Sustainability & Energy Statement
Hunters Lodge, Friars Lane, Richmond

Prepared by Ivan Ball

Bluesky Unlimited
39 Marsh Baldon
Oxfordshire
OX44 9LP

ivan@blueskyunlimited.co.uk

28th February 2024

Table of Contents

Executive Summary

This Sustainability and Energy Statement has been prepared in support of a planning application for the demolition of the existing garage building at Hunters Lodge, Friars Lane, Richmond and the construction of a 2½-storey building, comprising four, 1 and 2-bedroom apartments.

The Statement sets out the commitments of the applicant to the site and the targets that will be applied to the development.

The methodology used has been based upon the ‘Energy Assessment Guidance’ published by the Mayor of London in June 2022 and uses the carbon factors for gas and electricity proposed for SAP 10.2.

In order to demonstrate the energy efficiency of the building a set of SAP calculations have been prepared for representative apartments for the ‘Be Lean’ scenario based on the notional systems specification set out in the Part L 2021 baseline. This is not the proposed strategy but purely demonstrates the reduction from the ‘Be Lean’ condition.

The TER & DER Worksheets for the modelled units and the Be Lean case are attached as Appendix 1.

The fabric standards of the apartments will exceed the requirements of the Building Regulations.

It is proposed to install heat pump hot water cylinders into each apartment. In addition, the Roof Plan & Elevation attached as Appendix 3 demonstrates a total of 22 photovoltaic panels could be installed without detrimentally impacting on the aesthetics of the development (the output of the panels is assumed to be 400W).

A further set of SAP calculations have been prepared based on the proposed specification and the DER Worksheets for the Be Green scenario are attached as Appendix 2.

The completed GLA Carbon Emissions Reporting Spreadsheet accompanies the planning application but the reductions in emissions can be summarised as follows:

	Total Emissions	% Reduction
	kg CO_2 per year	
Be Lean		
Baseline (Building Regulations TER)	3,135	
Be Lean - after energy efficiency (DER)	2,725	**13.08%**
Be Clean	2,725	13.08%
Be Green (ASHP & Photovoltaic Panels)		
Be Green Emissions	923	**70.56%**

The residual emissions are 0.923 tonnes and therefore the carbon offset payment would be **£2,631** (0.923 x £2,850).

The LBRuT Sustainable Construction Checklist is attached as Appendix 4.

1.0 Introduction

This report has been commissioned by Mr C Deehan and provides a Sustainability and Energy Statement in support of a planning application for the demolition of the existing garage building at Hunters Lodge, Friars Lane, Richmond and the construction of a 2½-storey building, comprising four, 1 and 2-bedroom apartments.

The report describes the methodology used in assessing the development and the initiatives proposed.

The building has been designed and will be constructed to reduce energy demand and carbon dioxide emissions.

The objective is to reduce the energy demand to an economic minimum by making investments in the parts of the building that has the greatest impact on energy demand and are the most difficult and costly to change in the future, namely the building fabric.

Once a cost-effective structure has been designed, low-carbon and renewable technologies have been considered to provide heat and/or electricity.

The following hierarchy has been followed:

- Lean reduce demand and consumption
- Clean increase energy efficiency
- Green provide low carbon renewable energy sources

The report has been prepared by Ivan Ball of Bluesky Unlimited who are sustainability consultants.

2.0 Planning Policy Context

National Policy

The UK Government published its sustainable development strategy in 1999 entitled "A better quality of life: A strategy for sustainable development in the UK". This sets out four main objectives for sustainable development in the UK:

- Social progress that recognises the needs of everyone.
- Effective protection of the environment.
- Prudent use of natural resources.
- Maintenance of high stable levels of economic growth and employment.

Sustainable Communities: Building for the Future, known colloquially as the Communities Plan was published in 2003. The Plan sets out a long-term programme of action for delivering sustainable communities in both urban and rural areas. It aims to tackle housing supply issues in parts of the country, low demand in other parts and the quality of our public spaces. The Communities Plan describes sustainable communities as: Active, inclusive and safe, well run, environmentally sensitive, well designed and built, well connected, thriving, well served and fair for everyone.

The most relevant national planning policy guidance on sustainability is set out in:

- National Planning Policy Framework - 2023

Paragraph 157 states;

"The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."

Regional and Local Policies

The Development Plan comprises the London Plan (2021) and the London Borough of Richmond Local Plan (2018).

London Plan, published March 2021 **–** the following policies are relevant to the application:

Policy SI 1 Improving air quality

A Development Plans, through relevant strategic, site-specific and area-based policies, should seek opportunities to identify and deliver further improvements to air quality and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality.

B To tackle poor air quality, protect health and meet legal obligations the following criteria should be addressed:

1) Development proposals should not:
- *a) lead to further deterioration of existing poor air quality*
- *b) create any new areas that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits*
- *c) create unacceptable risk of high levels of exposure to poor air quality.*

2) In order to meet the requirements in Part 1, as a minimum:
- *a) development proposals must be at least Air Quality Neutral*
- *b) development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality in preference to post-design or retro-fitted mitigation measures*
- *c) major development proposals must be submitted with an Air Quality Assessment. Air quality assessments should show how the development will meet the requirements of B1*
- *d) development proposals in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people should demonstrate that design measures have been used to minimise exposure.*

C Masterplans and development briefs for large-scale development proposals subject to an Environmental Impact Assessment should consider how local air quality can be improved across the area of the proposal as part of an air quality positive approach. To achieve this a statement should be submitted demonstrating:

1) how proposals have considered ways to maximise benefits to local air quality, and

2) what measures or design features will be put in place to reduce exposure to pollution, and how they will achieve this.

D In order to reduce the impact on air quality during the construction and demolition phase development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions from the demolition and construction of buildings following best practice guidance.

E Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on-site. Where it can be demonstrated that emissions cannot be further reduced by on-site measures, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated within the area affected by the development.

Policy SI 2 Minimising greenhouse gas emissions

A Major development should be net zero-carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

1) be lean: use less energy and manage demand during operation
2) be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly
3) be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site
4) be seen: monitor, verify and report on energy performance.

B Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

C A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:

1) through a cash in lieu contribution to the borough's carbon offset fund, or
2) off-site provided that an alternative proposal is identified and delivery is certain.

D Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually.

E Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.

F Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

Policy SI 4 Managing heat risk

A Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

B Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

1) reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure

2) minimise internal heat generation through energy efficient design

3) manage the heat within the building through exposed internal thermal mass and high ceilings

4) provide passive ventilation

5) provide mechanical ventilation

6) provide active cooling systems.

Policy SI 5 Water infrastructure

A In order to minimise the use of mains water, water supplies and resources should be protected and conserved in a sustainable manner.

B Development Plans should promote improvements to water supply infrastructure to contribute to security of supply. This should be done in a timely, efficient and sustainable manner taking energy consumption into account.

C Development proposals should:

1) through the use of Planning Conditions minimise the use of mains water in line with the Optional Requirement of the Building Regulations (residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption)

2) achieve at least the BREEAM excellent standard for the 'Wat 01' water category or equivalent (commercial development)

3) incorporate measures such as smart metering, water saving and recycling measures, including retrofitting, to help to achieve lower water consumption rates and to maximise future-proofing.

D In terms of water quality, Development Plans should:

1) promote the protection and improvement of the water environment in line with the Thames River Basin Management Plan, and should take account of Catchment Plans

2) support wastewater treatment infrastructure investment to accommodate London's growth and climate change impacts. Such infrastructure should be constructed in a timely and sustainable manner taking account of new, smart technologies, intensification opportunities on existing sites, and energy implications. Boroughs should work with Thames Water in relation to local wastewater infrastructure requirements.

E Development proposals should:

1) seek to improve the water environment and ensure that adequate wastewater infrastructure capacity is provided

2) take action to minimise the potential for misconnections between foul and surface water networks. F Development Plans and proposals for strategically or locally defined growth locations with particular flood risk constraints or where there is insufficient water infrastructure capacity should be informed by Integrated Water Management Strategies at an early stage.

London Borough of Richmond

The London Borough of Richmond adopted its Local Plan on the 3rd July 2018.

The following policy is of particular relevance to the topic area of this Statement and has been edited for clarity and relevance to the application in question.

Local Plan (2018)

Policy LP 22 - Sustainable Design and Construction

A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:

1. *Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.*
2. *Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).*
3. *New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.*

Reducing Carbon Dioxide Emissions

B. Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:

1. *All new major residential developments (10 units or more) should achieve zero carbon standards in line with London Plan policy.*
2. *All other new residential buildings should achieve a 35% reduction.*
3. *All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non-residential buildings should achieve zero carbon standards in line with London Plan policy.*

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations. *

C. This should be achieved by following the Energy Hierarchy:

1. *Be lean: use less energy*
2. *Be clean: supply energy efficiently*
3. *Be green: use renewable energy*

Decentralised Energy Networks

D. The Council requires developments to contribute towards the Mayor of London target of 25% of heat and power to be generated through localised decentralised energy (DE) systems by 2025. The following will be required:

1. *All new development will be required to connect to existing DE networks where feasible. This also applies where a DE network is planned and expected to be operational within 5 years of the development being completed.*

Applicants are required to consider the installation of low, or preferably ultra-low, NOx boilers to reduce the amount of NOx emitted in the borough.

Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where appropriate.

* As a result of revisions to the Building Regulations the LBRuT have published an update to the policy. This sets out a requirement for smaller residential schemes (below 10 units) to achieve a 35% reduction in emissions against a Building Regulations Part L (2021) baseline.

The update also sets out a requirement to follow the GLA Energy Assessment Guidance (2022) and to complete the 2022 Carbon Emissions Reporting Spreadsheet.

3.0 Assessment Methodology

The methodology used has followed that set out in the Energy Assessment Guidance published by the GLA in June 2022.

SAP calculations have been prepared using Part L 2021 to 'test' the Be Lean emissions. This uses the specification for building systems set out in the notional dwelling specification for new dwellings (Part L 2021 - Table 1.1).

Further SAP calculations have been prepared for the Be Green scenario, which uses the fabric specification established at the Be Lean stage but includes the actual building systems proposed.

Emission Factors

The CO_2 emission factors, where applicable, used throughout this report have been taken from SAP 10.2 as required by the GLA Energy Assessment Guidance.

	kg CO_2/kWh
Mains gas	0.210
Grid supplied and displaced electricity	0.136

4.0 Proposal

The accommodation schedule in detail is (note these figures differ from the areas quoted on the floor plans because of the different measuring requirements);

Unit Type	Number	Area	Total Area
		m^2	m^2
1-Bedroom Ground-floor apartments	2	55.4	110.8
2-Bedroom duplex apartments (1st & 2nd-floor)	2	73.8	147.6
Total	**4**		**258.4**

5.0 Energy Efficiency

5.1 Demand Reduction (Be Lean)

Design

The energy performance of a building is affected by its design, construction and use and whilst occupant behaviour is beyond the remit of this statement, better design and construction methods can significantly reduce the life cycle emissions of a building and assist the occupant to reduce consumption.

Sustainable design is not just about incorporating renewable technologies; buildings should be designed at the outset to provide suitable environmental conditions for the occupants whilst also consuming as little energy as practical.

Passive Design Measures

The passive design measures proposed include;

Passive Solar Gain

Passive measures include allowing for natural ventilation and exposed thermal mass coupled with high levels of insulation, air tightness and the control of solar gain.

The location and design of the building is in context with surrounding development and the shape of the site. The apartments are designed with dual aspects with the front of each being orientated towards the northeast and the rear towards the southwest.

All apartments benefit from access to direct sunlight at some point throughout the day and from cross ventilation to limit summer overheating.

Natural Daylighting

The orientation and the size of the windows have been optimised to maximise the amount of natural daylight whilst avoiding summer overheating and therefore reduce the demand for artificial lighting.

Efficient Building Fabric

Building Envelope

U-values of the building envelope must meet Building Regulations Part L standards and further improvements to U-values will reduce the building's heating requirements.

The ground-floor will be insulated with 200mm 'Kingspan' PIR insulation or similar.

The external walls will be built in traditional cavity wall construction with an overall width of 350mm. This will be comprised of 100mm facing brick, 150mm fully-filled cavity and 100mm medium density block internally.

The flat roof over the rear portion of Units 1 & 2 will be insulated with 200mm PIR insulation. Cold roofs will be insulated with 450mm of mineral wool, sloping ceilings and low-level walls within the second floor will be insulated with at least 150mm of PIR insulation.

Windows are proposed as double glazed with Low 'e' soft coat and argon filled.

It is proposed to set maximum limits for the elemental U-values as follows:

Element	Part L Limiting U-values	Proposed U-values	Proposed Improvement
	W/m²K	W/m²K	
Ground-Floors	**0.18**	**0.11**	**39%**
External Walls	**0.26**	**0.18**	**31%**
Flat Roof	**0.16**	**0.13**	**19%**
Roofs (cold)	**0.16**	**0.10**	**38%**
Sloping Ceilings & Low-level walls to 2nd Floor	**0.16**	**0.15**	**6%**
Windows, Glazed Doors & Rooflights	**1.60**	**1.20**	**25%**
Entrance Doors	**1.60**	**1.20**	**38%**

'g' Value for Windows and Glazed Doors	**0.54**
'g' Value for Rooflights	**0.45**

Air Leakage

Large amounts of heat are lost in winter through air leakage from a building (also referred to as infiltration or air permeability) often through poor sealing of joints and openings in the building.

The Building Regulations set a minimum standard for air permeability of 8 m^3 of air per hour per m^2 of envelope area, at 50Pa. It is proposed to achieve a 50% improvement over Building Regulations and the apartments will target a permeability of 4.0 $m^3/hr/m^2$.

Thermal Bridging

The significance of Thermal Bridging, as a potentially major source of fabric heat losses, is increasingly understood. Improving the U-values for the main building fabric without accurately addressing the Thermal Bridging is no longer an option and will not achieve the fabric energy efficiency and energy and CO_2 reduction targets set out in this strategy.

The thermal details for the building will be modelled at the detailed working drawing stage but for the purposes of this assessment the thermal details formulated by the Recognised Construction Details have been used. Any details not available on the RCD website will be modelled. These will enable the building to achieve the higher energy efficiency requirements of the Building Regulations.

