Sustainability & Energy Statement

99 Atbara Road, Teddington

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Table of Contents

Executive Summary

This Sustainability and Energy Statement has been prepared in support of a planning application for the demolition of the bungalow and the construction of a new 4-bedroom, 2½-storey house at 99 Atbara Road, Teddington.

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 the proposed house 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 proposed house for the Be Lean case are attached as Appendix 1.

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

It is proposed to install an air source heat pump into the house to provide space heating and hot water.

It is also proposed to install a total of 6 x 400W photovoltaic panels on the southeast orientated front elevation. A Roof Plan showing the indicative location of the panels is attached as Appendix 3.

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)	1,938	
Be Lean - after energy efficiency (DER)	1,557	**19.66%**
Be Clean	1,557	19.66%
Be Green (ASHP)		
Be Green Emissions	435	**77.55%**

The water efficiency measures incorporated into the house ensures it achieves a standard of 110 litres per person per day (including 5 l/p/d for external water use) and therefore meets the enhanced standard required by the Building Regulations and the planning policy.

The LBRuT Sustainable Construction Checklist is attached as Appendix 4.

1.0 Introduction

This report has been commissioned by Jamie and Beverley McDaid and provides a Sustainability and Energy Statement in support of a planning application for the demolition of the existing bungalow and the construction of a new 4-bedroom, 2½-storey house at 99 Atbara Road, Teddington.

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

The house 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;

Unit Type	Number	Area	Total Area
		m^2	m^2
4-Bedroom 2½-storey detached house	1	230.2	230.2
Total	**1**		**230.2**

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 house is in context with surrounding development and the shape of the site. The house has been designed with multiple aspects but benefits predominantly from orientations towards the southeast (front) and northwest (rear). The house therefore benefits from access to direct sunlight throughout the day and from cross ventilation, which will assist in limiting 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 using a timber frame system with an overall width of 352mm. This will be insulated with Kingspan ULTIMA insulation.

The (cold) roof will be insulated with 400mm of mineral wool and flat and sloping roofs will be insulated with 200mm 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-Floor	**0.18**	**0.11**	**39%**
External Walls	**0.26**	**0.15**	**42%**
Low-level Walls at Second-floor	**0.26**	**0.15**	**42%**
Cold Roofs	**0.16**	**0.10**	**38%**
Flat Roof	**0.16**	**0.13**	**19%**
Sloping Ceilings	**0.16**	**0.13**	**19%**
Windows and Glazed Doors	**1.60**	**1.20**	**25%**

'g' Value for Windows and Glazed Doors	**0.5**

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 house 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
E10	Eaves (Ceiling)	0.051
E14	Flat Roof	0.041
E16	Corner (normal)	0.037
E17	Corner (inverted)	-0.079

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-Suite and Bathroom 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 80 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 the house (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 an air source heat pump.

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 the house and 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 proposed house can be summarised as follows;

Unit Type	TER	DER
	kg CO_2/yr	kg CO_2/yr
4-Bedroom 2½-storey detached house	8.42	9.61

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 house are calculated as **1,938 kg CO_2 per year** with DER emissions of **1,557 kg CO_2 per year**.

The spreadsheet makes an allowance for the energy saving/ renewable technologies including within the TER calculation.

The reduction in emissions is therefore **381 kg CO_2 per year**, which equates to a reduction of **19.66%** 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 Atbara Road 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.

Whilst the house has a private garden area it is unlikely there is sufficient space to install a horizontal collection network. Therefore, the installation of a ground source heat pump is likely to require one or more boreholes to service a system.

This will be cost prohibitive and is not proposed.

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 a heat pump reduces the emissions from the hot water demand significantly and the installation of solar hot water heating panels would only reduce further emissions marginally.

This does not represent good value when compared with only technologies and therefore solar hot water heating panels 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 attached as Appendix 3 demonstrates a total of 6 x 400W photovoltaic panels could be installed on the southeast orientated front elevation.

