Area provided:		sqm
Garden space	*4*	Area provided:	55	sqm
Additional native and/or wildlife friendly planting to peripheral areas	*3*	Area provided:	47	sqm
Additional planting to peripheral areas	*2*	Area provided:		sqm
A living wall	*2*	Area provided:		sqm
Bat boxes	*0.5*			
Bird boxes	*0.5*			
Swift boxes	*0.5*			
Other	*0.5*			

e. Does your development use at least 70% of available roof plate as green/brown roof 1

Policy LP 17 requires 70%

Subtotal 18

Please give any additional relevant comments to the Biodiversity Section below

The existing site consisting of 94% concrete/tarmac hardstanding and garages is being replaced with 5 dwellings with substantial green roofs and permeable/landscaped garden amentiy, with an enhancement of 26% green space for ecology/biodiversity.

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*

Have you submitted a Flood Risk Assessment? (Indicate if yes)

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*
Use of infiltration techniques such as porous surfacing materials to allow drainage on-site	*3*
Attenuate rainwater in ponds or open water features	*4*
Store rainwater in tanks for gradual release to a watercourse	*3*
Discharge rainwater directly to watercourse	*2*
Discharge rainwater to surface water drain	*1*
Discharge rainwater to combined sewer	*0*
Have you submitted a Drainage Statement (Indicate if yes)	

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: 690 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 existing site of 1118m² has an existing garden of circa 64m². The proposal increases the permeable area with flat green roofs to all proposed dwellings and additional gardens/landscaping totalling 690m² (62% increase in permeable area). Part of the landscaping will be used as rainwater gardens.

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*

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*

Have you submitted an assessment of the site contamination?	*2*
Are plans in place to remediate the contamination?	*2*
Have you submitted a remediation plan?	*1*
Are plans in place to include composting on site?	*1*

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

Subtotal 6

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*

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*

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*

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 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

Though the development is not major being only 5 dwellings, 4 of the units are wheelchair dwellings M4(3) and 1 unit is wheelcahir accessible and adaptable M4(2), with a wheelchair accessible wet-room.

LBRUT Sustainable Construction Checklist- Scoring Matrix for *New Construction* **(Non-Residential and domestic refurb)** ***TOTAL*** ***76***

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 – SAP Worksheets - Base Case Scenario

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

Assessor name	Andrew Gilbert	Assessor number	2
Client	Richmond Charities	Last modified	20/06/2022
Address	n/a n/a n/a St Mary's Grove, Garage site to rear, Richmond, UK, TW9 1UY		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		60.00	(1a)	x	2.67	(2a)	=	160.20	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	60.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			160.20	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		8.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.52	(18)
Number of sides on which the dwelling is sheltered		3	(19)
Shelter factor	1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.41	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.52	0.51	0.50	0.45	0.44	0.39	0.39	0.38	0.41	0.44	0.46	0.48	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.63	0.63	0.62	0.60	0.60	0.57	0.57	0.57	0.58	0.60	0.60	0.61	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.63	0.63	0.62	0.60	0.60	0.57	0.57	0.57	0.58	0.60	0.60	0.61	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			3.06	x	1.60	=	4.90			(26)
Window			11.51	x	1.50	=	17.31			(27)
Roof window			1.62	x	2.02	=	3.28			(27a)
Ground floor			60.00	x	0.18	=	10.80			(28a)
External wall			54.87	x	0.26	=	14.27			(29a)
Party wall			21.29	x	0.00	=	0.00			(32)
Roof			58.65	x	0.16	=	9.38			(30)
Total area of external elements ∑A, m²			189.71							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	59.93	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		28.46	(36)
Total fabric heat loss	(33) + (36) =	88.39	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	33.54	33.27	33.00	31.72	31.49	30.38	30.38	30.17	30.81	31.49	31.97	32.47	(38)
Heat transfer coefficient, W/K (37)m + (38)m	121.93	121.65	121.38	120.11	119.87	118.77	118.77	118.56	119.19	119.87	120.35	120.86	
Average = ∑(39)1...12/12 =												120.11	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	2.03	2.03	2.02	2.00	2.00	1.98	1.98	1.98	1.99	2.00	2.01	2.01	
Average = ∑(40)1...12/12 =												2.00	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.98	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	81.26	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	89.39	86.14	82.89	79.64	76.39	73.14	73.14	76.39	79.64	82.89	86.14	89.39	
∑(44)1...12 =												975.17	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	132.56	115.94	119.64	104.31	100.08	86.36	80.03	91.83	92.93	108.30	118.22	128.38	
∑(45)1...12 =												1278.60	(45)
Distribution loss 0.15 x (45)m	19.88	17.39	17.95	15.65	15.01	12.95	12.00	13.78	13.94	16.25	17.73	19.26	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c	45.55	39.65	42.24	39.27	38.93	36.07	37.27	38.93	39.27	42.24	42.48	45.55	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