The following table provides the values currently used within the modelled SAP calculations.

Reference	Location	PSI Values
		W/mK
E2	Other Lintels (including other steel lintels)	0.028
E3	Sill	0.024
E4	Jamb	0.019
E5	Ground Floor	0.046
E7	Party Floor	0.036
E10	Eaves (Ceiling)	0.051
E14	Flat Roof	0.041
E16	Corner (normal)	0.037
E17	Corner (inverted)	-0.079
E18	Party Wall	0.041

Ventilation

As a result of increasing thermal efficiency and air tightness, Building Regulations Approved Document F was also revised in 2021 to address the possibility of overheating and poor air quality. The ventilation to the En-Suites and Bathrooms will be comprised of continuous extract ventilation as per System 3 criteria. This reduces the number of external penetrations required to the building envelope.

Active Design Measures will include;

Efficient Lighting and Controls

Throughout the scheme natural lighting will be optimised.

Part L of the Building Regulations requires all light fitting to have lamps with a minimum luminous efficacy of 85 light source lumens per circuit-watt.

Space Heating and Hot Water

The baseline SAP modelling has been based upon the use of a combination boiler installed to each apartment (as required by the GLA Guidance in order to test the efficiency of the building structure) but the proposed specification is based on the installation of heat pump hot water cylinders.

5.2 Establishing Carbon Dioxide Emissions (Be Lean)

The GLA Energy Assessment Guidance requires the energy efficiency of a building (Be Lean) to be tested using the building systems set out in Table 1.1 of Part L 2021.

SAP calculations have been prepared for one of the ground-floor 1-bedroom apartments and for one of the 1st and 2nd-floor duplex apartments. These are proposed as representative of all four units.

The baseline calculations are based on the fabric specification set out above but using the notional systems as required by the GLA Energy Assessment Guidance. These are not the proposed final option but are used to test the 'Be Lean' reductions only.

The TER & DER Worksheets for the 'Be Lean' scenario are attached as Appendix 1 but the emissions from the modelled apartments can be summarised as follows;

Unit Type	TER	DER
	kg CO_2/yr	kg CO_2/yr
1-Bed Ground-floor apartment	13.95	14.13
2-Bed Duplex apartment	10.78	11.60

Summary

The SAP calculations have allowed the GLA Carbon Reporting Spreadsheet to be populated.

This accompanies the planning application but from the spreadsheet the total TER emissions for the site are calculated as **3,135 kg CO_2 per year** with DER emissions of **2,725 kg CO_2 per year**.

The reduction in emissions is therefore **410 kg CO_2 per year**, which equates to a reduction of **13.08%** for the 'Be Lean' case.

The energy efficiency measures incorporated into the development therefore meet the requirements of the Guidance.

5.3 Low-Carbon and Renewable Technologies (Be Clean and Be Green)

The carbon dioxide emissions established above have been used to test the viability of various renewable and low carbon technologies as follows.

The Government's Renewable Obligation defines renewable energy in the UK. The identified technologies are;

- Small hydro-electric
- Landfill and sewage gas
- Onshore and offshore wind
- Biomass
- Tidal and wave power
- Geothermal power
- Solar

The use of landfill or sewage gas, offshore wind or any form of hydroelectric power is not suitable for the site due to its location. The remaining technologies are considered below;

Wind

Wind turbines are available in various sizes from large rotors able to supply whole communities to small roof or wall-mounted units for individual dwellings.

The Government wind speed database predicts local wind speeds at Friars Lane to be 4.8 m/s at 10m above ground level and 5.5 m/s at 25m above ground level. This is below the level generally required for commercial investment in large wind turbines. In addition the land take, potential for noise and signal interference make a large wind turbine unsuitable for this development.

Roof mounted turbines could be used at the development to generate small but valuable amounts of renewable electricity but the small output and contribution to total emissions means any investment would be small and purely tokenism. In addition the use of wind turbines will have a detrimental aesthetic impact on the appearance of the development.

Combined Heat and Power and Community Heating

Combined heat and power (CHP) also called co-generation is a de-centralised method of producing electricity from a fuel and 'capturing' the heat generated for use in buildings. The plant is essentially a small-scale electrical power station. The production and transportation of electricity via the National Grid is very inefficient with over 65% of the energy produced at the power station being lost to the atmosphere and through transportation.

CHP units are generally gas fuelled and generate electricity with heat being a by-product. The heat is usually used to meet the hot water load, which is fairly consistent throughout the year.

Historically CO_2 savings have been achieved because gas has been used to generate electricity and gas has had a lower emissions factor than electricity, However, with the de-carbonisation of the electricity grid the benefit of CHP is negated and consequently the use of a CHP would increase emissions rather than reduce them.

CHP is not proposed.

Ground Source Heat Pumps

Sub soil temperatures are reasonably constant and predictable in the UK, providing a store of the sun's energy throughout the year. Below London the groundwater in the lower London aquifer is at a fairly constant temperature of 12^{o} C. Ground source heat pumps (GSHP) extract this low-grade heat and convert it to usable heat for space heating.

GSHP operates on a similar principle to refrigerators, transferring heat from a cool place to a warmer place. They operate most efficiently when providing space heating at a low temperature, typically via under floor heating or with low temperature radiators.

The installation of ground source heat pumps to this scheme is not appropriate.

Solar

(i) Solar Water Heating

Solar hot water panels use the suns energy to directly heat water circulating through panels or pipes. The technology is simple and easily understood by purchasers.

Solar hot water heating panels are based generally around two types, which are available being 'flat plate collectors' and 'evacuated tubes'. Flat plate collectors can achieve an output of up to 1,124 kWh/annum (Schuco) and evacuated tubes can achieve outputs up to 1,365 kWh/annum (Riomay).

Panels are traditionally roof mounted and for highest efficiencies should be mounted plus or minus 30 degrees of due south. Evacuated tubes can be laid horizontally on flat roofs but flat plate collectors are recommended for installation at an incline of 30 degrees

The installation of heat pumps reduces the emissions from the hot water demand significantly and the installation of solar hot water heating panels only reduces further emissions marginally and does not represent good value when compared with only technologies.

In addition, solar hot water panels are only applicable to the duplex apartments.

They are therefore are not proposed.

(ii) Photovoltaics

Photovoltaic panels (PV) provide clean silent electricity. They generate electricity during most daylight conditions although they are most efficient when exposed to direct sunlight or are orientated to face plus or minus 30 degrees of due south.

PV panels can be integrated into many different aspects of a development including roofs, walls, shading devices or architectural panels. The panels typically have an electrical warranty of 20-25 years and an expected system lifespan of 25-40 years.

The Roof Plan & Elevation attached as Appendix 3 demonstrate a total of 22 panels could be installed. These will be very gently inclined at around 10 degrees to allow for self-cleaning on racks and orientated towards the southeast. Assuming the installation of 400W panels the total reduction in emissions from the array will be **731 kg CO_2 per year**. This reduction has been incorporated into the Be Green SAP calculations.

Air Source Heat Pumps (ASHP)

Air sourced heat pumps operate using the same reverse refrigeration cycle as ground source heat pumps; however, the initial heat energy is extracted from the external air rather than the ground.

The installation of heat pump hot water cylinders is appropriate and the analysis set out in 5.4 below considers the use of this technology.

5.4 Establishing Carbon Dioxide Emissions (Be Green)

SAP calculations have been prepared for the modelled apartments based on the fabric specification set out above but with the actual systems proposed for installation.

These include the installation of a heat pump hot water cylinder to each unit and the installation of 22 x 400W photovoltaic panels on the southwest orientated rear roof of the building.

The DER Worksheets for the 'Be Green' scenario are attached as Appendix 2 but the emissions from the apartments can be summarised as follows;

Unit Type	DER
	kg CO_2/yr
1-Bed Ground-floor apartment	4.38
2-Bed Duplex apartment	2.97

Summary

These emissions have been inputted into the GLA Carbon Emissions Reporting Spreadsheet and from these the total DER emissions for the Be Green scenario are calculated as **923 kg CO_2 per year**.

The reduction in emissions is therefore **2,212 kg CO_2 per year**, which equates to a reduction of **70.56%** for the 'Be Green' case.

5.5 Summary of Calculations

Be Lean

SAP calculations have been prepared using Part L 2021 of the Building Regulations.

Based on the Be Lean scenario the total CO_2 emissions are calculated as **3,135 kg CO_2 per year** (TER) and **2,725 kg CO_2 per year** (DER)**.**

This equates to a reduction of **410 kg CO_2 per year** or **13.08%** of the total TER emissions and is therefore compliant with the GLA energy guidance.

The TER & DER Worksheets for the modelled apartments for the Be Lean scenario are attached as Appendix 1.

Be Green

A further set of calculations has been prepared for the proposed energy strategy.

These propose the installation of a heat pump hot water cylinder into each apartment as well as a total of 22 x 400W photovoltaic panels installed on the southwest orientated rear roof of the building.

A Roof Plan & Elevation showing the indicative layout of the panels is attached as Appendix 3.

Based on the Be Green scenario the total CO_2 emissions are calculated as **923 kg CO_2 per year** (DER)**.**

This equates to a reduction of **2,212 kg CO_2 per year** or **70.56%** of the total TER emissions.

The DER Worksheets for the modelled apartments for the Be Green scenario are attached as Appendix 2.

<u>Summary</u>

The GLA Carbon Emissions Reporting Spreadsheet has been completed and (separately) accompanies this Statement

The residual emissions are **0.923 tonnes**, which requires a carbon offset payment of **£2,631** (based on the carbon offset payment of £2,850 per tonne).

6.0 Climate change adaption and Water resources

Sustainable Drainage Systems (SUDS)

The site lies within Flood Zone 1 and is classified as being of low risk.

Surface Water Management

Consideration has been given to the use of grey water recycling. However, customer's resistance to the appearance of the recycled water and the cost of the systems does not currently make them a viable option. They have therefore not been included in the proposals.

Water efficiency measures

In excess of 20% of the UK's water is used domestically with over 50% of this used for flushing WCs and washing (source: Environment Agency). The majority of this comes from drinking quality standard or potable water.

The water efficiency measures included will ensure that the water use target of 110 litres per person per day is achieved.

Water efficient devices will be fully evaluated, and installed, wherever possible. The specification of such devices will be considered at detailed design stage and each will be subject to an evaluation based on technical performance, cost and market appeal, together with compliance with the water use regulations.

The following devices will be incorporated within the apartments:

- water efficient taps
- water efficient toilets
- low output showers
- flow restrictors to manage water pressures to achieve optimum levels and
- water meters

Water consumption calculations have been carried out using the Water Efficiency Calculator provided by the BRE. Although not perfect this calculator gives a good indication of the probable water use in a dwelling, although this is largely dependent on the way on which occupants use their homes.

Below is a typical specification, which would achieve the 110 Litres per person per day target (including five litres per person per day allowance for external water use).

Schedule of Appliance Water Consumption		
Appliance	Flow rate or capacity	Total Litres
WC	6/3 litres dual flush	17.64
Basin	2.0 litres/min.	4.74
Shower	9.0 litres/min	39.33
Bath	175 litres	19.25
Sink	5.0 litres/min	12.56
Washing Machine	6.75 litres/kg	14.18
Dishwasher	1.25 litres/places	4.50
		112.20
	Normalisation Factor	0.91
	Total Internal Water Consumption	102.10
	External Water Use	5.00
	Total Water Consumption	107.10

7.0 Materials and Waste

The BRE Green Guide to Specification is a simple guide for design professionals. The guide provides environmental impact, cost and replacement interval information for a wide range of commonly used building specifications over a notional 60-year building life. The construction specification will prioritise materials within ratings A+, A or B.

Preference will be given to the use of local materials & suppliers where viable to reduce the transport distances and to support the local economy. A full evaluation of these suppliers will be undertaken at the next stage of design.

In addition, timber would be sourced, where practical, certified by PEFC or an equivalent approved certification body and all site timber used within the construction process would be recycled.

All insulation materials to will have a zero ozone depleting potential

Construction waste

Targets will be set to promote resource efficiency in accordance with guidance from WRAP, Envirowise, BRE and DEFRA.

The overarching principle of waste management is that waste should be treated or disposed of within the region where it is produced.

Construction operations generate waste materials as a result of general handling losses and surpluses. These wastes can be reduced through appropriate selection of the construction method, good site management practices and spotting opportunities to avoid creating unnecessary waste.

The Construction Strategy will explore these issues, some of which are set out below:

- Proper handling and storage of all materials to avoid damage.
- Efficient purchasing arrangements to minimise over ordering.
- Segregation of construction waste to maximise potential for reuse/recycling.
- Suppliers who collect and reuse/recycle packaging materials.

