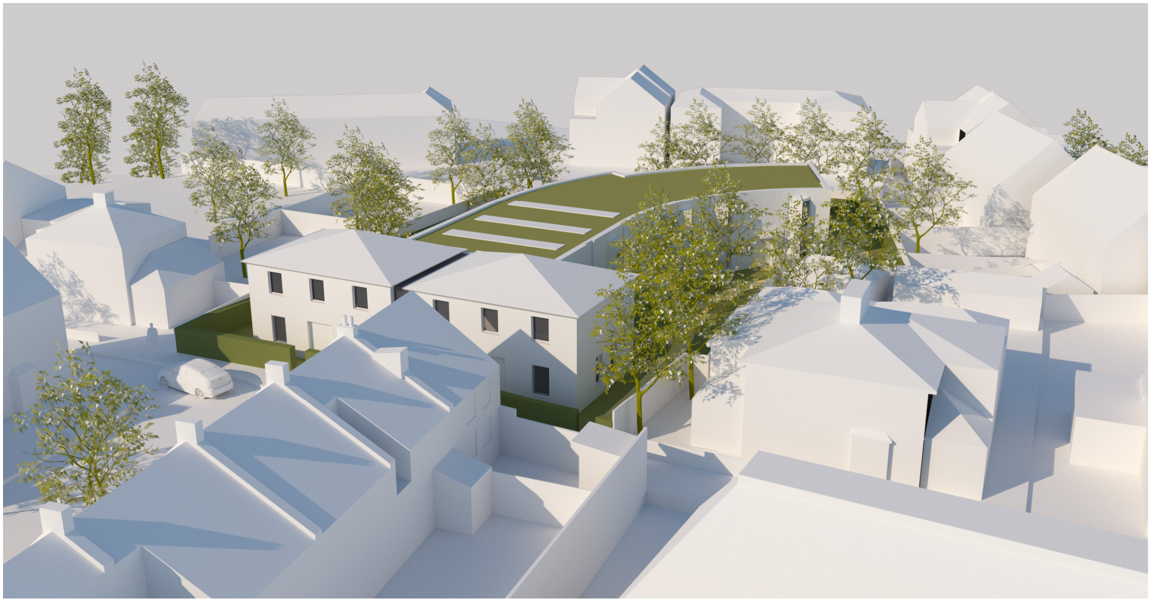
New 16No. Residential Flats

Elleray Housing Development

Elleray Road, Teddington, London
TW11 0HG



Energy & Sustainability Report

May 2021

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1.0 Introduction

Clive Chapman Architects has been appointed to carry out a sustainability assessment and energy report for a proposed housing development at Elleray Road, Teddington.

The scheme comprises of total of 16No. dwellings - 12No. 1-bed, 2-persons (1B2P) flats at 50m^2, 2No. 1-bed, 2-person (1B2P) for wheelchair users at 61m^2; and 2No. 2-bed, 3-persons (2B3P) at 61m^2, with provisions of cycle storage, additional associated amenity space and landscaped garden.

For new-build major residential schemes, the London Borough of Richmond upon Thames (LBRuT) has adopted in the Local Plan 2018 (2020 amendments) policies from the Draft London Plan 2020, followed by newly updated London Plan 2021. A detailed study has been carried out to assess options to meet the current sustainability criteria are listed below:

- Endeavour for all new major residential developments (10 units or more) to achieve net zero carbon standards in line with LBRuT Local Plan 2018 Policy LP 22 & London Plan 2021 Policy SI 2 A. Proposals should aim to reduce greenhouse gas emissions in operation and minimise both annual and peak energy demand in accordance with the following energy hierarchy:

  - Be Lean: less energy use and demand
  - Be Clean: supply energy efficiently and cleanly
  - Be Green: producing, storing and using renewable energy on-site

- Assessment of the development using the London Borough of Richmond upon Thames Sustainable Construction Checklist (June 2020) (LBRuT Local Plan 2018 Policy LP 22)

- Be Lean – Residential developments are expected to achieve carbon reduction of 10% (15% non-residential) through energy efficiency measures alone to reduce energy demand through good fabric performance (LBRuT Local Plan 2018 Policy LP 22 & London Plan 2021 Policy SI 2 C)

- Be Green – A minimum on-site reduction in carbon dioxide emissions of -35% over baseline of Building Regulations Part L1A: Conservation of fuel and power in new dwellings 2013 edition (2016 amendments) (LBRuT Local Plan 2018 Policy LP 22 & London Plan 2021 Policy SI 2 C)