178.12	155.59	161.88	143.58	139.01	122.43	117.30	130.76	132.21	150.54	160.70	173.93	(62)

Solar DHW input calculated using Appendix G or Appendix H

-13.46	-11.84	-12.09	-9.96	-9.25	-7.64	-6.47	-7.83	-8.06	-9.95	-11.51	-13.01	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

164.66	143.75	149.79	133.62	129.76	114.80	110.83	122.93	124.15	140.59	149.19	160.93

∑(64)1...12 = 1644.99 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

55.47	48.46	50.34	44.50	43.01	37.73	35.93	40.27	40.72	46.57	49.93	54.07	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	38.63	34.31	27.90	21.12	15.79	13.33	14.40	18.72	25.13	31.91	37.24	39.70	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	258.13	260.81	254.06	239.69	221.55	204.50	193.11	190.43	197.18	211.55	229.69	246.74	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	(71)
Water heating gains (Table 5)	74.55	72.12	67.66	61.81	57.81	52.41	48.29	54.12	56.55	62.59	69.35	72.68	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	462.81	458.74	441.13	414.12	386.65	361.74	347.31	354.78	370.37	397.56	427.79	450.63	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.54	x	1.73	x	10.63	x 0.9 x	0.76	x	0.70	=	4.76	(74)
West	1.00	x	2.98	x	19.64	x 0.9 x	0.76	x	0.70	=	28.02	(80)
West	0.54	x	4.59	x	19.64	x 0.9 x	0.76	x	0.70	=	23.31	(80)
South	0.54	x	2.21	x	46.75	x 0.9 x	0.76	x	0.70	=	26.71	(78)
South	1.00	x	1.62	x	29.11	x 0.9 x	0.76	x	0.80	=	25.80	(78)

Solar gains in watts ∑(74)m...(82)m

108.61	205.38	326.36	466.08	568.00	581.34	553.41	476.55	375.58	240.06	134.01	90.29	(83)

Total gains - internal and solar (73)m + (83)m

571.42	664.11	767.49	880.21	954.65	943.08	900.72	831.33	745.95	637.62	561.79	540.92	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.96	0.92	0.82	0.68	0.54	0.59	0.81	0.94	0.98	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.43	19.59	19.88	20.26	20.59	20.80	20.88	20.86	20.69	20.26	19.78	19.40	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.98	19.99	19.99	20.00	20.00	20.01	20.01	20.01	20.01	20.00	20.00	19.99	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.95	0.90	0.78	0.61	0.43	0.49	0.75	0.93	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.54	18.70	18.99	19.37	19.67	19.86	19.91	19.91	19.78	19.38	18.90	18.52	(90)

Living area fraction — Living area ÷ (4) = 0.43 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

18.92	19.08	19.37	19.75	20.06	20.26	20.32	20.31	20.17	19.75	19.27	18.89	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.77	18.93	19.22	19.60	19.91	20.11	20.17	20.16	20.02	19.60	19.12	18.74	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.97	0.95	0.89	0.78	0.61	0.45	0.50	0.75	0.92	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	561.74	645.50	726.70	781.73	744.49	579.88	405.52	418.53	557.20	586.85	546.50	533.19	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1763.93	1707.06	1543.94	1284.67	983.96	654.15	424.44	446.21	705.10	1079.20	1446.91	1757.71	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	894.42	713.36	608.02	362.12	178.17	0.00	0.00	0.00	0.00	366.31	648.29	911.04	