Appendix 1 – TER & DER Worksheets for the Modelled Apartments for the Be Lean scenario

Full SAP Calculation Printout

elmhurst energy

Property Reference	Friars Lane 1BF GND 55 - Lean	Issued on Date	01/03/2024
Assessment Reference	Friars Lane 1BF GND 55 Lean	Prop Type Ref	Friars Lane 1BF GND 55 - Lean
Property	Hunters Lodge, Friars Lane, Richmond, London, TW9 1NX		

SAP Rating	85 B	DER	14.13	TER	13.95
Environmental	90 B	% DER < TER			-1.29
CO_2 Emissions (t/year)	0.69	DFEE	29.10	TFEE	34.02
Compliance Check	See BREL	% DFEE < TFEE			14.47
% DPER < TPER	-7.32	DPER	79.05	TPER	73.66

Assessor Details	Mr. Ivan Ball	Assessor ID	X001-7283
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	55.4000 (1b)	x	2.4500 (2b)	=	135.7300	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 55.4000						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	135.7300	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	1 * 10 =	10.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	10.0000 / (5) =	0.0737	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.2737	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2121	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.2704	0.2651	0.2598	0.2333	0.2280	0.2015	0.2015	0.1962	0.2121	0.2280	0.2386	0.2492	(22b)
Effective ac	0.5366	0.5351	0.5338	0.5272	0.5260	0.5203	0.5203	0.5192	0.5225	0.5260	0.5285	0.5311	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Glazed Door/ Window (Uw = 1.20)			15.2900	1.1450	17.5076			(27)
Heatloss Floor 1			55.4000	0.1100	6.0940			(28b)
External Wall 1	53.7800	15.2900	38.4900	0.1500	5.7735			(29a)
Flat Roof	6.8500		6.8500	0.1300	0.8905			(30)
Total net area of external elements Aum(A, m2)			116.0300					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		30.2656			(33)
Party Wall			29.8800	0.0000	0.0000			(32)
Party Ceiling			48.5500					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	9.4000	0.0280	0.2632
E3 Sill	6.7000	0.0240	0.1608
E4 Jamb	22.4000	0.0190	0.4256
E16 Corner (normal)	7.3500	0.0370	0.2719
E18 Party wall between dwellings	4.9000	0.0410	0.2009
E5 Ground floor (normal)	21.9500	0.0460	1.0097
E14 Flat roof	5.5400	0.0410	0.2271
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0790	-0.1936

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 2.3657 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 32.6314 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	24.0332	23.9696	23.9073	23.6145	23.5597	23.3047	23.3047	23.2575	23.4029	23.5597	23.6705	23.7864	(38)
Heat transfer coeff	56.6646	56.6010	56.5387	56.2459	56.1911	55.9361	55.9361	55.8888	56.0343	56.1911	56.3019	56.4178	(39)
Average = Sum(39)m / 12 =												56.2456	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0228	1.0217	1.0206	1.0153	1.0143	1.0097	1.0097	1.0088	1.0114	1.0143	1.0163	1.0184	(40)
HLP (average)												1.0153	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

---

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.8491 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	63.6272	62.6822	61.3515	58.8980	57.0608	55.0236	53.9232	55.2446	56.6834	58.8632	61.3673	63.4121	(42b)
Hot water usage for other uses	33.5663	32.3457	31.1251	29.9045	28.6840	27.4634	27.4634	28.6840	29.9045	31.1251	32.3457	33.5663	(42c)
Average daily hot water use (litres/day)												89.5072	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	97.1935	95.0279	92.4767	88.8025	85.7447	82.4870	81.3866	83.9286	86.5879	89.9883	93.7130	96.9784	(44)
Energy conte	153.9307	135.3185	142.1332	121.5662	115.4289	101.4273	98.4300	103.9211	106.7716	122.1133	133.5114	151.8447	(45)
Energy content (annual)										Total = Sum(45)m =		1486.3969	
Distribution loss (46)m = 0.15 x (45)m	23.0896	20.2978	21.3200	18.2349	17.3143	15.2141	14.7645	15.5882	16.0157	18.3170	20.0267	22.7767	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	49.5287	43.7389	47.1251	43.7930	43.6946	40.6785	41.4737	42.7691	42.7009	45.8571	46.2146	49.4191	(61)
Total heat required for water heating calculated for each month	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(64)

Total per year (kWh/year) = Sum(64)m = 2023.3902 (64)
12Total per year (kWh/year) 2023 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	63.5641	55.9281	59.0406	51.3690	49.3037	43.8942	43.0964	45.2460	46.1768	52.0669	55.9462	62.8431	(65)

---

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	81.3149	90.0272	81.3149	84.0254	81.3149	84.0254	81.3149	81.3149	84.0254	81.3149	84.0254	81.3149	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	161.2159	162.8888	158.6731	149.6984	138.3694	127.7218	120.6085	118.9356	123.1513	132.1260	143.4550	154.1026	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	(71)
Water heating gains (Table 5)	85.4357	83.2264	79.3556	71.3458	66.2685	60.9642	57.9253	60.8146	64.1344	69.9825	77.7030	84.4666	(72)
Total internal gains	381.7025	389.8784	373.0796	358.8057	339.6888	323.4474	310.5847	311.8011	322.0471	337.1594	358.9194	373.6201	(73)

---

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	5.5700	11.2829	0.5400	0.7000	0.7700	16.4628	(75)
Southeast	5.9400	36.7938	0.5400	0.7000	0.7700	57.2515	(77)
Southwest	3.7800	36.7938	0.5400	0.7000	0.7700	36.4327	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	110.1470	193.0893	278.7178	369.6905	436.3057	442.9251	422.9593	371.7671	309.9870	217.3210	132.9265	93.6185	(83)
Total gains	491.8494	582.9677	651.7974	728.4962	775.9945	766.3725	733.5441	683.5682	632.0341	554.4804	491.8459	467.2386	(84)

---

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	67.8946	67.9709	68.0459	68.4001	68.4668	68.7789	68.7789	68.8370	68.6583	68.4668	68.3320	68.1917
alpha	5.5263	5.5314	5.5364	5.5600	5.5645	5.5853	5.5853	5.5891	5.5772	5.5645	5.5555	5.5461

util living area

	0.9869	0.9678	0.9259	0.8173	0.6471	0.4636	0.3350	0.3751	0.5958	0.8690	0.9704	0.9899	(86)
MIT	20.0870	20.3124	20.5713	20.8310	20.9595	20.9946	20.9993	20.9987	20.9800	20.7966	20.3945	20.0379	(87)
Th 2	20.0644	20.0653	20.0662	20.0706	20.0715	20.0753	20.0753	20.0760	20.0738	20.0715	20.0698	20.0681	(88)
util rest of house	0.9830	0.9590	0.9069	0.7786	0.5909	0.3982	0.2649	0.3003	0.5223	0.8298	0.9607	0.9868	(89)
MIT 2	19.0228	19.3043	19.6189	19.9151	20.0412	20.0725	20.0751	20.0755	20.0620	19.8878	19.4140	18.9636	(90)
Living area fraction									fLA = Living area / (4) =			0.5235	(91)
MIT	19.5799	19.8320	20.1174	20.3946	20.5219	20.5552	20.5589	20.5588	20.5426	20.3635	19.9273	19.5259	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.4299	19.6820	19.9674	20.2446	20.3719	20.4052	20.4089	20.4088	20.3926	20.2135	19.7773	19.3759	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9797	0.9546	0.9046	0.7863	0.6095	0.4217	0.2902	0.3273	0.5482	0.8364	0.9570	0.9839	(94)
Useful gains	481.8568	556.5097	589.5987	572.8141	472.9967	323.1664	212.9006	223.7494	346.4518	463.7593	470.6824	459.7159	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	857.3296	836.6762	761.4310	638.0846	487.2827	324.7179	213.0522	224.0449	352.5990	540.1944	713.7542	856.1930	(97)
Space heating kWh	279.3517	188.2719	127.8432	46.9947	10.6288	0.0000	0.0000	0.0000	0.0000	56.8678	175.0117	294.9790	(98a)
Space heating requirement - total per year (kWh/year)												1179.9488	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	279.3517	188.2719	127.8432	46.9947	10.6288	0.0000	0.0000	0.0000	0.0000	56.8678	175.0117	294.9790	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1179.9488	
Space heating per m2										(98c) / (4) =		21.2987	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	89.5000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	279.3517	188.2719	127.8432	46.9947	10.6288	0.0000	0.0000	0.0000	0.0000	56.8678	175.0117	294.9790	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	312.1248	210.3596	142.8416	52.5081	11.8757	0.0000	0.0000	0.0000	0.0000	63.5394	195.5438	329.5855	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month	227.3290	200.0641	211.4617	184.7589	177.7915	158.7775	156.3170	163.8996	167.0083	187.6764	200.8112	224.8758	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	16.5503	13.2773	11.9547	8.7585	6.7653	5.5273	6.1716	8.0220	10.4198	13.6714	15.4418	17.0103	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1318.3785	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	89.5000	
Water heating fuel used	2260.7712	(219)
Space cooling fuel	0.0000	(221)

Electricity for pumps and fans:

central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	133.5703	(232)

Energy saving/generation technologies (Appendices M ,N and Q)

PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3798.7200	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1318.3785	0.2100	276.8595	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2260.7712	0.2100	474.7619	(264)
Space and water heating			751.6214	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	133.5703	0.1443	19.2783	(268)
Total CO2, kg/year			782.8290	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			14.1300	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1318.3785	1.1300	1489.7677	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2260.7712	1.1300	2554.6714	(278)
Space and water heating			4044.4391	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	133.5703	1.5338	204.8746	(282)
Total Primary energy kWh/year			4379.4145	(286)
Dwelling Primary energy Rate (DPER)			79.0500	(287)

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

1. Overall dwelling characteristics

	Area (m2)			Storey height (m)			Volume (m3)	
Ground floor	55.4000	(1b)	x	2.4500	(2b)	=	135.7300	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 55.4000								(4)
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	135.7300	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	2 * 10 =	20.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1474	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3974	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3079	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3926	0.3849	0.3772	0.3387	0.3310	0.2925	0.2925	0.2849	0.3079	0.3310	0.3464	0.3618	(22b)
Effective ac	0.5771	0.5741	0.5712	0.5574	0.5548	0.5428	0.5428	0.5406	0.5474	0.5548	0.5600	0.5655	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			13.8400	1.1450	15.8473			(27)
Heatloss Floor 1			55.4000	0.1300	7.2020			(28b)
External Wall 1	53.7800	13.8400	39.9400	0.1800	7.1892			(29a)
Flat Roof	6.8500		6.8500	0.1100	0.7535			(30)
Total net area of external elements Aum(A, m2)			116.0300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	30.9920			(33)
Party Wall			29.8800	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	9.4000	0.0500	0.4700
E3 Sill	6.7000	0.0500	0.3350

E4 Jamb	22.4000	0.0500	1.1200
E16 Corner (normal)	7.3500	0.0900	0.6615
E18 Party wall between dwellings	4.9000	0.0600	0.2940
E5 Ground floor (normal)	21.9500	0.1600	3.5120
E14 Flat roof	5.5400	0.0800	0.4432
E17 Corner (inverted – internal area greater than external area)	2.4500	-0.0900	-0.2205

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 6.6152 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 37.6072 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	25.8479	25.7139	25.5825	24.9652	24.8498	24.3122	24.3122	24.2126	24.5192	24.8498	25.0834	25.3276	(38)
Heat transfer coeff	63.4552	63.3211	63.1897	62.5725	62.4570	61.9194	61.9194	61.8199	62.1265	62.4570	62.6906	62.9348	(39)
Average = Sum(39)m / 12 =												62.5719	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1454	1.1430	1.1406	1.1295	1.1274	1.1177	1.1177	1.1159	1.1214	1.1274	1.1316	1.1360	(40)
HLP (average)												1.1295	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.8491 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	63.6272	62.6822	61.3515	58.8980	57.0608	55.0236	53.9232	55.2446	56.6834	58.8632	61.3673	63.4121	(42b)
Hot water usage for other uses	33.5663	32.3457	31.1251	29.9045	28.6840	27.4634	27.4634	28.6840	29.9045	31.1251	32.3457	33.5663	(42c)
Average daily hot water use (litres/day)												89.5072	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	97.1935	95.0279	92.4767	88.8025	85.7447	82.4870	81.3866	83.9286	86.5879	89.9883	93.7130	96.9784	(44)
Energy conte	153.9307	135.3185	142.1332	121.5662	115.4289	101.4273	98.4300	103.9211	106.7716	122.1133	133.5114	151.8447	(45)
Energy content (annual)										Total = Sum(45)m =		1486.3969	
Distribution loss (46)m = 0.15 x (45)m	23.0896	20.2978	21.3200	18.2349	17.3143	15.2141	14.7645	15.5882	16.0157	18.3170	20.0267	22.7767	(46)
Water storage loss: Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	49.5287	43.7389	47.1251	43.7930	43.6946	40.6785	41.4737	42.7691	42.7009	45.8571	46.2146	49.4191	(61)
Total heat required for water heating calculated for each month	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(64)