- A maximum water consumption of 110 litres per person, per day (excluding an allowance of 5 litres or less per head per day for external water consumption), 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 SI 5)

- To fully achieve the zero-carbon target Carbon Offsetting Shortfall above the 35% improvement up to 100% (Zero Carbon) should be provided as required by the LBRuT through a cash in lieu contribution to the borough's Carbon Offset Fund (LBRuT Local Plan 2018 Policy LP 22 & London Plan 2021 Policy SI 2 C1)

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	26
Transport[1]	7
Biodiversity	15
Flooding and Drainage	4
Improving Resource Efficiency	3
Accessibility	4
TOTAL	60

An overall score achieved of 60 credits will be achieving an A rating – a major contribution towards achieving sustainable development in Richmond. Please see Appendix A for the completed Sustainable Construction Checklist.

To improve scoring, we could further suggest options for improved fabric energy performance and air-tightness plus integrated services (MVHR for heat-recovery ventilation) to bring energy demand at or below 15kWh/m^2/year per unit; and/or the incorporation of rainwater harvesting systems.

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 (excluding 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 93.1 litres person per day on average per each new dwelling.

4.0 Energy Efficiency Measures

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

Notes: Please 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.

4.1 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 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 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 building has a flat green roof that can be used for photovoltaic panels. They will be tilted slightly 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 area of 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	May be suitable for this site

	reason being that the solar water panels reduce the running times of the gas boiler for space & hot water generation, whereas PVs reduce the electricity consumption of the building, and electricity generation has a larger carbon footprint.	
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 not suitable for either horizontal or vertical trench systems because the outdoor space of the site is not large enough to take up the 6 x 50m trenches required for the GSHP. As the development is within close proximity to neighbouring residential buildings, boring would be strategically difficult and likely to cause disturbance. In turn the mitigation costs of the system would be proportionally inappropriate for this development.	Rejected
Ground sourced 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.	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

4.2 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 Model Design values (notional concurrent values above the absolute minimum) outlined in Building Regulations Part L1A: Conservation and Fuel in New Dwellings 2013 (2016 revision), as 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. However, in this case the building performance has already been evaluated, so Base Case U-values have been specified, as an improvement to Model Design. (Appendix B) Then further improvements have been assessed to achieve the enhanced LBRuT requirements with the addition of renewables. (Appendix C)

Option	Specification	DER/TER Variance BREGS L1A 2016 TARGET 0% LBRUT TARGET -35% (minimum)	% reduction through renewables
New dwelling - Base Case	U-values in accordance with B.Regs Part L1A 2013 (2016 revision) concurrent notional dwelling specification - Ground floor U = 0.13 W/m²K - External walls U = 0.18 W/m²K - Green roof U = 0.13 W/m²K - Windows (double-glazed) U = 1.4 W/m²K - Rooflights (double-glazed) U = 1.4 W/m²K - Front door (solid) U = 2 W/m²K - Thermal bridging: standard psi values -Air tightness 10 m³/hrm² -85% energy efficient lighting -Thermal bridging: minimal. -Instantaneous combi boiler 89.4% efficient (Worcester Greenstar 42 CDi) - No PV panels - Ventilation – Passive cross-ventilation and Decentralised whole dwelling extract	47.18%	n/a

New Dwelling - Improved Case	Improvements to reach LBRuT fabric efficiency measures - Ground floor U = 0.11 W/m²K - External walls U = 0.13 W/m²K - Green roof U = 0.11 W/m²K - Windows (double-glazed) U = 1.2 W/m²K - Rooflights (double-glazed) U = 1.3 W/m²K - Front door (solid) U = 1.0 W/m²K - Thermal bridging: minimal; Accredited Construction Details (ACDs) - Air tightness 4 m^3/hrm^2 - Air Source Heat Pump (ASHP) air-to-water connection to U/F Heating for Space Heating and for Domestic Water Heating; 100L storage cylinder per each 1B/2P & 170L storage cylinder per 2B4P units. - 100% energy efficient lighting - Ventilation – Passive cross-ventilation and Decentralised whole dwelling extract	-25.66% (meeting policy requirement for 10% minimum)	1%
New Dwelling - Proposed Case	Improvements to reach LBRuT CO_2 reduction targets - Total of 45 No. 0.370kWp PV Panels; Area of 1,85m² per panel (overall approx. 72m²); 1.04kWp per dwelling (total of 16.65kWp; mounted horizontally on the flat green roof and under 35 degree angle to hipped roofs; all panels facing South	-58.23%	22%