∑(98)1...5, 10...12 = 4681.75 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 78.03 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		84.00	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1064.79	849.24	723.84	431.10	212.11	0.00	0.00	0.00	0.00	436.08	771.78	1084.58

∑(211)1...5, 10...12 = 5573.51 (211)

Water heating

Efficiency of water heater

82.46	82.34	82.05	81.37	79.96	75.00	75.00	75.00	75.00	81.29	82.16	82.51	(217)

Water heating fuel, kWh/month

199.68	174.57	182.56	164.22	162.29	153.06	147.77	163.91	165.53	172.94	181.59	195.03

∑(219a)1...12 = 2063.15 (219)

Annual totals

Space heating fuel - main system 1 — 5573.51

Water heating fuel		2063.15	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		30.00	(231)
Electricity for lighting (Appendix L)		272.89	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	7939.54	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5573.51	x	3.48	x 0.01 =	193.96	(240)
Water heating	2063.15	x	3.48	x 0.01 =	71.80	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	272.89	x	13.19	x 0.01 =	35.99	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		425.71	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.70	(257)
SAP value	76.25	
SAP rating (section 13)	76	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	5573.51	x	0.216	=	1203.88	(261)
Water heating	2063.15	x	0.216	=	445.64	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1649.52	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	272.89	x	0.519	=	141.63	(268)
Total CO_2, kg/year			(265)...(271) =		1806.72	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		30.11	(273)
EI value					76.94	
EI rating (section 14)					77	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	5573.51	x	1.22	=	6799.68	(261)
Water heating	2063.15	x	1.22	=	2517.05	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9316.72	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	272.89	x	3.07	=	837.76	(268)
Primary energy kWh/year					10246.58	(272)
Dwelling primary energy rate kWh/m2/year					170.78	(273)

Appendix C – SAP Worksheets – Improved Case Scenario

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

Assessor name	Andrew Gilbert	Assessor number	2
Client	Richmond Charities	Last modified	20/06/2022
Address	n/a n/a n/a St Mary's Grove, Garage site to rear, Richmond, UK, TW9 1UY		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		60.00	(1a)	x	2.67	(2a)	=	160.20	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	60.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	160.20	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.37	(18)
Number of sides on which the dwelling is sheltered		3	(19)
Shelter factor	1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.37	0.36	0.36	0.32	0.31	0.28	0.28	0.27	0.29	0.31	0.33	0.34	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			3.06	x	1.20	=	3.67			(26)
Window			11.51	x	0.77	=	8.81			(27)
Roof window			1.62	x	0.73	=	1.18			(27a)
Ground floor			60.00	x	0.13	=	7.80			(28a)
External wall			25.19	x	0.17	=	4.28			(29a)
External wall			29.68	x	0.14	=	4.16			(29a)
Party wall			21.29	x	0.00	=	0.00			(32)
Roof			58.65	x	0.11	=	6.45			(30)
Total area of external elements ∑A, m²			189.71							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	36.35	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		28.46	(36)
Total fabric heat loss	(33) + (36) =	64.81	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	30.06	29.92	29.78	29.13	29.01	28.45	28.45	28.34	28.66	29.01	29.26	29.51	(38)
Heat transfer coefficient, W/K (37)m + (38)m	94.87	94.73	94.59	93.94	93.82	93.26	93.26	93.15	93.48	93.82	94.07	94.32	
Average = ∑(39)1...12/12 =												93.94	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.58	1.58	1.58	1.57	1.56	1.55	1.55	1.55	1.56	1.56	1.57	1.57	
Average = ∑(40)1...12/12 =												1.57	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.98	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	81.26	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	89.39	86.14	82.89	79.64	76.39	73.14	73.14	76.39	79.64	82.89	86.14	89.39	
∑(44)1...12 =												975.17	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	132.56	115.94	119.64	104.31	100.08	86.36	80.03	91.83	92.93	108.30	118.22	128.38	
∑(45)1...12 =												1278.60	(45)
Distribution loss 0.15 x (45)m	19.88	17.39	17.95	15.65	15.01	12.95	12.00	13.78	13.94	16.25	17.73	19.26	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.03	(51)
Volume factor from Table 2a	0.93	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	2.08	(54)

Enter (50) or (54) in (55) | 2.08 | (55)