Total per year (kWh/year) = Sum(64)m = 2023.3902 (64)
12Total per year (kWh/year) 2023 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	63.5641	55.9281	59.0406	51.3690	49.3037	43.8942	43.0964	45.2460	46.1768	52.0669	55.9462	62.8431	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	81.3149	90.0272	81.3149	84.0254	81.3149	84.0254	81.3149	81.3149	84.0254	81.3149	84.0254	81.3149	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	161.2159	162.8888	158.6731	149.6984	138.3694	127.7218	120.6085	118.9356	123.1513	132.1260	143.4550	154.1026	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	(71)
Water heating gains (Table 5)	85.4357	83.2264	79.3556	71.3458	66.2685	60.9642	57.9253	60.8146	64.1344	69.9825	77.7030	84.4666	(72)
Total internal gains	381.7025	389.8784	373.0796	358.8057	339.6888	323.4474	310.5847	311.8011	322.0471	337.1594	358.9194	373.6201	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	5.0400	11.2829	0.6300	0.7000	0.7700	17.3790	(75)
Southeast	5.3800	36.7938	0.6300	0.7000	0.7700	60.4963	(77)
Southwest	3.4200	36.7938	0.6300	0.7000	0.7700	38.4568	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	116.3321	203.9292	294.3579	390.4243	460.7660	467.7525	446.6693	392.6137	327.3780	229.5194	140.3903	98.8758	(83)
Total gains	498.0346	593.8076	667.4375	749.2300	800.4549	791.1999	757.2540	704.4148	649.4251	566.6788	499.3097	472.4959	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.6290	60.7573	60.8837	61.4843	61.5979	62.1327	62.1327	62.2328	61.9256	61.5979	61.3684	61.1302	
alpha	5.0419	5.0505	5.0589	5.0990	5.1065	5.1422	5.1422	5.1489	5.1284	5.1065	5.0912	5.0753	
util living area	0.9881	0.9717	0.9359	0.8404	0.6806	0.4936	0.3586	0.4014	0.6312	0.8876	0.9741	0.9907	(86)
MIT	19.9008	20.1427	20.4349	20.7524	20.9299	20.9888	20.9982	20.9969	20.9635	20.7152	20.2525	19.8570	(87)
Th 2	19.9639	19.9659	19.9678	19.9768	19.9785	19.9864	19.9864	19.9879	19.9834	19.9785	19.9751	19.9715	(88)
util rest of house	0.9845	0.9635	0.9181	0.8018	0.6196	0.4187	0.2766	0.3143	0.5495	0.8498	0.9651	0.9878	(89)
MIT 2	18.7123	19.0165	19.3753	19.7467	19.9259	19.9807	19.9859	19.9869	19.9618	19.7187	19.1647	18.6625	(90)
Living area fraction									fLA = Living area / (4) =			0.5235	(91)
MIT	19.3345	19.6061	19.9299	20.2732	20.4515	20.5084	20.5158	20.5156	20.4861	20.2404	19.7341	19.2878	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3345	19.6061	19.9299	20.2732	20.4515	20.5084	20.5158	20.5156	20.4861	20.2404	19.7341	19.2878	(93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9816	0.9600	0.9174	0.8138	0.6486	0.4576	0.3196	0.3600	0.5910	0.8605	0.9625	0.9852	(94)
Useful gains	488.8729	570.0717	612.2873	609.7187	519.2132	362.0884	241.9931	253.5653	383.7848	487.6321	480.5650	465.5246	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	954.0137	931.2039	848.6327	711.6466	546.5897	365.8469	242.4654	254.4255	396.7488	602.1080	792.0404	949.5458	(97)
Space heating kWh	346.0648	242.6808	175.8409	73.3881	20.3681	0.0000	0.0000	0.0000	0.0000	85.1701	224.2623	360.1118	(98a)
Space heating requirement - total per year (kWh/year)												1527.8870	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	346.0648	242.6808	175.8409	73.3881	20.3681	0.0000	0.0000	0.0000	0.0000	85.1701	224.2623	360.1118	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1527.8870	
Space heating per m2										(98c) / (4) =		27.5792	(99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	346.0648	242.6808	175.8409	73.3881	20.3681	0.0000	0.0000	0.0000	0.0000	85.1701	224.2623	360.1118	(98)
Space heating efficiency (main heating system 1)	92.4000	92.4000	92.4000	92.4000	92.4000	0.0000	0.0000	0.0000	0.0000	92.4000	92.4000	92.4000	(210)
Space heating fuel (main heating system)	374.5290	262.6416	190.3040	79.4244	22.0434	0.0000	0.0000	0.0000	0.0000	92.1754	242.7082	389.7314	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	203.4595	179.0574	189.2583	165.3592	159.1234	142.1059	139.9038	146.6902	149.4724	167.9704	179.7260	201.2638	(64)
Efficiency of water heater												80.3000	(216)
(217)m	85.5093	85.0335	84.2241	82.7610	81.1913	80.3000	80.3000	80.3000	80.3000	83.0015	84.8569	85.6127	(217)
Fuel for water heating, kWh/month	237.9383	210.5729	224.7079	199.8033	195.9859	176.9687	174.2263	182.6777	186.1425	202.3703	211.7989	235.0863	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	16.8956	13.5543	12.2041	8.9413	6.9065	5.6427	6.3003	8.1894	10.6372	13.9566	15.7640	17.3652	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-19.0075	-27.7491	-41.2986	-48.1504	-53.4357	-50.4560	-49.8619	-46.3336	-40.3472	-32.5112	-21.2404	-16.3256	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	-8.0313	-17.1442	-34.5328	-52.5304	-70.0942	-70.6361	-69.7815	-58.7746	-42.6898	-24.7111	-10.7874	-6.3308	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1653.5573	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	80.3000	
Water heating fuel used	2438.2790	(219)
Space cooling fuel	0.0000	(221)

Electricity for pumps and fans:

Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	136.3574	(232)

Energy saving/generation technologies (Appendices M ,N and Q)

PV generation	-912.7613	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)

Energy used		0.0000 (237)
Total delivered energy for all uses		3401.4324 (238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1653.5573	0.2100	347.2470	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2438.2790	0.2100	512.0386	(264)
Space and water heating			859.2856	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	136.3574	0.1443	19.6806	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-446.7171	0.1338	-59.7868	
PV Unit electricity exported	-466.0441	0.1255	-58.5037	
Total			-118.2905	(269)
Total CO2, kg/year			772.6050	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			13.9500	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1653.5573	1.1300	1868.5198	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2438.2790	1.1300	2755.2552	(278)
Space and water heating			4623.7750	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	136.3574	1.5338	209.1495	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-446.7171	1.4946	-667.6599	
PV Unit electricity exported	-466.0441	0.4608	-214.7411	
Total			-882.4010	(283)
Total Primary energy kWh/year			4080.6243	(286)
Target Primary Energy Rate (TPER)			73.6600	(287)

Full SAP Calculation Printout

Property Reference	Friars Lane 2BF DUP 74 - Lean	Issued on Date	01/03/2024
Assessment Reference	Friars Lane 2BF DUP 74 Lean	Prop Type Ref	Friars Lane 2BF DUP 74 - Lean
Property	Hunters Lodge, Friars Lane, Richmond, London, TW9 1NX		

SAP Rating	87 B	DER	11.60	TER	10.78
Environmental	91 B	% DER < TER			-7.61
CO_2 Emissions (t/year)	0.75	DFEE	23.14	TFEE	26.28
Compliance Check	See BREL	% DFEE < TFEE			11.92
% DPER < TPER	-15.26	DPER	65.05	TPER	56.44

Assessor Details	Mr. Ivan Ball	Assessor ID	X001-7283
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		40.8900 (1b)	x	2.4500 (2b)	=	100.1805 (1b) - (3b)	
First floor		32.8800 (1c)	x	1.8000 (2c)	=	59.1840 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	73.7700					(4)	
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	159.3645 (5)	

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	2 * 10 =	20.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1255	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.3255	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2523	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3216	0.3153	0.3090	0.2775	0.2712	0.2396	0.2396	0.2333	0.2523	0.2712	0.2838	0.2964	(22b)
Effective ac	0.5517	0.5497	0.5477	0.5385	0.5368	0.5287	0.5287	0.5272	0.5318	0.5368	0.5403	0.5439	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Glazed Door/ Window (Uw = 1.20)			13.0600	1.1450	14.9542			(27)
Bedroom 1			0.9600	1.1450	1.0992			(27a)
Landing			0.9600	1.1450	1.0992			(27a)
Bedroom 1 & Landing			1.4400	1.1450	1.6489			(27a)
External Wall 1	47.0400	13.0600	33.9800	0.1500	5.0970			(29a)
External Wall 2	16.4700		16.4700	0.1500	2.4705			(29a)
Cold Roof	18.1100		18.1100	0.1000	1.8110			(30)
Sloping Ceiling	30.6600	3.3600	27.3000	0.1500	4.0950			(30)
Total net area of external elements Aum(A, m2)			112.2800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	32.2750			(33)
Party Wall			29.2500	0.0000	0.0000			(32)
Party Floor 1			40.8900					(32d)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	8.4000	0.0280	0.2352
E3 Sill	8.4000	0.0240	0.2016
E4 Jamb	14.4000	0.0190	0.2736

```
        E16 Corner (normal)                                                                        7.3500          0.0370          0.2719
        E18 Party wall between dwellings                                                           6.7000          0.0410          0.2747
        E17 Corner (inverted - internal area greater than external area)                           2.4500         -0.0790         -0.1936
        E7 Party floor between dwellings (in blocks of flats)                                     19.2000          0.0360          0.6912
        R1 Head of roof window                                                                     4.2000          0.0280          0.1176
        R2 Sill of roof window                                                                     4.2000          0.0240          0.1008
        R3 Jamb of roof window                                                                    11.2000          0.0190          0.2128
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                                                   2.1859 (36)
Point Thermal bridges                                                                                                        (36a) =      0.0000
Total fabric heat loss                                                                                      (33) + (36) + (36a) =        34.4609 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m        29.0153    28.9097    28.8062    28.3198    28.2289    27.8053    27.8053    27.7269    27.9685    28.2289    28.4129    28.6054 (38)
Heat transfer coeff
             63.4762    63.3706    63.2671    62.7808    62.6898    62.2662    62.2662    62.1878    62.4294    62.6898    62.8739    63.0663 (39)
Average = Sum(39)m / 12 =                                                                                                            62.7803

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP           0.8605     0.8590     0.8576     0.8510     0.8498     0.8441     0.8441     0.8430     0.8463     0.8498     0.8523     0.8549 (40)
HLP (average)                                                                                                                         0.8510
Days in mont      31         28         31         30         31         30         31         31         30         31         30         31
```

```
-----------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                     2.3341 (42)
Hot water usage for mixer showers
              0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
             73.0422    71.9574    70.4298    67.6132    65.5041    63.1655    61.9023    63.4192    65.0709    67.5733    70.4479    72.7952 (42b)
Hot water usage for other uses
             38.5332    37.1320    35.7308    34.3296    32.9284    31.5271    31.5271    32.9284    34.3296    35.7308    37.1320    38.5332 (42c)
Average daily hot water use (litres/day)                                                                                            102.7518 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
            111.5753   109.0894   106.1606   101.9427    98.4325    94.6927    93.4295    96.3476    99.4004   103.3040   107.5799   111.3284 (44)
Energy conte 176.7081  155.3418   163.1648   139.5545   132.5090   116.4357   112.9949   119.2985   122.5707   140.1826   153.2672   174.3134 (45)
Energy content (annual)                                                                                  Total = Sum(45)m =      1706.3412
Distribution loss  (46)m = 0.15 x (45)m
             26.5062    23.3013    24.4747    20.9332    19.8764    17.4654    16.9492    17.8948    18.3856    21.0274    22.9901    26.1470 (46)
Water storage loss:
Total storage loss
              0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (56)
If cylinder contains dedicated solar storage
              0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (57)
Primary loss  0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (59)
Combi loss   50.9589    46.0274    50.9589    49.3151    50.1601    46.6978    47.6106    49.0977    49.0194    50.9589    49.3151    50.9589 (61)
Total heat required for water heating calculated for each month
            227.6670   201.3692   214.1237   188.8696   182.6692   163.1335   160.6055   168.3961   171.5901   191.1415   202.5823   225.2723 (62)
WWHRS         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63a)
PV diverter   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63b)
Solar input   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63c)
FGHRS         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63d)
Output from w/h
            227.6670   201.3692   214.1237   188.8696   182.6692   163.1335   160.6055   168.3961   171.5901   191.1415   202.5823   225.2723 (64)
                                                                                   Total per year (kWh/year) = Sum(64)m =      2297.4199 (64)
12Total per year (kWh/year)                                                                                                         2297 (64)
Electric shower(s)
              0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (64a)
                                                   Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =      0.0000 (64a)
Heat gains from water heating, kWh/month
             71.4952    63.1580    66.9920    58.7306    56.5993    50.3893    49.4735    51.9412    53.0096    59.3504    63.2901    70.6989 (65)
```

```
-----------------------------------------------------------------------------------------
5. Internal gains (see Table 5 and 5a)
-----------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m       116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034   116.7034 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
            103.8688   114.9976   103.8688   107.3310   103.8688   107.3310   103.8688   103.8688   107.3310   103.8688   107.3310   103.8688 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
            205.9314   208.0684   202.6834   191.2194   176.7482   163.1473   154.0610   151.9241   157.3091   168.7731   183.2443   196.8452 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
             34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703    34.6703 (69)
Pumps, fans   3.0000     3.0000     3.0000     3.0000     3.0000     0.0000     0.0000     0.0000     0.0000     3.0000     3.0000     3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
            -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627   -93.3627 (71)
Water heating gains (Table 5)
             96.0956    93.9851    90.0430    81.5703    76.0743    69.9852    66.4966    69.8134    73.6245    79.7721    87.9029    95.0254 (72)
Total internal gains
            466.9068   478.0620   457.6062   441.1318   417.7022   398.4745   382.4374   383.6173   396.2756   413.4249   439.4893   456.7504 (73)
```

```
-----------------------------------------------------------------------------------------
6. Solar gains
-----------------------------------------------------------------------------------------

[Jan]                                      Area         Solar flux             g               FF           Access             Gains
                                             m2           Table 6a   Specific data   Specific data           factor                 W
                                                              W/m2     or Table 6b     or Table 6c         Table 6d
-----------------------------------------------------------------------------------------
Northeast                                4.7300            11.2829          0.5400          0.7000           0.7700           13.9800 (75)
Southwest                                6.5100            36.7938          0.5400          0.7000           0.7700           62.7453 (79)
Northwest                                1.8200            11.2829          0.5400          0.7000           0.7700            5.3792 (81)
Northeast                                0.9600            26.0000          0.4500          0.7000           1.0000            7.0762 (82)
Southwest                                1.4400            26.0000          0.4500          0.7000           1.0000           10.6142 (82)
Northwest                                0.9600            26.0000          0.4500          0.7000           1.0000            7.0762 (82)
-----------------------------------------------------------------------------------------

Solar gains 106.8711   197.7230   308.6791   440.6757   542.5743   559.0880   530.5970   452.1843   354.3985   229.1500   130.9478    89.5104 (83)
Total gains 573.7779   675.7850   766.2853   881.8075   960.2765   957.5625   913.0344   835.8016   750.6741   642.5750   570.4371   546.2608 (84)
```