4.3 Calculations – SAP CO_2 Emission Data

	Total $kgCO_2$/yr	
	Base Case to comply with Part L of the Building Regulations	Improved Case to achieve and exceed 35% reduction over Part L of the Building Regulations
Space Heating	244.66	125.12
Secondary Heating	0	0
Hot Water Heating	707.99	527.63
Fixed Electrical	190.89	76.36
Lighting	137.21	131.21
Appliances	17.38	17.38
Cooking	3.19	3.19
Less amount of renewables	0	-410.48
TOTAL	**1301.32**	**470.41**
DER/TER Variance % reduction overall[1]	**47.18%**	**-58.23%**
% reduction through renewables[2]	0%	22%

[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 the incorporation of renewable energy installations.
[3] The numbers refer to one dwelling only – worst case scenario Flat 5 out of 16no. total dwellings

Proposed roof layout:

4.4 Carbon Offsetting

The LBRuT Policy LP 22 in line with the London Plan 2016 Policy 5.2 and London Plan 2021 Policy SI 2 requires compliance with the Sustainability Construction Checklist and all major residential schemes to achieve zero carbon standards:
"Zero Carbon Standards apply to all new major residential development (10 or more housing units). This means that at least 35% of regulated CO_2 emission reductions (against a Building regulations Part L (20130 baseline) must be achieved on-site, with the remaining emissions, up to 100%, to be offset through a contribution to the Council's Carbon Offset Fund.
The price for offsetting carbon is regularly reviewed and changes to the suggested carbon offset price will be updated in future guidance. A nationally recognised non-traded price of £95/tonne has been tested as part of the viability assessment for the London Plan, which this borough will use to collect offset payments. Further detail can be found in the Cabinet Member Decision." [1]

The results in the energy modelling undertaken show that the residential development achieves and exceeds the required 35% improvement on site – 58.23% via providing a number of photovoltaic arrays while preserving 70% of extensive green roof space for biodiversity benefits. A carbon shortfall is identified at approximately 7.296 tonnes CO_2 per year.

The following formula is used to calculate the Carbon Offset payment which may be required:

Carbon Shortfall (t/year) x 30 (years) x £95 (non-traded price) =

= 7.296 x 30 x 95 =

= £20,794 (total potential required contribution)

This is considered an optimal balanced proposal for the scale and location of development, whereas an additional exercise showed that maximum number of PV arrays of 83no. could be incorporated at the full extent of roof surface available achieving -86.7% on-site CO2 offset via renewables. In this scenario the monetary contribution would be less and larger investment in technology would be imposed on developers.

[1] LBRuT - Local Plan – Sustainable Design and Construction – Carbon Dioxide Emissions and Zero Carbon Standards [https://www.richmond.gov.uk/sustainable_construction_checklist]

4.5 Conclusion

The proposal gives an opportunity to provide a new residential development of 16No. units in two-storey terraced housing configuration 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 Air-source heat pump 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 for the major residential development. 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 **58.23%** over Building Regulations Part L1A 2010, 2013 edition, 2016 revision;
- Provides a **22%** reduction of predicted carbon emissions through the use of small-scale Renewable Energy Technologies;
- Provides a portion of **25.66%** reduction in CO_2 emissions and CO_2 sequestration through the provision of energy efficiency measures alone;
- 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 **93.1** litres person per day per one new dwelling.
- **72%** available green roof area
- LBRuT Carbon Offset Fund potential monetary contribution of **£20,794**

Notes: The second consultation on proposed changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for non-domestic buildings and dwellings; and overheating in new residential buildings, closed on 13 April 2021 and it informed on the Future Homes Standard Consultation, expected to be implemented later in 2021 upon review of consultation results. The changes to regulations applying to domestic buildings propose to introduce a new overheating mitigation requirement in the regulations for new homes in Part F; an uplift on the Fabric Efficiency Standard, as well as other standards for building services in new homes; and guidance on the calibration of devices that carry out airtightness testing,

The proposal for improved case scenario achieves performance exceeding the current and the expected fabric efficiency targets specified in Part L and Part F used for the base case scenario.

Further considerations for improvements:

Triple-glazed windows could be considered to reduce the annual energy demand and fabric performance. The incorporation of a heat-recovery ventilation system (MVHR) might be appropriate to complement improved fabric performance in order to ensure better air-tightness and best ventilation rates throughout the year and reduce marginal risks for summer overheating, where the decentralised extract system and passive cross-ventilation satisfies the regulations and requirements for each separate dwelling.