Water storage loss calculated for each month (55) x (41)m

64.39	58.16	64.39	62.31	64.39	62.31	64.39	64.39	62.31	64.39	62.31	64.39	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

64.39	58.16	64.39	62.31	64.39	62.31	64.39	64.39	62.31	64.39	62.31	64.39	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

220.21	195.11	207.29	189.13	187.73	171.19	167.68	179.48	177.75	195.95	203.04	216.03	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

220.21	195.11	207.29	189.13	187.73	171.19	167.68	179.48	177.75	195.95	203.04	216.03

∑(64)1...12 = | 2310.60 | (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

114.20	101.88	109.90	102.54	103.40	96.57	96.73	100.65	98.76	106.13	107.17	112.81	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	118.90	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	39.19	34.81	28.31	21.43	16.02	13.53	14.62	19.00	25.50	32.38	37.79	40.28	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	258.13	260.81	254.06	239.69	221.55	204.50	193.11	190.43	197.18	211.55	229.69	246.74	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	-79.27	(71)
Water heating gains (Table 5)	153.49	151.61	147.72	142.42	138.98	134.13	130.01	135.29	137.16	142.65	148.84	151.62	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	542.32	538.74	521.59	495.04	468.05	443.66	429.24	436.22	451.35	478.08	507.83	530.15	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.54	x	1.73	x	10.63	x 0.9 x	0.57	x	0.70	=	3.57	(74)
West	1.00	x	2.98	x	19.64	x 0.9 x	0.57	x	0.70	=	21.02	(80)
West	0.54	x	4.59	x	19.64	x 0.9 x	0.57	x	0.70	=	17.48	(80)
South	0.54	x	2.21	x	46.75	x 0.9 x	0.57	x	0.70	=	20.04	(78)
South	1.00	x	1.62	x	29.11	x 0.9 x	0.64	x	0.80	=	21.73	(78)

Solar gains in watts ∑(74)m...(82)m

83.83	158.83	253.05	362.19	441.97	452.56	430.74	370.55	291.49	185.84	103.50	69.65	(83)

Total gains - internal and solar (73)m + (83)m

626.15	697.57	774.64	857.23	910.02	896.22	859.98	806.77	742.84	663.92	611.32	599.80	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.98	0.97	0.95	0.89	0.78	0.62	0.46	0.51	0.74	0.92	0.97	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.88	20.01	20.24	20.53	20.76	20.88	20.92	20.91	20.83	20.53	20.15	19.85	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.63	19.63	19.63	19.64	19.64	19.65	19.65	19.65	19.64	19.64	19.64	19.63	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.98	0.97	0.94	0.86	0.71	0.51	0.33	0.37	0.64	0.88	0.96	0.98	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.19	18.38	18.70	19.10	19.38	19.52	19.54	19.54	19.47	19.12	18.59	18.15	(90)

Living area fraction — Living area ÷ (4) = 0.43 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	18.90	19.07	19.36	19.71	19.97	20.10	20.13	20.13	20.05	19.72	19.26	18.87	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	18.90	19.07	19.36	19.71	19.97	20.10	20.13	20.13	20.05	19.72	19.26	18.87	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.96	0.93	0.86	0.73	0.54	0.38	0.42	0.67	0.89	0.96	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	610.68	670.98	721.24	736.89	664.51	487.39	324.57	340.05	498.02	587.86	586.26	587.04	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1385.53	1342.49	1216.14	1015.24	775.65	512.75	329.05	347.03	556.00	855.74	1143.52	1383.90	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	576.49	451.25	368.21	200.41	82.69	0.00	0.00	0.00	0.00	199.30	401.23	592.87	

∑(98)1...5, 10...12 = 2872.43 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 47.87 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		319.70	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	180.32	141.15	115.17	62.69	25.86	0.00	0.00	0.00	0.00	62.34	125.50	185.44

∑(211)1...5, 10...12 = 898.48 (211)

Water heating

Efficiency of water heater

170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	(217)

Water heating fuel, kWh/month

129.54	114.77	121.94	111.25	110.43	100.70	98.63	105.58	104.56	115.27	119.44	127.08	

∑(219a)1...12 = 1359.18 (219)