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	80.7060	80.8406	80.9729	81.6001	81.7185	82.2744	82.2744	82.3782	82.0594	81.7185	81.4793	81.2307	
alpha	6.3804	6.3894	6.3982	6.4400	6.4479	6.4850	6.4850	6.4919	6.4706	6.4479	6.4320	6.4154	
util living area	0.9908	0.9745	0.9292	0.7933	0.5973	0.4153	0.3000	0.3420	0.5670	0.8719	0.9767	0.9930	(86)
MIT	20.2459	20.4450	20.6849	20.9076	20.9855	20.9988	20.9999	20.9997	20.9921	20.8591	20.5132	20.2060	(87)
Th 2	20.2012	20.2025	20.2037	20.2093	20.2104	20.2153	20.2153	20.2162	20.2134	20.2104	20.2082	20.2060	(88)
util rest of house	0.9881	0.9676	0.9120	0.7566	0.5499	0.3648	0.2465	0.2839	0.5053	0.8363	0.9691	0.9910	(89)
MIT 2	19.3304	19.5806	19.8725	20.1249	20.1997	20.2147	20.2153	20.2161	20.2087	20.0820	19.6733	19.2836	(90)
Living area fraction									fLA = Living area / (4) =			0.3728	(91)
MIT	19.6717	19.9028	20.1753	20.4167	20.4926	20.5070	20.5078	20.5082	20.5008	20.3717	19.9864	19.6274	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.5217	19.7528	20.0253	20.2667	20.3426	20.3570	20.3578	20.3582	20.3508	20.2217	19.8364	19.4774	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9851	0.9628	0.9076	0.7594	0.5580	0.3740	0.2562	0.2944	0.5162	0.8368	0.9647	0.9885	(94)
Useful gains	565.2126	650.6659	695.4683	669.6798	535.8258	358.0815	233.9560	246.0920	387.4926	537.7325	550.3003	539.9602	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	966.2140	941.2312	855.7077	713.6104	541.8048	358.4651	233.9815	246.1541	390.2310	603.1793	800.7866	963.4906	(97)
Space heating kWh	298.3450	195.2598	119.2181	31.6300	4.4483	0.0000	0.0000	0.0000	0.0000	48.6924	180.3501	315.1066	(98a)
Space heating requirement - total per year (kWh/year)												1193.0505	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	298.3450	195.2598	119.2181	31.6300	4.4483	0.0000	0.0000	0.0000	0.0000	48.6924	180.3501	315.1066	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1193.0505	
Space heating per m2										(98c) / (4) =		16.1726	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	89.5000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	298.3450	195.2598	119.2181	31.6300	4.4483	0.0000	0.0000	0.0000	0.0000	48.6924	180.3501	315.1066	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	333.3464	218.1674	133.2046	35.3408	4.9702	0.0000	0.0000	0.0000	0.0000	54.4050	201.5085	352.0744	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	227.6670	201.3692	214.1237	188.8696	182.6692	163.1335	160.6055	168.3961	171.5901	191.1415	202.5823	225.2723	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month	254.3765	224.9935	239.2444	211.0275	204.0996	182.2720	179.4475	188.1521	191.7208	213.5659	226.3489	251.7009	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	21.1408	16.9599	15.2705	11.1878	8.6418	7.0604	7.8833	10.2471	13.3099	17.4633	19.7248	21.7283	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1333.0173	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	89.5000	
Water heating fuel used	2566.9496	(219)
Space cooling fuel	0.0000	(221)

Electricity for pumps and fans:

central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	170.6180	(232)

Energy saving/generation technologies (Appendices M ,N and Q)

```
PV generation                                                                                               0.0000 (233)
Wind generation                                                                                             0.0000 (234)
Hydro-electric generation (Appendix N)                                                                      0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                              0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                  -0.0000 (236)
Energy used                                                                                                 0.0000 (237)
Total delivered energy for all uses                                                                      4156.5849 (238)


----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                   Energy      Emission factor          Emissions
                                                                 kWh/year          kg CO2/kWh         kg CO2/year
Space heating - main system 1                                   1333.0173              0.2100            279.9336 (261)
Total CO2 associated with community systems                                                                0.0000 (373)
Water heating (other fuel)                                      2566.9496              0.2100            539.0594 (264)
Space and water heating                                                                                  818.9931 (265)
Pumps, fans and electric keep-hot                                 86.0000              0.1387             11.9293 (267)
Energy for lighting                                              170.6180              0.1443             24.6254 (268)
Total CO2, kg/year                                                                                       855.5478 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                           11.6000 (273)


----------------------------------------------------------------------------------------------------
13a. Primary energy - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                   Energy Primary energy factor      Primary energy
                                                                 kWh/year          kg CO2/kWh            kWh/year
Space heating - main system 1                                   1333.0173              1.1300           1506.3096 (275)
Total CO2 associated with community systems                                                                0.0000 (473)
Water heating (other fuel)                                      2566.9496              1.1300           2900.6531 (278)
Space and water heating                                                                                 4406.9627 (279)
Pumps, fans and electric keep-hot                                 86.0000              1.5128            130.1008 (281)
Energy for lighting                                              170.6180              1.5338            261.6996 (282)
Total Primary energy kWh/year                                                                           4798.7630 (286)
Dwelling Primary energy Rate (DPER)                                                                       65.0500 (287)


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



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



----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
----------------------------------------------------------------------------------------------------
                                                                     Area         Storey height             Volume
                                                                     (m2)                   (m)               (m3)
Ground floor                                                      40.8900 (1b)    x    2.4500 (2b)    =   100.1805 (1b) - (3b)
First floor                                                       32.8800 (1c)    x    1.8000 (2c)    =    59.1840 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             73.7700                                        (4)
Dwelling volume                                                        (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =   159.3645 (5)



----------------------------------------------------------------------------------------------------
2. Ventilation rate
----------------------------------------------------------------------------------------------------
                                                                                                     m3 per hour

Number of open chimneys                                                                      0 * 80 =     0.0000 (6a)
Number of open flues                                                                         0 * 20 =     0.0000 (6b)
Number of chimneys / flues attached to closed fire                                           0 * 10 =     0.0000 (6c)
Number of flues attached to solid fuel boiler                                                0 * 20 =     0.0000 (6d)
Number of flues attached to other heater                                                     0 * 35 =     0.0000 (6e)
Number of blocked chimneys                                                                   0 * 20 =     0.0000 (6f)
Number of intermittent extract fans                                                          3 * 10 =    30.0000 (7a)
Number of passive vents                                                                      0 * 10 =     0.0000 (7b)
Number of flueless gas fires                                                                 0 * 40 =     0.0000 (7c)

                                                                                            Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =     30.0000 / (5) =     0.1882 (8)
Pressure test                                                                                                Yes
Pressure Test Method                                                                                 Blower Door
Measured/design AP50                                                                                      5.0000 (17)
Infiltration rate                                                                                         0.4382 (18)
Number of sides sheltered                                                                                      3 (19)

Shelter factor                                                          (20) = 1  -  [0.075 x (19)]  =     0.7750 (20)
Infiltration rate adjusted to include shelter factor                             (21) = (18) x (20)  =     0.3396 (21)

                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Wind speed       5.1000    5.0000    4.9000    4.4000    4.3000    3.8000    3.8000    3.7000    4.0000    4.3000    4.5000    4.7000 (22)
Wind factor      1.2750    1.2500    1.2250    1.1000    1.0750    0.9500    0.9500    0.9250    1.0000    1.0750    1.1250    1.1750 (22a)
Adj infilt rate
                 0.4330    0.4246    0.4161    0.3736    0.3651    0.3227    0.3227    0.3142    0.3396    0.3651    0.3821    0.3991 (22b)
Effective ac     0.5938    0.5901    0.5866    0.5698    0.5667    0.5521    0.5521    0.5494    0.5577    0.5667    0.5730    0.5796 (25)



----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
----------------------------------------------------------------------------------------------------
Element                                       Gross     Openings      NetArea      U-value        A x U     K-value      A x K
                                                 m2           m2           m2        W/m2K          W/K     kJ/m2K       kJ/K
TER Opening Type (Uw = 1.20)                                          13.0600       1.1450      14.9542                        (27)
Bedroom 1                                                              0.9600       1.5918       1.5281                        (27a)
```

Landing			0.9600	1.5918	1.5281	(27a)
Bedroom 1 & Landing			1.4400	1.5918	2.2921	(27a)
External Wall 1	47.0400	13.0600	33.9800	0.1800	6.1164	(29a)
External Wall 2	16.4700		16.4700	0.1800	2.9646	(29a)
Cold Roof	18.1100		18.1100	0.1100	1.9921	(30)
Sloping Ceiling	30.6600	3.3600	27.3000	0.1100	3.0030	(30)
Total net area of external elements Aum(A, m2)			112.2800			(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	34.3786	(33)
Party Wall			29.2500	0.0000	0.0000	(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	8.4000	0.0500	0.4200	
E3 Sill	8.4000	0.0500	0.4200	
E4 Jamb	14.4000	0.0500	0.7200	
E16 Corner (normal)	7.3500	0.0900	0.6615	
E18 Party wall between dwellings	6.7000	0.0600	0.4020	
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0900	-0.2205	
E7 Party floor between dwellings (in blocks of flats)	19.2000	0.0700	1.3440	
R1 Head of roof window	4.2000	0.0800	0.3360	
R2 Sill of roof window	4.2000	0.0600	0.2520	
R3 Jamb of roof window	11.2000	0.0800	0.8960	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				5.2310 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	39.6096 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	31.2262	31.0347	30.8470	29.9655	29.8005	29.0327	29.0327	28.8905	29.3285	29.8005	30.1342	30.4830	(38)
Heat transfer coeff	70.8358	70.6443	70.4566	69.5751	69.4101	68.6423	68.6423	68.5001	68.9381	69.4101	69.7438	70.0926	(39)
Average = Sum(39)m / 12 =												69.5743	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9602	0.9576	0.9551	0.9431	0.9409	0.9305	0.9305	0.9286	0.9345	0.9409	0.9454	0.9502	(40)
HLP (average)												0.9431	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.3341 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	73.0422	71.9574	70.4298	67.6132	65.5041	63.1655	61.9023	63.4192	65.0709	67.5733	70.4479	72.7952	(42b)
Hot water usage for other uses	38.5332	37.1320	35.7308	34.3296	32.9284	31.5271	31.5271	32.9284	34.3296	35.7308	37.1320	38.5332	(42c)
Average daily hot water use (litres/day)												102.7518	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	111.5753	109.0894	106.1606	101.9427	98.4325	94.6927	93.4295	96.3476	99.4004	103.3040	107.5799	111.3284	(44)
Energy conte	176.7081	155.3418	163.1648	139.5545	132.5090	116.4357	112.9949	119.2985	122.5707	140.1826	153.2672	174.3134	(45)
Energy content (annual)										Total = Sum(45)m =		1706.3412	
Distribution loss (46)m = 0.15 x (45)m	26.5062	23.3013	24.4747	20.9332	19.8764	17.4654	16.9492	17.8948	18.3856	21.0274	22.9901	26.1470	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.1601	46.6978	47.6106	49.0977	49.0194	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month	227.6670	201.3692	214.1237	188.8696	182.6692	163.1335	160.6055	168.3961	171.5901	191.1415	202.5823	225.2723	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	227.6670	201.3692	214.1237	188.8696	182.6692	163.1335	160.6055	168.3961	171.5901	191.1415	202.5823	225.2723	(64)
								Total per year (kWh/year) = Sum(64)m =				2297.4199	(64)
12Total per year (kWh/year)												2297	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	71.4952	63.1580	66.9920	58.7306	56.5993	50.3893	49.4735	51.9412	53.0096	59.3504	63.2901	70.6989	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	103.8688	114.9976	103.8688	107.3310	103.8688	107.3310	103.8688	103.8688	107.3310	103.8688	107.3310	103.8688	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	205.9314	208.0684	202.6834	191.2194	176.7482	163.1473	154.0610	151.9241	157.3091	168.7731	183.2443	196.8452	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	(71)
Water heating gains (Table 5)	96.0956	93.9851	90.0430	81.5703	76.0743	69.9852	66.4966	69.8134	73.6245	79.7721	87.9029	95.0254	(72)
Total internal gains	466.9068	478.0620	457.6062	441.1318	417.7022	398.4745	382.4374	383.6173	396.2756	413.4249	439.4893	456.7504	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	4.7300	11.2829	0.6300	0.7000	0.7700	16.3100	(75)
Southwest	6.5100	36.7938	0.6300	0.7000	0.7700	73.2028	(79)
Northwest	1.8200	11.2829	0.6300	0.7000	0.7700	6.2757	(81)
Northeast	0.9600	26.0000	0.6300	0.7000	1.0000	9.9066	(82)
Southwest	1.4400	26.0000	0.6300	0.7000	1.0000	14.8599	(82)
Northwest	0.9600	26.0000	0.6300	0.7000	1.0000	9.9066	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	130.4618	242.6791	381.4630	547.4613	675.6780	696.7221	661.0378	562.4438	439.0253	282.0111	160.1072	109.0963	(83)
Total gains	597.3686	720.7411	839.0692	988.5930	1093.3803	1095.1966	1043.4751	946.0611	835.3009	695.4361	599.5964	565.8467	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	72.3210	72.5170	72.7102	73.6315	73.8065	74.6320	74.6320	74.7870	74.3119	73.8065	73.4534	73.0878	
alpha	5.8214	5.8345	5.8473	5.9088	5.9204	5.9755	5.9755	5.9858	5.9541	5.9204	5.8969	5.8725	
util living area	0.9906	0.9732	0.9236	0.7786	0.5794	0.4001	0.2893	0.3328	0.5607	0.8710	0.9767	0.9929	(86)
MIT	20.1102	20.3435	20.6284	20.8911	20.9819	20.9983	20.9998	20.9996	20.9889	20.8245	20.4207	20.0715	(87)
Th 2	20.1166	20.1188	20.1209	20.1310	20.1329	20.1417	20.1417	20.1433	20.1383	20.1329	20.1291	20.1251	(88)
util rest of house	0.9878	0.9658	0.9047	0.7390	0.5291	0.3469	0.2329	0.2710	0.4944	0.8334	0.9689	0.9908	(89)
MIT 2	19.0924	19.3864	19.7332	20.0325	20.1197	20.1408	20.1416	20.1431	20.1318	19.9737	19.4943	19.0500	(90)
Living area fraction									fLA = Living area / (4) =			0.3728	(91)
MIT	19.4718	19.7432	20.0669	20.3526	20.4411	20.4605	20.4615	20.4624	20.4513	20.2909	19.8397	19.4308	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.4718	19.7432	20.0669	20.3526	20.4411	20.4605	20.4615	20.4624	20.4513	20.2909	19.8397	19.4308	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9852	0.9620	0.9034	0.7496	0.5472	0.3667	0.2540	0.2940	0.5188	0.8409	0.9657	0.9886	(94)
Useful gains	588.5171	693.3443	758.0161	741.0146	598.3147	401.6340	265.0089	278.1453	433.3466	584.7679	579.0575	559.3707	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1074.7085	1048.5879	955.8787	796.8151	606.7196	402.2752	265.0638	278.2748	437.8487	672.6438	888.5118	1067.5650	(97)
Space heating kWh	361.7264	238.7237	147.2097	40.1763	6.2532	0.0000	0.0000	0.0000	0.0000	65.3797	222.8071	378.0966	(98a)
Space heating requirement - total per year (kWh/year)												1460.3728	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	361.7264	238.7237	147.2097	40.1763	6.2532	0.0000	0.0000	0.0000	0.0000	65.3797	222.8071	378.0966	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1460.3728	
Space heating per m2										(98c) / (4) =		19.7963	(99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	361.7264	238.7237	147.2097	40.1763	6.2532	0.0000	0.0000	0.0000	0.0000	65.3797	222.8071	378.0966	(98)
Space heating efficiency (main heating system 1)	92.4000	92.4000	92.4000	92.4000	92.4000	0.0000	0.0000	0.0000	0.0000	92.4000	92.4000	92.4000	(210)
Space heating fuel (main heating system)	391.4788	258.3590	159.3179	43.4809	6.7676	0.0000	0.0000	0.0000	0.0000	70.7572	241.1332	409.1954	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	227.6670	201.3692	214.1237	188.8696	182.6692	163.1335	160.6055	168.3961	171.5901	191.1415	202.5823	225.2723	(64)
Efficiency of water heater												80.3000	(216)
(217)m	85.3684	84.7471	83.5946	81.6861	80.5579	80.3000	80.3000	80.3000	80.3000	82.3299	84.5858	85.4819	(217)
Fuel for water heating, kWh/month	266.6877	237.6120	256.1454	231.2139	226.7550	203.1550	200.0069	209.7088	213.6863	232.1654	239.4990	263.5321	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	21.5819	17.3138	15.5891	11.4213	8.8221	7.2077	8.0478	10.4609	13.5876	17.8277	20.1364	22.1817	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-25.0301	-36.3934	-53.9358	-62.5919	-69.1820	-65.1892	-64.3882	-59.9500	-52.4057	-42.4783	-27.9071	-21.5127	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-10.9745	-23.3860	-47.0404	-71.4735	-95.3090	-96.0556	-94.9277	-80.0109	-58.1653	-33.7181	-14.7407	-8.6563	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													