5.0 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): Elleray Housing Development

Application No. (if known):

Address (include. postcode): Teddington, London, UK

Completed by: Dayana Anastasova

For Non-Residential
Size of development (m2):

For Residential
Number of dwellings: 16

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 — -47.74 %
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 — -21.03 %
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? — 18 %

What is the total remaining carbon to be offset — 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? — £
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

		Score
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 26

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

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:

		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?	21
	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 7

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
If so, please state how much in sqm? [ ] 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:		sqm
An extensive green roof	*5*	Area provided:	274	sqm
An intensive green roof	*4*	Area provided:		sqm
Garden space	*4*	Area provided:	690	sqm
Additional native and/or wildlife friendly planting to peripheral areas	*3*	Area provided:	60	sqm
Additional planting to peripheral areas	*2*	Area provided:	160	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 15

Please give any additional relevant comments to the Biodiversity Section below

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: 169 sqm
Please provide details of the permeable surfacing below *please represent a loss in permeable area as a negative number*

Subtotal 4

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

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? [ ] %

What percentage of demolition waste will be recycled? [ ] %

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 [ ]

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 3

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

LBRUT Sustainable Construction Checklist- Scoring Matrix for *New Construction* **(Non-Residential and domestic refurb)** ***TOTAL*** ***60***

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

SAP Worksheet
Design - Draft

NHER

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	Dayana Anastasova	Assessor number	5
Client		Last modified	10/02/2021
Address	Flat 5 , Teddington, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		50.00	(1a)	x	2.40	(2a)	=	120.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	50.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			120.00	(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	0	x 10 =	0	(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) =	0	÷ (5) =	0.00	(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)		0.25	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.21	(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	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

c) whole house extract ventilation or positive input ventilation from outside

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(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	
Window			4.40	x	1.33	=	5.83			(27)
Door			1.89	x	1.00	=	1.89			(26)
Party wall			53.65	x	0.00	=	0.00			(32)
External wall			21.86	x	0.18	=	3.93			(29a)
Roof			50.00	x	0.13	=	6.50			(30)
Total area of external elements ∑A, m²			78.15							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	18.16	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		11.72	(36)
Total fabric heat loss	(33) + (36) =	29.88	(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)	20.63	20.42	20.21	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	(38)
Heat transfer coefficient, W/K (37)m + (38)m	50.51	50.30	50.09	49.68	49.68	49.68	49.68	49.68	49.68	49.68	49.68	49.68	
Average = ∑(39)1...12/12 =												49.84	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.01	1.01	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	
Average = ∑(40)1...12/12 =												1.00	(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	1.69	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.34	(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)	81.77	78.80	75.83	72.85	69.88	66.91	66.91	69.88	72.85	75.83	78.80	81.77	
∑(44)1...12 =												892.08	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	121.27	106.06	109.45	95.42	91.56	79.01	73.21	84.01	85.01	99.08	108.15	117.44	
∑(45)1...12 =												1169.66	(45)
Distribution loss 0.15 x (45)m	18.19	15.91	16.42	14.31	13.73	11.85	10.98	12.60	12.75	14.86	16.22	17.62	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	100.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.06	(51)
Volume factor from Table 2a	1.06	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	3.37	(54)
Enter (50) or (54) in (55)	3.37	(55)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
104.35	94.25	104.35	100.98	104.35	100.98	104.35	104.35	100.98	104.35	100.98	104.35	(56)

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

104.35	94.25	104.35	100.98	104.35	100.98	104.35	104.35	100.98	104.35	100.98	104.35	(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

248.88	221.32	237.06	218.91	219.17	202.50	200.82	211.62	208.51	226.68	231.64	245.05	(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

248.88	221.32	237.06	218.91	219.17	202.50	200.82	211.62	208.51	226.68	231.64	245.05

∑(64)1...12 = 2672.16 (64)

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

142.41	127.47	138.48	130.52	132.53	125.06	126.43	130.02	127.06	135.03	134.75	141.14	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	37.42	33.24	27.03	20.46	15.30	12.92	13.96	18.14	24.35	30.91	36.08	38.46	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	219.75	222.03	216.29	204.05	188.61	174.10	164.40	162.12	167.87	180.10	195.54	210.06	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	(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)	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	(71)
Water heating gains (Table 5)	191.41	189.69	186.13	181.28	178.13	173.70	169.93	174.76	176.47	181.49	187.16	189.70	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	532.22	528.60	513.08	489.43	465.67	444.34	431.92	438.65	452.32	476.14	502.41	521.85	(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	
SouthWest	1.00	x	1.60	x	36.79	x 0.9 x	0.63	x	0.70	=	23.37	(79)
SouthEast	1.00	x	2.80	x	36.79	x 0.9 x	0.63	x	0.70	=	40.89	(77)