Annual totals

Space heating fuel - main system 1		898.48	
Water heating fuel		1359.18	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		30.00	(231)
Electricity for lighting (Appendix L)		276.87	(232)
Energy saving/generation technologies			
electricity generated by PV (Appendix M)		-1597.03	(233)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	967.49	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	898.48	x	13.19	x 0.01 =	118.51	(240)
Water heating	1359.18	x	13.19	x 0.01 =	179.28	(247)
Pumps and fans	30.00	x	13.19	x 0.01 =	3.96	(249)
Electricity for lighting	276.87	x	13.19	x 0.01 =	36.52	(250)
Additional standing charges					0.00	(251)
Energy saving/generation technologies						
pv savings	-1597.03	x	13.19	x 0.01 =	-210.65	(252)
Total energy cost				(240)...(242) + (245)...(254) =	127.61	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.51	(257)
SAP value	92.88	
SAP rating (section 13)	93	(258)
SAP band	A	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	898.48	x	0.519	=	466.31	(261)
Water heating	1359.18	x	0.519	=	705.41	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1171.72	(265)
Pumps and fans	30.00	x	0.519	=	15.57	(267)
Electricity for lighting	276.87	x	0.519	=	143.70	(268)
Energy saving/generation technologies						
pv savings	-1597.03	x	0.519	=	-828.86	(269)
Total CO_2, kg/year				(265)...(271) =	502.13	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	8.37	(273)
EI value					93.59	

EI rating (section 14)	94 (274)
EI band	A

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	898.48	x	3.07	=	2758.33	(261)
Water heating	1359.18	x	3.07	=	4172.67	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6931.00	(265)
Pumps and fans	30.00	x	3.07	=	92.10	(267)
Electricity for lighting	276.87	x	3.07	=	850.00	(268)
Energy saving/generation technologies						
Electricity generated - PVs	-1597.03	x	3.07	=	-4902.90	(269)
Primary energy kWh/year					2970.20	(272)
Dwelling primary energy rate kWh/m2/year					49.50	(273)

Appendix D – Energy Summary Sheet

	Total $kgCO_2/yr$	
	Base Case to meet Part L of the building regulations	Improved Case to achieve 35% reduction over Part L of the building regulations
Space Heating	1203.88	466.31
Secondary Heating	0	0
Hot Water Heating	445.64	705.41
Fixed Electrical	15.57	15.57
Lighting	141.63	143.7
Appliances	17.01	17.01
Cooking	2.78	2.78
Less amount of renewables	0	-828.86
TOTAL	**1826.51**	**521.92**
DER/TER Variance % reduction overall	**44.54%**	**-70.28%**
% reduction through renewables	0.00%	41.74%

Appendix E – Water Calculator

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

Project Details

Adress/Reference	St Mary's Grove Garage Site, Richmond	Case Reference	
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
			0.00
			0.00
			0.00
			0.00
Total No. of Fittings (No.)		0	
Total Capacity (l)			0.00
Maximum Capacity (l)			0.00
Average Capacity (l)			0.00
Weighted Average Capacity (l)			0.00
Capacity for Calculation (l)			**0.00**

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)	89.60
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)	0.00	0.11	0.00	0.00
Shower (bath present)	(l/s)	0.00	4.37	0.00	0.00
Bath Only	(l)	0.00	0.50	0.00	0.00
Shower Only	(l/s)	8.00	5.60	0.00	44.80
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)					**102.47**
Grey/RainWater Reused (l)					0.00
Normalisation Factor	(Factor)				0.91
Total Consumption CSH (l/p/day)					**93.25**
External Water Use Allowance (l)					5.00
Total Comsumption Part G (l/p/day)					**98.25**

Assesment Result	**PASS**

Appendix F – Overheating Assessment

Overheating

The London Plan overheating checklist (GLA Energy Assessment Guidance 2018 - Appendix 5) has been used to assess the risk of overheating in the flats.