(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	1580.4900	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	80.3000	
Water heating fuel used	2780.1674	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	174.1781	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1215.4224	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3405.4132	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1580.4900	0.2100	331.9029	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2780.1674	0.2100	583.8352	(264)
Space and water heating			915.7381	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	174.1781	0.1443	25.1393	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-580.9644	0.1339	-77.8130	
PV Unit electricity exported	-634.4580	0.1256	-79.6607	
Total			-157.4737	(269)
Total CO2, kg/year			795.3329	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.7800	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1580.4900	1.1300	1785.9537	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2780.1674	1.1300	3141.5891	(278)
Space and water heating			4927.5429	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	174.1781	1.5338	267.1602	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-580.9644	1.4950	-868.5266	
PV Unit electricity exported	-634.4580	0.4609	-292.3995	
Total			-1160.9261	(283)
Total Primary energy kWh/year			4163.8778	(286)
Target Primary Energy Rate (TPER)			56.4400	(287)

Appendix 2 – DER Worksheets for the Modelled Apartments for the Be Green scenario

Full SAP Calculation Printout

Property Reference	Friars Lane 1BF GND 55 - Green	Issued on Date	01/03/2024
Assessment Reference	Friars Lane 1BF GND 55 Green	Prop Type Ref	Friars Lane 1BF GND 55 - Green
Property	Hunters Lodge, Friars Lane, Richmond, London, TW9 1NX		

SAP Rating	84 B	DER	4.38	TER	13.81
Environmental	97 A	% DER < TER			68.28
CO_2 Emissions (t/year)	0.17	DFEE	29.10	TFEE	34.02
Compliance Check	See BREL	% DFEE < TFEE			14.47
% DPER < TPER	27.24	DPER	53.04	TPER	72.90

Assessor Details	Mr. Ivan Ball	Assessor ID	X001-7283
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	55.4000 (1b)	x	2.4500 (2b)	=	135.7300 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 55.4000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	135.7300 (5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	1 * 10 =	10.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	10.0000 / (5) =	0.0737	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.2737	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2121	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.2704	0.2651	0.2598	0.2333	0.2280	0.2015	0.2015	0.1962	0.2121	0.2280	0.2386	0.2492	(22b)
Effective ac	0.5366	0.5351	0.5338	0.5272	0.5260	0.5203	0.5203	0.5192	0.5225	0.5260	0.5285	0.5311	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Glazed Door/ Window (Uw = 1.20)			15.2900	1.1450	17.5076			(27)
Heatloss Floor 1			55.4000	0.1100	6.0940			(28b)
External Wall 1	53.7800	15.2900	38.4900	0.1500	5.7735			(29a)
Flat Roof	6.8500		6.8500	0.1300	0.8905			(30)
Total net area of external elements Aum(A, m2)			116.0300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	30.2656			(33)
Party Wall			29.8800	0.0000	0.0000			(32)
Party Ceiling			48.5500					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	9.4000	0.0280	0.2632
E3 Sill	6.7000	0.0240	0.1608
E4 Jamb	22.4000	0.0190	0.4256
E16 Corner (normal)	7.3500	0.0370	0.2719
E18 Party wall between dwellings	4.9000	0.0410	0.2009
E5 Ground floor (normal)	21.9500	0.0460	1.0097
E14 Flat roof	5.5400	0.0410	0.2271
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0790	-0.1936

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		2.3657 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	32.6314 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	24.0332	23.9696	23.9073	23.6145	23.5597	23.3047	23.3047	23.2575	23.4029	23.5597	23.6705	23.7864	(38)
Heat transfer coeff	56.6646	56.6010	56.5387	56.2459	56.1911	55.9361	55.9361	55.8888	56.0343	56.1911	56.3019	56.4178	(39)
Average = Sum(39)m / 12 =												56.2456	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0228	1.0217	1.0206	1.0153	1.0143	1.0097	1.0097	1.0088	1.0114	1.0143	1.0163	1.0184	(40)
HLP (average)												1.0153	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												1.8491	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	63.6272	62.6822	61.3515	58.8980	57.0608	55.0236	53.9232	55.2446	56.6834	58.8632	61.3673	63.4121	(42b)
Hot water usage for other uses	33.5663	32.3457	31.1251	29.9045	28.6840	27.4634	27.4634	28.6840	29.9045	31.1251	32.3457	33.5663	(42c)
Average daily hot water use (litres/day)												89.5072	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	97.1935	95.0279	92.4767	88.8025	85.7447	82.4870	81.3866	83.9286	86.5879	89.9883	93.7130	96.9784	(44)
Energy conte	153.9307	135.3185	142.1332	121.5662	115.4289	101.4273	98.4300	103.9211	106.7716	122.1133	133.5114	151.8447	(45)
Energy content (annual)										Total = Sum(45)m =		1486.3969	
Distribution loss (46)m = 0.15 x (45)m	23.0896	20.2978	21.3200	18.2349	17.3143	15.2141	14.7645	15.5882	16.0157	18.3170	20.0267	22.7767	(46)
Water storage loss:													
Store volume												200.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(57)
Primary loss	54.8576	49.5488	54.8576	53.0880	54.8576	22.5120	23.2624	23.2624	22.5120	54.8576	53.0880	54.8576	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	231.1083	205.0273	219.3108	196.2542	192.6065	145.5393	144.0124	149.5035	150.8836	199.2909	208.1994	229.0223	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	231.1083	205.0273	219.3108	196.2542	192.6065	145.5393	144.0124	149.5035	150.8836	199.2909	208.1994	229.0223	(64)
								Total per year (kWh/year) = Sum(64)m =				2270.7585	(64)
12Total per year (kWh/year)												2271	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	95.0680	84.6324	91.1454	82.8912	82.2662	51.7342	51.3379	53.1637	53.5111	84.4888	86.8629	94.3744	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	92.4535	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	81.3149	90.0272	81.3149	84.0254	81.3149	84.0254	81.3149	81.3149	84.0254	81.3149	84.0254	81.3149	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	161.2159	162.8888	158.6731	149.6984	138.3694	127.7218	120.6085	118.9356	123.1513	132.1260	143.4550	154.1026	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	32.2453	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	-73.9628	(71)
Water heating gains (Table 5)	127.7796	125.9411	122.5072	115.1266	110.5728	71.8530	69.0026	71.4566	74.3210	113.5602	120.6430	126.8474	(72)
Total internal gains	421.0464	429.5932	413.2312	399.5864	380.9932	334.3363	321.6620	322.4431	332.2337	377.7371	398.8594	413.0009	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W
Northeast	5.5700	11.2829	0.5400	0.7000	0.7700	16.4628 (75)
Southeast	5.9400	36.7938	0.5400	0.7000	0.7700	57.2515 (77)
Southwest	3.7800	36.7938	0.5400	0.7000	0.7700	36.4327 (79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	110.1470	193.0893	278.7178	369.6905	436.3057	442.9251	422.9593	371.7671	309.9870	217.3210	132.9265	93.6185	(83)
Total gains	531.1934	622.6824	691.9491	769.2769	817.2989	777.2613	744.6213	694.2102	642.2208	595.0581	531.7858	506.6194	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	67.8946	67.9709	68.0459	68.4001	68.4668	68.7789	68.7789	68.8370	68.6583	68.4668	68.3320	68.1917	
alpha	5.5263	5.5314	5.5364	5.5600	5.5645	5.5853	5.5853	5.5891	5.5772	5.5645	5.5555	5.5461	
util living area	0.9815	0.9580	0.9089	0.7912	0.6192	0.4573	0.3301	0.3694	0.5874	0.8399	0.9593	0.9853	(86)
MIT	20.4052	20.5361	20.6834	20.8252	20.8911	20.9081	20.9107	20.9105	20.8998	20.8101	20.5865	20.3769	(87)
Th 2	20.0644	20.0653	20.0662	20.0706	20.0715	20.0753	20.0753	20.0760	20.0738	20.0715	20.0698	20.0681	(88)
util rest of house	0.9763	0.9470	0.8871	0.7507	0.5640	0.3927	0.2610	0.2957	0.5145	0.7967	0.9467	0.9811	(89)
MIT 2	19.3777	19.5403	19.7175	19.8785	19.9425	19.9597	19.9611	19.9618	19.9531	19.8682	19.6088	19.3454	(90)
Living area fraction									fLA = Living area / (4) =			0.5235	(91)
MIT	19.9156	20.0616	20.2231	20.3740	20.4391	20.4561	20.4582	20.4584	20.4486	20.3612	20.1206	19.8854	(92)
Temperature adjustment												0.4000	
adjusted MIT	20.3156	20.4616	20.6231	20.7740	20.8391	20.8561	20.8582	20.8584	20.8486	20.7612	20.5206	20.2854	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9778	0.9520	0.9007	0.7819	0.6099	0.4473	0.3195	0.3582	0.5758	0.8296	0.9532	0.9822	(94)
Useful gains	519.4197	592.7787	623.2144	601.4880	498.4409	347.7015	237.9094	248.6531	369.7920	493.6696	506.9227	497.5946	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	907.5151	880.8006	798.5015	667.8653	513.5355	349.9443	238.1880	249.1741	378.1557	570.9713	755.6051	907.5002	(97)
Space heating kWh	288.7430	193.5508	130.4136	47.7916	11.2304	0.0000	0.0000	0.0000	0.0000	57.5124	179.0513	304.9698	(98a)
Space heating requirement - total per year (kWh/year)												1213.2629	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	288.7430	193.5508	130.4136	47.7916	11.2304	0.0000	0.0000	0.0000	0.0000	57.5124	179.0513	304.9698	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1213.2629	
Space heating per m2										(98c) / (4) =		21.9001	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	288.7430	193.5508	130.4136	47.7916	11.2304	0.0000	0.0000	0.0000	0.0000	57.5124	179.0513	304.9698	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	288.7430	193.5508	130.4136	47.7916	11.2304	0.0000	0.0000	0.0000	0.0000	57.5124	179.0513	304.9698	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	231.1083	205.0273	219.3108	196.2542	192.6065	145.5393	144.0124	149.5035	150.8836	199.2909	208.1994	229.0223	(64)
Efficiency of water heater												170.0000	(216)
(217)m	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	(217)
Fuel for water heating, kWh/month	135.9461	120.6043	129.0063	115.4436	113.2979	85.6114	84.7132	87.9432	88.7550	117.2300	122.4702	134.7190	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	16.5503	13.2773	11.9547	8.7585	6.7653	5.5273	6.1716	8.0220	10.4198	13.6714	15.4418	17.0103	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-28.3568	-42.2521	-62.9123	-71.2555	-77.2611	-70.1292	-69.2733	-64.5204	-55.8732	-47.5175	-31.6574	-24.2826	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-7.5638	-17.3878	-37.8283	-62.4971	-86.8460	-90.7394	-89.6708	-75.1139	-54.4398	-28.5012	-10.8910	-5.8159	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	1213.2629	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	170.0000	
Water heating fuel used	1335.7403	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	133.5703	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1212.5863	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	1469.9872	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1213.2629	0.1573	190.8716	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1335.7403	0.1418	189.4074	(264)
Space and water heating			380.2790	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	133.5703	0.1443	19.2783	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-645.2913	0.1344	-86.7444	
PV Unit electricity exported	-567.2951	0.1233	-69.9329	
Total			-156.6773	(269)
Total CO2, kg/year			242.8801	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			4.3800	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1213.2629	1.5824	1919.8341	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1335.7403	1.5244	2036.1861	(278)
Space and water heating			3956.0203	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	133.5703	1.5338	204.8746	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-645.2913	1.4968	-965.8866	
PV Unit electricity exported	-567.2951	0.4524	-256.6324	
Total			-1222.5190	(283)
Total Primary energy kWh/year			2938.3759	(286)
Dwelling Primary energy Rate (DPER)			53.0400	(287)

Full SAP Calculation Printout

elmhurst energy

Property Reference	Friars Lane 2BF DUP 74 - Green	Issued on Date	01/03/2024
Assessment Reference	Friars Lane 2BF DUP 74 Green	Prop Type Ref	Friars Lane 2BF DUP 74 - Green
Property	Hunters Lodge, Friars Lane, Richmond, London, TW9 1NX		

SAP Rating	87 B	DER	2.97	TER	10.52
Environmental	98 A	% DER < TER			71.77
CO_2 Emissions (t/year)	0.14	DFEE	23.14	TFEE	26.28
Compliance Check	See BREL	% DFEE < TFEE			11.92
% DPER < TPER	29.59	DPER	38.76	TPER	55.05