Solar gains in watts ∑(74)m...(82)m	64.26	109.45	149.75	185.55	207.84	206.33	198.93	182.30	162.15	120.97	76.96	54.99	(83)
Total gains - internal and solar (73)m + (83)m	596.47	638.05	662.83	674.98	673.51	650.68	630.85	620.96	614.47	597.10	579.38	576.84	(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)

0.85	0.82	0.77	0.70	0.59	0.45	0.34	0.35	0.51	0.69	0.80	0.86	(86)

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

19.74	19.92	20.19	20.51	20.76	20.92	20.97	20.97	20.88	20.59	20.15	19.72	(87)

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

20.07	20.08	20.08	20.09	20.09	20.09	20.09	20.09	20.09	20.09	20.09	20.09	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.83	0.80	0.75	0.67	0.55	0.40	0.27	0.29	0.45	0.65	0.78	0.84	(89)

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

18.43	18.69	19.07	19.50	19.83	20.01	20.07	20.07	19.98	19.62	19.02	18.41	(90)

Living area fraction — Living area ÷ (4) = 1.00 (91)

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

19.74	19.92	20.19	20.51	20.76	20.92	20.97	20.97	20.88	20.59	20.15	19.72	(92)

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

19.59	19.77	20.04	20.36	20.61	20.77	20.82	20.82	20.73	20.44	20.00	19.57	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.83	0.80	0.75	0.68	0.57	0.44	0.32	0.34	0.49	0.66	0.78	0.83	(94)
Useful gains, ηmGm, W (94)m x (84)m	492.53	507.43	496.26	455.68	385.72	286.49	203.76	212.14	301.22	396.12	450.31	481.32	(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]	772.20	748.10	678.42	569.14	442.51	306.32	209.83	219.50	329.37	489.07	640.74	763.52	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	208.07	161.73	135.52	81.69	42.25	0.00	0.00	0.00	0.00	69.16	137.11	209.96	

∑(98)1...5, 10...12 = 1045.48 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 20.91 (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 (%)		92.30	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	225.43	175.22	146.83	88.51	45.77	0.00	0.00	0.00	0.00	74.93	148.54	227.47

∑(211)1...5, 10...12 = 1132.69 (211)

Water heating

Efficiency of water heater

83.74	83.39	82.78	81.85	80.75	79.20	79.20	79.20	79.20	81.47	82.87	83.80	(217)

Water heating fuel, kWh/month

297.21	265.40	286.36	267.46	271.40	255.68	253.56	267.20	263.27	278.25	279.53	292.42

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	∑(219a)1...12 =	3277.74 (219)

Annual totals

Space heating fuel - main system 1			1132.69	
Water heating fuel			3277.74	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	292.80			(230a)
central heating pump or water pump within warm air heating unit	30.00			(230c)
boiler flue fan	45.00			(230e)
Total electricity for the above, kWh/year			367.80	(231)
Electricity for lighting (Appendix L)			264.37	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	5042.60	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1132.69	x	3.48	x 0.01 =	39.42	(240)
Water heating	3277.74	x	3.48	x 0.01 =	114.07	(247)
Pumps and fans	367.80	x	13.19	x 0.01 =	48.51	(249)
Electricity for lighting	264.37	x	13.19	x 0.01 =	34.87	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	356.87	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.58	(257)
SAP value	77.99	
SAP rating (section 13)	78	(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	1132.69	x	0.216	=	244.66	(261)
Water heating	3277.74	x	0.216	=	707.99	(264)
Space and water heating				(261) + (262) + (263) + (264) =	952.65	(265)
Pumps and fans	367.80	x	0.519	=	190.89	(267)
Electricity for lighting	264.37	x	0.519	=	137.21	(268)
Total CO_2, kg/year				(265)...(271) =	1280.75	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	25.61	(273)
EI value					81.93	
EI rating (section 14)					82	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1132.69	x	1.22	=	1381.89	(261)
Water heating	3277.74	x	1.22	=	3998.84	(264)
Space and water heating				(261) + (262) + (263) + (264) =	5380.73	(265)
Pumps and fans	367.80	x	3.07	=	1129.15	(267)