Section 1 – Site features affecting vulnerability to overheating		Yes or No
Site location	Urban – within central London[29] or in a high density conurbation	No
	Peri-urban - on the suburban fringes of London[30]	Yes
Air quality and/or Noise sensitivity - are any of the following in the vicinity of buildings?	Busy roads / A roads	No
	Railways / Overground / DLR	No
	Airport / Flight path	No
	Industrial uses / waste facility	No
Proposed building use	Will any buildings be occupied by vulnerable people (e.g. elderly, disabled, young children)?	Yes
	Are residents likely to be at home during the day (e.g. students)?	Yes
Dwelling aspect	Are there any single aspect units?	No
Glazing ratio	Is the glazing ratio (glazing: internal floor area) greater than 25%?	No
	If yes, is this to allow acceptable levels of daylighting?	No
Security - Are there any security issues that could limit opening of windows for ventilation?	Single storey ground floor units	Yes
	Vulnerable areas identified by the Police Architectural Liaison Officer	No
	Other	N/A

[29] Urban - as defined in CIBSE Guide TM49. Broadly equivalent to Central Activities Zone and Inner London areas in Map 2.2 of the London Plan
[30] Peri-urban – as defined in CIBSE Guise TM49. Broadly equivalent to Outer London areas in Map 2.2 of the London Plan

Section 2 – Design features implemented to mitigate overheating risk		Please Respond
Landscaping	Will deciduous trees be provided for summer shading (to windows and pedestrian routes)?	Yes
	Will green roofs be provided?	Yes
	Will other green or blue infrastructure be provided around buildings for evaporative cooling?	Yes
Materials	Have high albedo (light colour) materials been specified?	Yes
Dwelling aspect	% of total units that are single aspect	0%
	% single aspect with NE orientation	0%
	% single aspect with E orientation	0%
	% single aspect with SW orientation	0%
	% single aspect with W orientation	0%
Glazing ratio - What is the glazing ratio (glazing; internal floor area) on each facade?	N	3.0%
	E	0%
	S	4%
	W	13%

Daylighting		TBC
Window opening	Are windows openable?	Yes
Window opening	What is the average percentage of openable area for the windows?	50%
Window opening - What is the extent of the opening?	Fully openable	Yes
	Limited (e.g. for security, safety, wind loading reasons)	Yes
Security	Where there are security issues (e.g. ground floor flats) has an alternative night time natural ventilation method been provided (e.g. ventilation grates)?	Yes - openable rooflights
Shading	Is there any external shading?	Yes - canopy L/D
	Is there any internal shading?	Yes - blinds
Glazing specification	Is there any solar control glazing?	Yes, low emissivity glazing is specified
Ventilation - What is the ventilation strategy?	Natural – background	Yes
	Natural – purge	Yes
	Mechanical – background (e.g. MVHR)	No
	Mechanical – purge	No
	What is the average design air change rate	5
Heating system	Is communal heating present?	Yes - GSHP
	What is the flow/return temperature?	35°C
	Have horizontal pipe runs been minimised?	TBC
	Do the specifications include insulation levels in line with the London Heat Network Manual[31]	TBC

[31] http://www.londonheatmap.org.uk/Content/uploaded/documents/LHNM_Manl2014Low.pdf

The impact of solar gain has been incorporated into the SAP analysis for compliance with Part L, and is in-line with the CIBSE TM59 Design methodology for the assessment of overheating risk in homes 2017. In this case, the sample used follows the guidance principles, and Plot 2 was assessed, being a typical layout and predominantly facing west.

Following the overheating checklist, and results of the SAP assessment, the risk over solar overheating is minimised, with the maximum summer internal temperature of 21.29 °C being achieved.

Windows will incorporate low emissivity coatings to reduce solar gain, and window proportions have been designed to reduce overheating, together with canopies over set-back living/ dining spaces. Additionally, all of the units have marginal access to dual aspects, plus openable rooflights, and therefore will benefit from cross ventilation with passive openable windows, and blinds to be installed.

Appendix G - 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 5° for the flat green roof.

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

Typical domestic systems range from 1 – 3.5kW$_p$ 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%.
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.

Smart Tariffs and Utilising Generated Electricity:

On-site electricity production from renewable sources reduces the amount of conventionally generated electricity (from the grid) that needs to be bought from suppliers, further reducing costs.