Assessor Details	Mr. Ivan Ball	Assessor ID	X001-7283
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	40.8900 (1b)	x	2.4500 (2b)	=	100.1805 (1b) - (3b)
First floor	32.8800 (1c)	x	1.8000 (2c)	=	59.1840 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 73.7700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	159.3645 (5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	2 * 10 =	20.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1255	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.3255	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2523	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3216	0.3153	0.3090	0.2775	0.2712	0.2396	0.2396	0.2333	0.2523	0.2712	0.2838	0.2964	(22b)
Effective ac	0.5517	0.5497	0.5477	0.5385	0.5368	0.5287	0.5287	0.5272	0.5318	0.5368	0.5403	0.5439	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Glazed Door/ Window (Uw = 1.20)			13.0600	1.1450	14.9542			(27)
Bedroom 1			0.9600	1.1450	1.0992			(27a)
Landing			0.9600	1.1450	1.0992			(27a)
Bedroom 1 & Landing			1.4400	1.1450	1.6489			(27a)
External Wall 1	47.0400	13.0600	33.9800	0.1500	5.0970			(29a)
External Wall 2	16.4700		16.4700	0.1500	2.4705			(29a)
Cold Roof	18.1100		18.1100	0.1000	1.8110			(30)
Sloping Ceiling	30.6600	3.3600	27.3000	0.1500	4.0950			(30)
Total net area of external elements Aum(A, m2)			112.2800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	32.2750			(33)
Party Wall			29.2500	0.0000	0.0000			(32)
Party Floor 1			40.8900					(32d)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E2 Other lintels (including other steel lintels)	8.4000	0.0280	0.2352
E3 Sill	8.4000	0.0240	0.2016
E4 Jamb	14.4000	0.0190	0.2736

E16 Corner (normal)	7.3500	0.0370	0.2719	
E18 Party wall between dwellings	6.7000	0.0410	0.2747	
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0790	-0.1936	
E7 Party floor between dwellings (in blocks of flats)	19.2000	0.0360	0.6912	
R1 Head of roof window	4.2000	0.0280	0.1176	
R2 Sill of roof window	4.2000	0.0240	0.1008	
R3 Jamb of roof window	11.2000	0.0190	0.2128	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				2.1859 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	34.4609 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	29.0153	28.9097	28.8062	28.3198	28.2289	27.8053	27.8053	27.7269	27.9685	28.2289	28.4129	28.6054	(38)
Heat transfer coeff	63.4762	63.3706	63.2671	62.7808	62.6898	62.2662	62.2662	62.1878	62.4294	62.6898	62.8739	63.0663	(39)
Average = Sum(39)m / 12 =												62.7803	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8605	0.8590	0.8576	0.8510	0.8498	0.8441	0.8441	0.8430	0.8463	0.8498	0.8523	0.8549	(40)
HLP (average)												0.8510	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

---

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.3341	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	73.0422	71.9574	70.4298	67.6132	65.5041	63.1655	61.9023	63.4192	65.0709	67.5733	70.4479	72.7952	(42b)
Hot water usage for other uses	38.5332	37.1320	35.7308	34.3296	32.9284	31.5271	31.5271	32.9284	34.3296	35.7308	37.1320	38.5332	(42c)
Average daily hot water use (litres/day)												102.7518	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	111.5753	109.0894	106.1606	101.9427	98.4325	94.6927	93.4295	96.3476	99.4004	103.3040	107.5799	111.3284	(44)
Energy conte	176.7081	155.3418	163.1648	139.5545	132.5090	116.4357	112.9949	119.2985	122.5707	140.1826	153.2672	174.3134	(45)
Energy content (annual)											Total = Sum(45)m =	1706.3412	
Distribution loss (46)m = 0.15 x (45)m	26.5062	23.3013	24.4747	20.9332	19.8764	17.4654	16.9492	17.8948	18.3856	21.0274	22.9901	26.1470	(46)
Water storage loss:													
Store volume												200.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.6000	(49)
Enter (49) or (54) in (55)												0.7200	(55)
Total storage loss	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(56)
If cylinder contains dedicated solar storage	22.3200	20.1600	22.3200	21.6000	22.3200	21.6000	22.3200	22.3200	21.6000	22.3200	21.6000	22.3200	(57)
Primary loss	54.8576	49.5488	54.8576	53.0880	54.8576	22.5120	23.2624	23.2624	22.5120	54.8576	53.0880	54.8576	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	253.8857	225.0506	240.3424	214.2425	209.6866	160.5477	158.5773	164.8809	166.6827	217.3602	227.9552	251.4910	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	253.8857	225.0506	240.3424	214.2425	209.6866	160.5477	158.5773	164.8809	166.6827	217.3602	227.9552	251.4910	(64)
								Total per year (kWh/year) = Sum(64)m =				2490.7028	(64)
12Total per year (kWh/year)												2491	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	102.6415	91.2902	98.1384	88.8723	87.9453	56.7245	56.1807	58.2767	58.7644	90.4968	93.4318	101.8453	(65)

---

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	116.7034	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	103.8688	114.9976	103.8688	107.3310	103.8688	107.3310	103.8688	103.8688	107.3310	103.8688	107.3310	103.8688	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	205.9314	208.0684	202.6834	191.2194	176.7482	163.1473	154.0610	151.9241	157.3091	168.7731	183.2443	196.8452	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	34.6703	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	-93.3627	(71)
Water heating gains (Table 5)	137.9590	135.8485	131.9064	123.4337	118.2061	78.7840	75.5117	78.3288	81.6172	121.6355	129.7663	136.8888	(72)
Total internal gains	505.7702	516.9254	496.4696	479.9952	456.8340	407.2733	391.4525	392.1327	404.2683	452.2883	478.3527	495.6138	(73)

---

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	4.7300	11.2829	0.5400	0.7000	0.7700	13.9800	(75)
Southwest	6.5100	36.7938	0.5400	0.7000	0.7700	62.7453	(79)
Northwest	1.8200	11.2829	0.5400	0.7000	0.7700	5.3792	(81)
Northeast	0.9600	26.0000	0.4500	0.7000	1.0000	7.0762	(82)
Southwest	1.4400	26.0000	0.4500	0.7000	1.0000	10.6142	(82)
Northwest	0.9600	26.0000	0.4500	0.7000	1.0000	7.0762	(82)

Solar gains	106.8711	197.7230	308.6791	440.6757	542.5743	559.0880	530.5970	452.1843	354.3985	229.1500	130.9478	89.5104	(83)
Total gains	612.6413	714.6484	805.1487	920.6709	999.4083	966.3613	922.0495	844.3171	758.6668	681.4383	609.3005	585.1242	(84)

---

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	80.7060	80.8406	80.9729	81.6001	81.7185	82.2744	82.2744	82.3782	82.0594	81.7185	81.4793	81.2307	
alpha	6.3804	6.3894	6.3982	6.4400	6.4479	6.4850	6.4850	6.4919	6.4706	6.4479	6.4320	6.4154	
util living area	0.9870	0.9668	0.9143	0.7701	0.5757	0.4116	0.2971	0.3386	0.5614	0.8459	0.9681	0.9900	(86)
MIT	20.5030	20.6190	20.7554	20.8761	20.9158	20.9227	20.9233	20.9233	20.9187	20.8532	20.6608	20.4800	(87)
Th 2	20.2012	20.2025	20.2037	20.2093	20.2104	20.2153	20.2153	20.2162	20.2134	20.2104	20.2082	20.2060	(88)
util rest of house	0.9833	0.9582	0.8946	0.7325	0.5294	0.3615	0.2441	0.2810	0.5001	0.8070	0.9582	0.9871	(89)
MIT 2	19.6207	19.7660	19.9306	20.0681	20.1063	20.1166	20.1169	20.1179	20.1122	20.0493	19.8248	19.5960	(90)

Living area fraction fLA = Living area / (4) = 0.3728 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	19.9496	20.0840	20.2381	20.3693	20.4081	20.4171	20.4175	20.4181	20.4128	20.3490	20.1364	19.9255	(92)

Temperature adjustment 0.4000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	20.3496	20.4840	20.6381	20.7693	20.8081	20.8171	20.8175	20.8181	20.8128	20.7490	20.5364	20.3255	(93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9841	0.9615	0.9058	0.7595	0.5646	0.4000	0.2848	0.3253	0.5470	0.8343	0.9626	0.9875	(94)
Useful gains	602.8945	687.1220	729.3141	699.2655	564.2540	386.4976	262.5544	274.6272	414.9993	568.4950	586.5335	577.8389	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1018.7670	987.5668	894.4760	745.1652	570.9824	387.1135	262.6089	274.7539	419.0781	636.2357	844.8007	1016.9758	(97)
Space heating kWh	309.4091	201.8989	122.8804	33.0478	5.0059	0.0000	0.0000	0.0000	0.0000	50.3991	185.9524	326.7179	(98a)

Space heating requirement - total per year (kWh/year) 1235.3115

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)

Solar heating contribution - total per year (kWh/year) 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating kWh	309.4091	201.8989	122.8804	33.0478	5.0059	0.0000	0.0000	0.0000	0.0000	50.3991	185.9524	326.7179	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 1235.3115

Space heating per m2 (98c) / (4) = 16.7454 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 100.0000 (206)

Efficiency of main space heating system 2 (in %) 0.0000 (207)

Efficiency of secondary/supplementary heating system, % 0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	309.4091	201.8989	122.8804	33.0478	5.0059	0.0000	0.0000	0.0000	0.0000	50.3991	185.9524	326.7179	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	309.4091	201.8989	122.8804	33.0478	5.0059	0.0000	0.0000	0.0000	0.0000	50.3991	185.9524	326.7179	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	253.8857	225.0506	240.3424	214.2425	209.6866	160.5477	158.5773	164.8809	166.6827	217.3602	227.9552	251.4910	(64)

Efficiency of water heater 170.0000 (216)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(217)m	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	(217)
Fuel for water heating, kWh/month	149.3445	132.3827	141.3779	126.0250	123.3451	94.4398	93.2807	96.9887	98.0486	127.8589	134.0913	147.9359	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	21.1408	16.9599	15.2705	11.1878	8.6418	7.0604	7.8833	10.2471	13.3099	17.4633	19.7248	21.7283	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-37.0316	-54.6723	-80.3076	-89.6924	-97.5218	-89.3458	-88.2071	-82.3941	-71.7388	-60.8637	-41.1196	-31.7564	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	-10.7999	-24.7436	-53.8373	-88.4110	-121.0015	-124.8649	-123.4411	-103.5414	-75.1528	-40.3619	-15.5373	-8.3225	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1 1235.3115 (211)

Space heating fuel - main system 2 0.0000 (213)

Space heating fuel - secondary 0.0000 (215)

Efficiency of water heater 170.0000

Water heating fuel used 1465.1193 (219)

Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:

Total electricity for the above, kWh/year 0.0000 (231)

Electricity for lighting (calculated in Appendix L) 170.6180 (232)

Energy saving/generation technologies (Appendices M ,N and Q)				
PV generation			-1614.6664	(233)
Wind generation			0.0000	(234)
Hydro-electric generation (Appendix N)			0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)			0.0000	(235)
Appendix Q - special features				
Energy saved or generated			-0.0000	(236)
Energy used			0.0000	(237)
Total delivered energy for all uses			1256.3823	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1235.3115	0.1579	195.1129	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1465.1193	0.1418	207.7201	(264)
Space and water heating			402.8330	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	170.6180	0.1443	24.6254	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-824.6513	0.1345	-110.9253	
PV Unit electricity exported	-790.0151	0.1237	-97.6994	
Total			-208.6246	(269)
Total CO2, kg/year			218.8339	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			2.9700	(273)

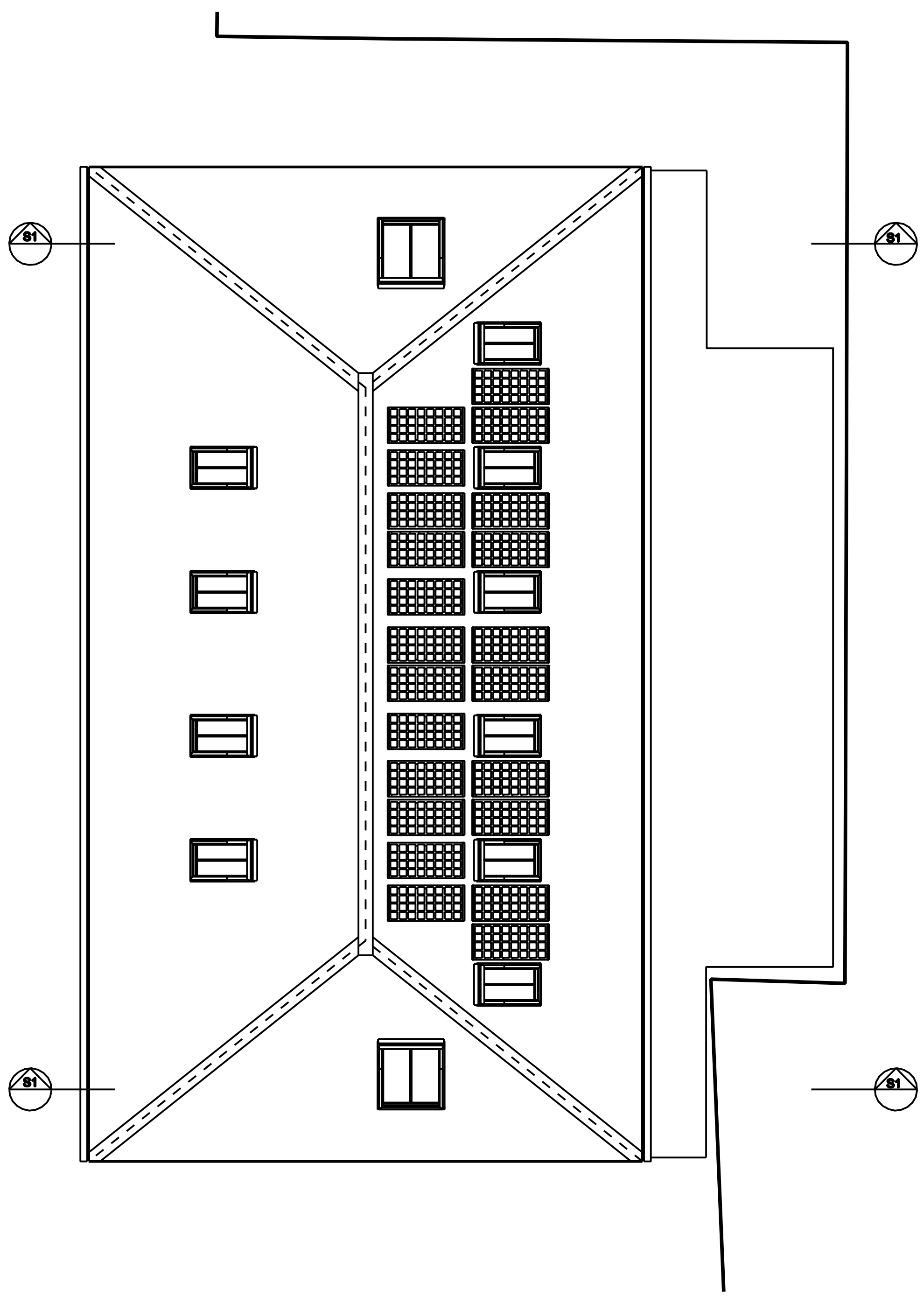
13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1235.3115	1.5847	1957.5513	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1465.1193	1.5243	2233.2829	(278)
Space and water heating			4190.8342	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	170.6180	1.5338	261.6996	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-824.6513	1.4971	-1234.6167	
PV Unit electricity exported	-790.0151	0.4539	-358.5567	
Total			-1593.1734	(283)
Total Primary energy kWh/year			2859.3604	(286)
Dwelling Primary energy Rate (DPER)			38.7600	(287)