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Electricity for lighting	264.37	x	3.07	=	811.60 (268)
Primary energy kWh/year					7321.48 (272)
Dwelling primary energy rate kWh/m2/year					146.43 (273)

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Appendix C – SAP Worksheets - Proposed 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	Dayana Anastasova	Assessor number	5
Client		Last modified	23/02/2021
Address	Flat 5 Elleray Road , Teddington, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		50.00	(1a)	x	2.40	(2a)	=	120.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	50.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			120.00	(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	0	x 10 =	0	(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) =	0	÷ (5) =	0.00	(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		4.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.20	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.17	(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	0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.20	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

c) whole house extract ventilation or positive input ventilation from outside

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24c)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(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	
Window			4.40	x	1.15	=	5.04			(27)
Door			1.89	x	1.00	=	1.89			(26)
Party wall			53.65	x	0.00	=	0.00			(32)
External wall			21.86	x	0.13	=	2.84			(29a)
Roof			50.00	x	0.11	=	5.50			(30)
Total area of external elements ∑A, m²			78.15							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	15.27	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		2.25	(36)
Total fabric heat loss	(33) + (36) =	17.52	(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)	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	(38)
Heat transfer coefficient, W/K (37)m + (38)m	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	
Average = ∑(39)1...12/12 =												37.32	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Average = ∑(40)1...12/12 =												0.75	(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	1.69	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.34	(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)	81.77	78.80	75.83	72.85	69.88	66.91	66.91	69.88	72.85	75.83	78.80	81.77	
∑(44)1...12 =												892.08	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	121.27	106.06	109.45	95.42	91.56	79.01	73.21	84.01	85.01	99.08	108.15	117.44	
∑(45)1...12 =												1169.66	(45)
Distribution loss 0.15 x (45)m	18.19	15.91	16.42	14.31	13.73	11.85	10.98	12.60	12.75	14.86	16.22	17.62	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	100.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.01	(51)
Volume factor from Table 2a	1.06	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.78	(54)
Enter (50) or (54) in (55)	0.78	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	24.18	21.84	24.18	23.40	24.18	23.40	24.18	24.18	23.40	24.18	23.40	24.18	(56)

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

24.18	21.84	24.18	23.40	24.18	23.40	24.18	24.18	23.40	24.18	23.40	24.18	(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

168.71	148.91	156.89	141.33	139.00	124.92	120.65	131.45	130.93	146.52	154.06	164.89	(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

168.71	148.91	156.89	141.33	139.00	124.92	120.65	131.45	130.93	146.52	154.06	164.89

∑(64)1...12 = 1728.27 (64)

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

78.28	69.55	74.35	68.46	68.40	63.00	62.30	65.89	65.00	70.90	72.69	77.00	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	101.41	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	37.42	33.24	27.03	20.46	15.30	12.92	13.96	18.14	24.35	30.91	36.08	38.46	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	219.75	222.03	216.29	204.05	188.61	174.10	164.40	162.12	167.87	180.10	195.54	210.06	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	46.83	(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)													
	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	-67.60	(71)
Water heating gains (Table 5)													
	105.21	103.49	99.93	95.08	91.93	87.50	83.73	88.56	90.27	95.29	100.96	103.50	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	446.02	442.40	426.88	403.23	379.47	358.14	345.72	352.45	366.12	389.94	416.21	435.65	(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	
SouthWest	1.00	x	1.60	x	36.79	x 0.9 x	0.63	x	0.70	=	23.37	(79)
SouthEast	1.00	x	2.80	x	36.79	x 0.9 x	0.63	x	0.70	=	40.89	(77)

Solar gains in watts ∑(74)m...(82)m

64.26	109.45	149.75	185.55	207.84	206.33	198.93	182.30	162.15	120.97	76.96	54.99	(83)

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

510.27	551.85	576.63	588.78	587.31	564.48	544.65	534.76	528.27	510.91	493.18	490.64	(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)

0.85	0.81	0.75	0.66	0.55	0.41	0.30	0.32	0.47	0.66	0.80	0.86	(86)

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

20.21	20.36	20.55	20.75	20.90	20.97	20.99	20.99	20.95	20.79	20.48	20.15	(87)

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

20.30	20.30	20.30	20.30	20.30	20.30	20.30	20.30	20.30	20.30	20.30	20.30	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.83	0.79	0.73	0.64	0.51	0.37	0.25	0.27	0.42	0.63	0.78	0.85	(89)