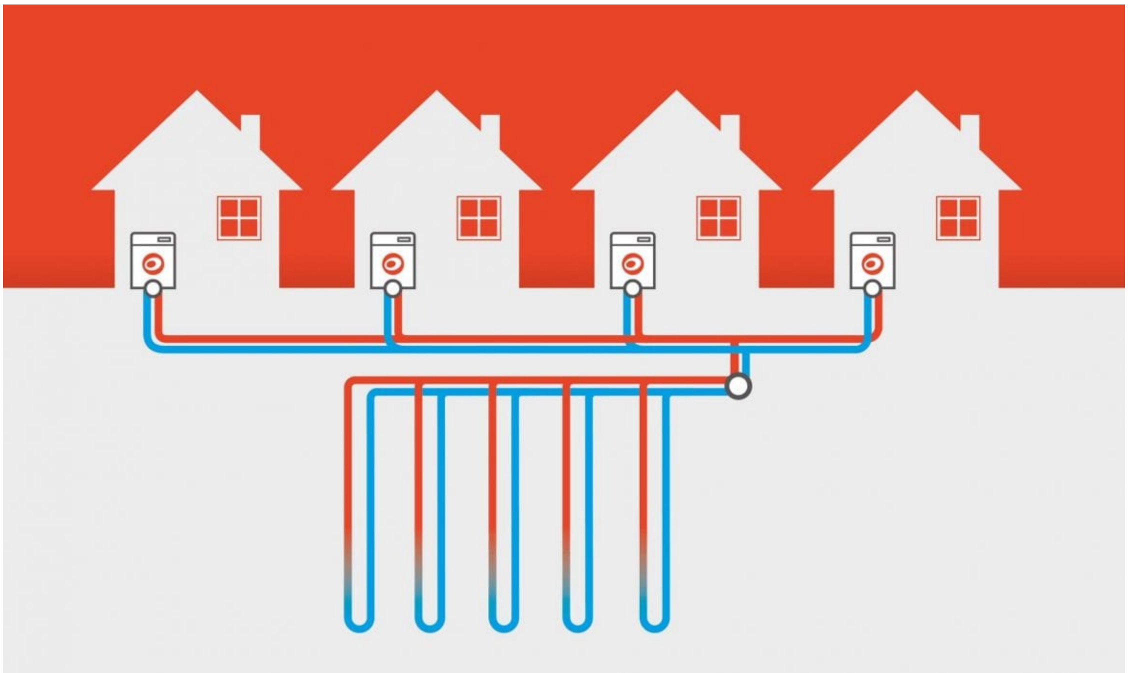
Encouraged in the Energy White Paper: Powering our Net Zero Future (December 2020) as a successor to the Feed-In Tariff (FIT, suspended in 2020) in order to continue to incentivise the generation of low carbon electricity the Government introduced **Agile Octopus Tariff, Octopus Energy.** It is a 'time-of-use' tariff, which gives the consumers access to half-hourly electricity prices, tied to wholesale prices, which are updated daily; allowing customers to adjust their consumption to times when the wholesale price of energy is cheapest. Thus, monthly and annual bills decrease when the energy prices drop. On the other hand, prices are capped at 35p/kWh* to protect consumers during price spikes; but when prices go 'negative' the consumers can be paid to use energy during that period.

*Details are set-out at: https://octopus.energy/

Appendix G - Renewable Energy Technologies, Supporting Data

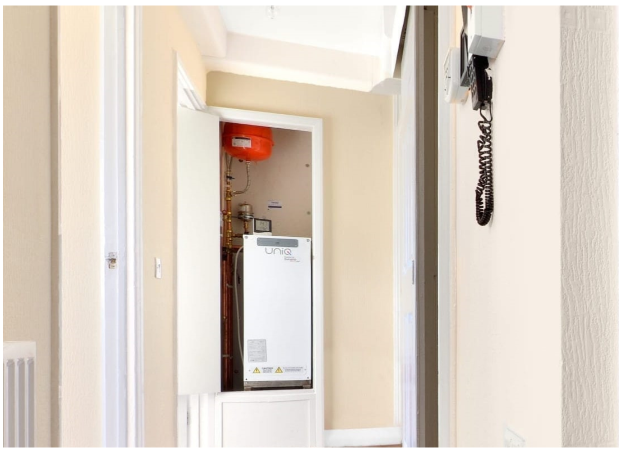
Ground Source Heat Pumps – Vertical System:

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.