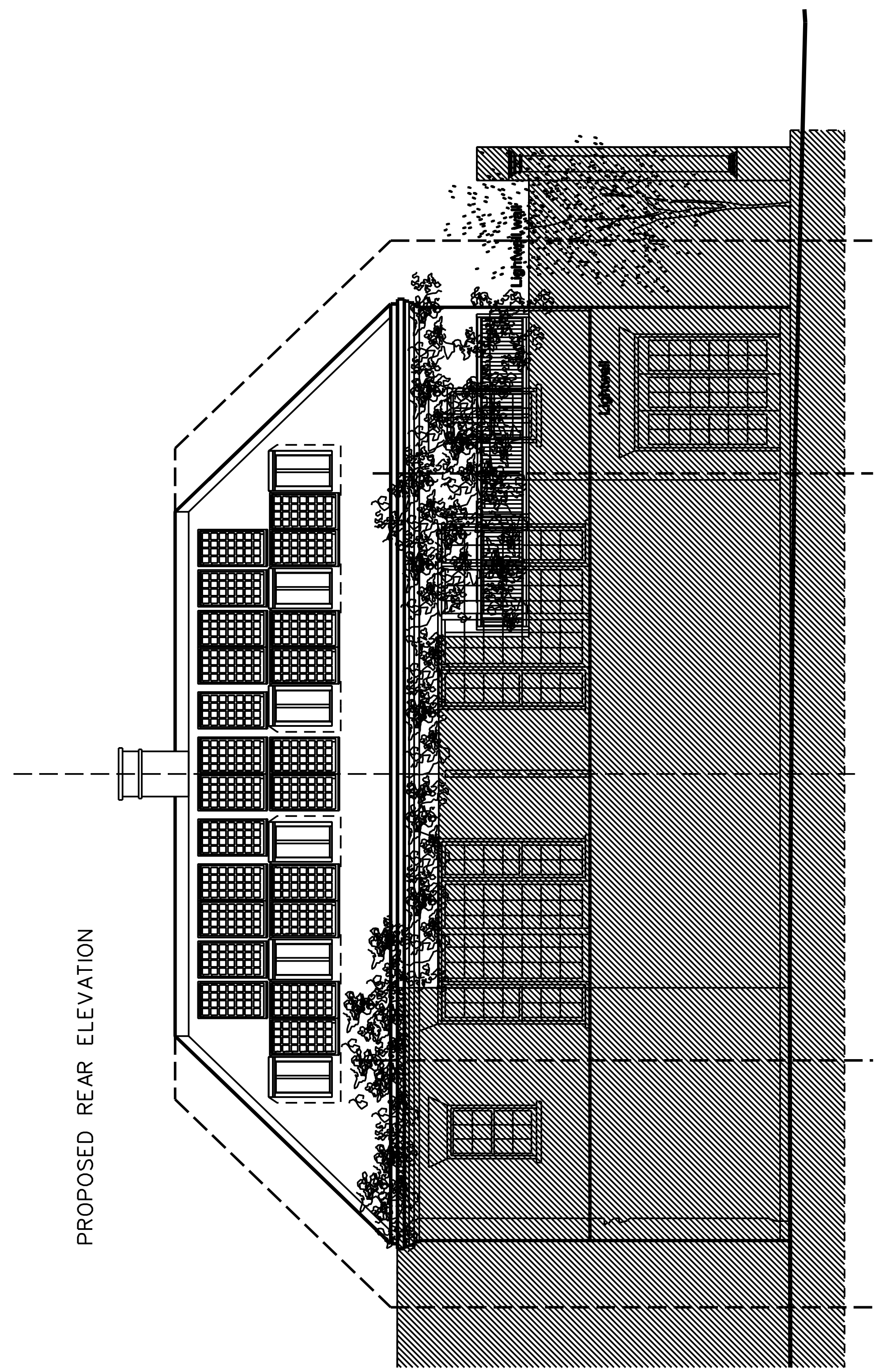
Appendix 3 – Roof Plan & Elevation showing the Indicative Location of Photovoltaic Panels

HUNTERS LODGE / FRIARS LANE / RICHMOND

REVISED PROPOSALS APP 3



PROPOSED ROOF PLAN



PROPOSED REAR ELEVATION

Notes: The General contractor is responsible for the verification of all dimensions on site & shall inform the contract administrator of any descrepencies. Do not scale from this drawing. Use figured dimension only. Existing foundations, lintels and wall to be exposed if req'd by Building Control for assessment & upgrading if found inadequate. Unless stated otherwise these drawings represent design intent only & approved assembly drawings will be required from the Trade Contractor prior to any work and/or procurement being undertaken. If in doubt, ask.

Any images shown are for illustrative purposes only.

Revisions

/ - 240215 - Issued to client via email
A - 240216 - Issued to client/FJ via email
B - 240223 - Issued to LBRUT via email

LOCATION Hunters Lodge Friars Lane Richmond	CLIENT Mr C Deehan SCALE 1:100 @ A3 STATUS Planning	DRAWING TITLE Proposed Elevations / Plan Roof plan showing PV and rooflight design	JOB No 2561 SIZE A3 DRAWING No 007 REV B
JOB DESCRIPTION 4 New Build Apartments			

Appendix 4 – 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): Hunters Lodge, Friars Lane, Richmond — Application No. (if known):

Address (include. postcode): Hunters Lodge, Friars Lane, Richmond
Completed by: Ivan Ball

For Non-Residential Size of development (m2):
For Residential Number of dwellings: 4

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 — 70.56 %
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 — 13.08 %
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? — 57.48 %

What is the total remaining carbon to be offset — 0.923 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? — 2631 £
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? — **FALSE**
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? — **FALSE**
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? — **FALSE**
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)

Water Usage

	Score	
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. *110l/p/d Required for new dwellings under Policy LP22 A 2 105l/p/d required under Draft London Plan Policy SI5*	*1*	**TRUE**
Subtotal	1	

2. ENERGY USE AND POLLUTION

2.1 Need for Cooling

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*	**TRUE**
Reduce heat entering a building through providing/improving insulation and living roofs and walls	*2*	**FALSE**
Reduce heat entering a building through shading	*3*	**FALSE**
Exposed thermal mass and high ceilings	*4*	**FALSE**
Passive ventilation	*3*	**TRUE**
Mechanical ventilation with heat recovery	*1*	**FALSE**
Active cooling systems, i.e. Air Conditioning Unit	*0*	**FALSE**

See Draft London Plan SI4

2.2 Heat Generation

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

See Draft London Plan SI3

2.3 Pollution: Air, Noise and Light

		Score	
a.	Does the development plan to implement reduction strategies for dust emissions from construction sites?	*2*	**TRUE**
b.	Does the development plan to include a biomass boiler?		**FALSE**
	If yes, please refer to the biomass guidelines for the Borough of Richmond, please see guidance for supplementary information. If the proposed boiler is of a qualifying size, you may need to complete the information request form found on the Richmond website.		
c.	Has an air quality impact assessment been provided		**FALSE**
	If yes, has 'Emissions Neutral' been achieved	*1*	**TRUE**
	If yes, have occupants of new development been protected from existing pollution	*1*	**FALSE**
	If no to any of the above are there any sensitive receptors as defined in Policy LP 10 present?	*-1*	**FALSE**
	see Policy LP 10		
d.	Please tick only one option below		
	Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site?	*3*	**TRUE**
	Has the development taken care to not create any new noise generation/transmission issues in its intended operation?	*1*	**TRUE**
	see Policy LP 10		
e.	Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity?	*3*	**TRUE**

	see Policy LP 10		
f.	Have you attached a Lighting Pollution Report?	-	

Subtotal 19

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

The proposals include all electric systems on site. Therefore will be no on-site emissions.

3. TRANSPORT

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

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

Please explain:

		Score	Response
b.	Does your development provide for 100% active provision for electric vehicle charging point(s) and have you successfully demonstrated that it would be able to operate satisfactorily in the future expectation of all vehicles being electrically powered?	2	TRUE
c.	**For major developments ONLY**: Has a Transport Assessment been produced for your development based on TfL's Best Practice Guidance?		
	If you have provided a Transport Assessment as part of your planning application, please tick here and move to Section 3 of this Checklist.	5	FALSE
	See policy LP44		
d.	**For smaller developments ONLY**: Have you provided a Transport Statement?	5	FALSE
e.	Does your development provide cycle storage? (Standard space requirements are set out in the Council's Parking Standards - Local Plan Appendix 3)	2	TRUE
	If so, for how many bicycles?	7	
	Is this shown on the site plans?		TRUE
	See Local Plan Appendix 3		
f.	Will the development create or improve links with local and wider transport networks? If yes, please provide details.	2	FALSE

Subtotal 4

Please give any additional relevant comments to the Transport Section below

Cycle storage is provided.

4 BIODIVERSITY

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

		Score	Response
a.	Does your development involve the loss of an ecological feature or habitat, including a loss of garden or other green space? (Indicate if yes)	-2	FALSE
	If so, please state how much in sqm?	sqm	
b.	Does your development involve the removal of any tree(s)? (Indicate if yes)		FALSE
	If so, has a tree report been provided in support of your application? (Indicate if yes)		FALSE
c.	Does your development plan to add (and not remove) any tree(s) on site? (Indicate if yes)		FALSE
d.	Please indicate which features and/or habitats that your development will incorporate to improve on site biodiversity:		

Feature	Score	Area provided:	Response
Pond, reedbed or extensive native planting	6	sqm	FALSE
An extensive green roof	5	sqm	FALSE
An intensive green roof	4	7.5 sqm	TRUE
Garden space	4	sqm	TRUE
Additional native and/or wildlife friendly planting to peripheral areas	3	sqm	FALSE
Additional planting to peripheral areas	2	sqm	FALSE
A living wall	2	sqm	FALSE
Bat boxes	0.5		TRUE
Bird boxes	0.5		TRUE
Swift boxes	0.5		TRUE
Other	0.5		FALSE

		Score	Response
e.	Does your development use at least 70% of available roof plate as green/brown roof	1	FALSE
	Policy LP 17 requires 70%		

Subtotal 9.5

Please give any additional relevant comments to the Biodiversity Section below

A green roof is provided to the bin and cycle store. Bat boxes, Bird boxes and Swift boxes could be installed.

5 FLOODING AND DRAINAGE

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

		Score	Response
a.	Is your site located in a high flood risk zone (Zone 3)? (Indicate if yes)	-2	FALSE
	Have you submitted a Flood Risk Assessment? (Indicate if yes)		FALSE
b.	Which of the following measures of the drainage hierarchy are incorporated onto your site? (tick all that apply)		
	Store rainwater for later use	5	FALSE
	Use of infiltration techniques such as porous surfacing materials to allow drainage on-site	3	TRUE
	Attenuate rainwater in ponds or open water features	4	FALSE
	Store rainwater in tanks for gradual release to a watercourse	3	FALSE
	Discharge rainwater directly to watercourse	2	FALSE
	Discharge rainwater to surface water drain	1	FALSE
	Discharge rainwater to combined sewer	0	TRUE
	Have you submitted a Drainage Statement (Indicate if yes)		FALSE
	See Policy LP 21 and Draft London Plan SL 13		
c.	Please give the change in area of permeable surfacing which will result from your development proposal:	0 sqm	
	Please provide details of the permeable surfacing below	*please represent a loss in permeable area as a negative number*	

Subtotal 3

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

		Score	Response
a.	Will demolition be required on your site prior to construction? *[Points will only be awarded if 10% or greater of demolition waste is reused/recycled]*	1	TRUE
	If so, what percentage of demolition waste will be reused in the new development?	20 %	
	What percentage of demolition waste will be recycled?	80 %	
b.	Does your site have any contaminated land?	1	FALSE
	Have you submitted an assessment of the site contamination?	2	FALSE

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

c. Will a waste management plan and facilities be in place in line with Policy LP24 — Yes

6.2 Reducing levels of water waste

a. Will the following measures of water conservation be incorporated into the development? (Please tick all that apply):

Fitting of water efficient taps, shower heads etc	1	TRUE
Use of water efficient A or B rated appliances	1	TRUE
Rainwater harvesting for internal use	4	FALSE
Greywater systems	4	FALSE
Fit a water meter	1	TRUE

Subtotal 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* — TRUE

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

AND

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

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

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

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* — FALSE

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

Subtotal 3

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* ***42.5***

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

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

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

Authorisation:

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

Signature ______________________ **Date** ____________________