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

19.25	19.46	19.73	20.00	20.18	20.27	20.29	20.29	20.25	20.05	19.63	19.18	(90)

Living area fraction — Living area ÷ (4) = 1.00 (91)

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

20.21	20.36	20.55	20.75	20.90	20.97	20.99	20.99	20.95	20.79	20.48	20.15	(92)

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

20.21	20.36	20.55	20.75	20.90	20.97	20.99	20.99	20.95	20.79	20.48	20.15	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.83	0.79	0.74	0.66	0.54	0.41	0.30	0.32	0.46	0.65	0.78	0.85	(94)
Useful gains, ηmGm, W (94)m x (84)m	424.34	438.02	425.91	386.00	319.02	230.82	162.16	169.09	244.76	332.86	385.42	414.70	(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]	593.63	576.86	524.41	442.23	343.16	237.74	163.92	171.31	255.75	380.27	499.17	595.25	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	125.95	93.30	73.28	40.49	17.96	0.00	0.00	0.00	0.00	35.27	81.90	134.32	

∑(98)1...5, 10...12 = 602.46 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 12.05 (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 (%)		249.90	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	50.40	37.33	29.32	16.20	7.19	0.00	0.00	0.00	0.00	14.11	32.77	53.75

∑(211)1...5, 10...12 = 241.08 (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	99.24	87.60	92.29	83.14	81.76	73.48	70.97	77.33	77.02	86.19	90.62	96.99	

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∑(219a)1...12 =	1016.63	(219)

Annual totals

Space heating fuel - main system 1			241.08	
Water heating fuel			1016.63	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	117.12			(230a)
central heating pump or water pump within warm air heating unit	30.00			(230c)
Total electricity for the above, kWh/year			147.12	(231)
Electricity for lighting (Appendix L)			264.37	(232)
Energy saving/generation technologies				
electricity generated by PV (Appendix M)			-790.91	(233)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	878.29	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	241.08	x	13.19	x 0.01 =	31.80	(240)
Water heating	1016.63	x	13.19	x 0.01 =	134.09	(247)
Pumps and fans	147.12	x	13.19	x 0.01 =	19.41	(249)
Electricity for lighting	264.37	x	13.19	x 0.01 =	34.87	(250)
Additional standing charges					0.00	(251)
Energy saving/generation technologies						
pv savings	-790.91	x	13.19	x 0.01 =	-104.32	(252)
Total energy cost				(240)...(242) + (245)...(254) =	115.85	(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	92.86	
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	241.08	x	0.519	=	125.12	(261)
Water heating	1016.63	x	0.519	=	527.63	(264)
Space and water heating				(261) + (262) + (263) + (264) =	652.75	(265)
Pumps and fans	147.12	x	0.519	=	76.36	(267)
Electricity for lighting	264.37	x	0.519	=	137.21	(268)
Energy saving/generation technologies						
pv savings	-790.91	x	0.519	=	-410.48	(269)
Total CO_2, kg/year				(265)...(271) =	455.83	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	9.12	(273)
EI value					93.57	
EI rating (section 14)					94	(274)
EI band					A	

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

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	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	241.08	x	3.07	=	740.12	(261)
Water heating	1016.63	x	3.07	=	3121.06	(264)
Space and water heating			(261) + (262) + (263) + (264) =		3861.18	(265)
Pumps and fans	147.12	x	3.07	=	451.66	(267)
Electricity for lighting	264.37	x	3.07	=	811.60	(268)
Energy saving/generation technologies						
Electricity generated - PVs	-790.91	x	3.07	=	-2428.10	(269)
Primary energy kWh/year					2696.34	(272)
Dwelling primary energy rate kWh/m2/year					53.93	(273)

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Appendix D - Baseline Energy Demand

BASE CASE TO MEET BUILDING REGS INC. APPROPRIATE SERVICES		
	Associated $kgCO_2/yr$	
Space Heating	244.66	[261]
Secondary Heating	0	[263]
Hot Water Heating	707.99	[264]
Fixed Electrical	190.89	[267]
Lighting	137.21	[268]
Appliances	17.38	Ene7 tool
Cooking	3.19	Ene7 tool
Savings through PVs	0	[SAP Box 269]
TOTAL	1301.32	

IMPROVED CASE TO MEET BUILDING REGS INC. APPROPRIATE SERVICES + PVs		
	Associated $kgCO_2/yr$	
Space Heating	125.12	[261]
Secondary Heating	0	[263]
Hot Water Heating	527.63	[264]
Fixed Electrical	76.36	[267]
Lighting	131.21	[268]
Appliances	17.38	Ene7 tool
Cooking	3.19	Ene7 tool
Savings through PVs	-410.48	[SAP Box 269]
TOTAL	470.41	

[…] Denotes SAP worksheet reference

Appliances and Cooking: Refer to and complete ENE07 Energy Tool

Appendix E – Water Calculator

http://www.thewatercalculator.org.uk/

Congratulations

Elleray Housing Development

You are within your target maximum consumption of potable water (110 litres per person per day).

Total water consumption from your calculation	**93.1**	litres per person per day

This calculator is intended to inform design choices by demonstrating the likely impact of specification changes on total water consumption. Results can only be used to demonstrate compliance with the Code for Sustainable Homes when the calculations have been verified by a suitably qualified Code for Sustainable Homes assessor.

Calculation summary

Installation type	Unit of measure	Capacity / flow rate	Use factor	Fixed use	Litres / person / day
WCs (single flush)	Flush volume (litres)		4.42	0	13.53
WCs (dual flush)	Average effective flushing volume (litres)	3.06			
Taps (excl. kitchen/utility room)	Flow rate (litres / minute)	4.9	1.58	1.58	9.32
Bath only	Capacity to overflow (litres)		0.5	0	
Shower only	Flow rate (litres / minute)	8	5.6	0	44.8
Kitchen/utility room sink taps	Flow rate (litres / minute)	6	0.44	10.36	13
Washing machine	Litres / kg dry load	8.17	2.1	0	17.16
Dishwasher	Litres / place setting	1.25	3.6	0	4.5
Waste disposal unit	Litres / use	☐	3.08	0	
Water softener	Litres / person / day	☐	1	0	
Contribution from Grey Water					undefined
Contribution from Rain Water					undefined
				Normalisation factor	∑ × 0.91

calculator & site development by Seedypea

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.

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%.
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.

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 F - Renewable Energy Technologies, Supporting Data

Air-Source Heat Pump:

The Air-source heat pump could be air-to-air for space heating only or air-to-water for heating the domestic hot water. Heat pumps deliver efficiently low grade heating output (up to 55C) and have the potential to supply heating requirements alone subject to the provision of oversized/low temperature radiators or an underfloor heating system as well as appropriately sized hot water cylinder for storage of water to use when intended.

ASHPs operate on electricity and feed in could be partially supplied from integrated PV panels array for on-site consumption of solar generated energy. ASHPs external units tend to generate noise and manufacturers offer new ultra-quiet models for domestic purpose. Nevertheless, the location and space available should be carefully considered in order to prevent disturbances to the building's occupants and nearby neighbours.

In principle, the ASHP takes in air from the outside to heat a liquid refrigerant via an external fan unit suspended on a wall or on top of a flat roof. Using electricity, the pump compresses the liquid to increase its temperature. This then condenses back into a liquid to release stored heat. Heat is sent to radiators or underfloor heating – the remainder is stored in a hot water cylinder inside the thermal envelope in a utility storage area. Stored heat water can be used for domestic activities – showers, baths and taps.

Fig. 4 ASHP image of external unit (Ecodan)

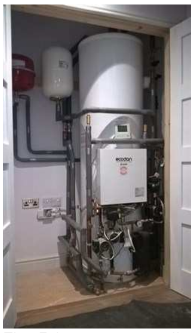

Fig. 5 hot water cylinder indoor unit (Ecodan)

Renewable Incentive & Payback scheme:

The installation of Air-Source Heat Pump as a small-scale renewable technology integrated with services on-site is eligible for the Renewable Heat Incentive (RHI) scheme introduced by the Government. Capital costs for ASHPs' incorporation can be offset and the owner/occupant can receive quarterly payments over the period of seven year after date of installation. The amount of payback is calculated based on the type of technology installed, regular metering provided and the latest tariffs adopted for the scheme. There are two parts to the RHI: Domestic RHI – open to homeowners, private landlords, social landlords, and self-builders; and Non-domestic RHI – to provide payments to industry, businesses, and public sector organisations. PV panels are not eligible for the scheme.

The current available tariff for ASHP is 7.3p/kWh.*

*Details are set out at: https://www.gov.uk/government/publications/2010-to-2015-government-policy-low-carbon-technologies/2010-to-2015-government-policy-low-carbon-technologies#appendix-6-renewable-heat-incentive-rhi