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 an air source heat pump 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)

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

This includes the installation of an air source heat pump and the installation of 6 x 400W photovoltaic panels (2.4 kW).

The DER Worksheets for the 'Be Green' scenario are attached as Appendix 2 and the results have been input into the GLA Carbon Emissions Reporting Spreadsheet.

The emissions rate from the proposed house can be summarised as follows;

Unit Type	DER
	kg CO_2/yr
4-Bedroom 2½-storey detached house	1.89

Summary

The total emissions for the Be Green scenario are therefore calculated as **435 kg CO_2 per year**.

The reduction in emissions is **1,503 kg CO_2 per year**, which equates to a reduction of **77.55%** 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 **1,938 kg CO_2 per year** (TER) and **1,557 kg CO_2 per year** (DER)**.**

This equates to a reduction of **381 kg CO_2 per year** or **19.66%** of the total TER emissions and is therefore compliant with the GLA energy guidance.

The TER & DER Worksheets for the proposed house 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 an air source heat pump into the proposed house and the installation of 6 x 400W photovoltaic panels. The panels will be installed on the southeast orientated front elevation and a Roof Plan showing the indicative location of the panels is attached as Appendix 3.

Based on the Be Green scenario the total CO_2 emissions are calculated as **435 kg CO_2 per year** (DER)**.**

This equates to a reduction of **1,503 kg CO_2 per year** or **77.55%** of the total TER emissions.

The DER Worksheets for the proposed house for the Be Green scenario are attached as Appendix 2.

Summary

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

6.0 Climate change adaption and Water resources

Sustainable Drainage Systems (SUDS)

The site lies within Flood Zones 2 and 3. Consequently, a Flood Risk Assessment has been prepared by STM Environmental and accompanies the application. This concludes that the overall flood risk to the development is acceptable and that the new development will provide betterment to the site and also increases storage potential of the flood plain.

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 house:

- 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 Proposed House for the Be Lean scenario

Full SAP Calculation Printout

Property Reference	Atbara 4BH DET 230 - Be Lean	**Issued on Date**	01/07/2024
Assessment Reference	Atbara 4BH DET 230 - Be Lean	**Prop Type Ref**	Atbara 4BH DET 230 - Be Lean
Property	99, Atbara Road, Teddington, London, TW11 9PA		

SAP Rating	92 A	**DER**	9.61	**TER**	8.42
Environmental	90 B	**% DER < TER**			-14.13
CO_2 Emissions (t/year)	1.79	**DFEE**	35.23	**TFEE**	39.53
Compliance Check	See BREL	**% DFEE < TFEE**			10.87
% DPER < TPER	-14.74	**DPER**	50.84	**TPER**	44.31

Assessor Details	Mr. Ivan Ball	**Assessor ID**	DE88-0001
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	102.5800	(1b)	x	2.4200	(2b)	=	248.2436	(1b) - (3b)
First floor	73.6900	(1c)	x	2.4000	(2c)	=	176.8560	(1c) - (3c)
Second floor	53.9200	(1d)	x	2.1100	(2d)	=	113.7712	(1d) - (3d)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 230.1900 (4)
Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 538.8708 (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	4 * 10 =	40.0000	(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) =	40.0000 / (5) =	0.0742	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.2742	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2331	(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	0.2972	0.2914	0.2855	0.2564	0.2506	0.2214	0.2214	0.2156	0.2331	0.2506	0.2622	0.2739	(22b)
Effective ac	0.5442	0.5424	0.5408	0.5329	0.5314	0.5245	0.5245	0.5232	0.5272	0.5314	0.5344	0.5375	(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	
Windows & Glazed Doors (Uw = 1.20)			36.4700	1.1450	41.7595			(27)
Doors			3.7500	1.2000	4.5000			(26a)
Kitchen			6.0000	1.1450	6.8702			(27a)
Ground Floor			102.5800	0.1100	11.2838			(28a)
External Walls	218.4100	38.0600	180.3500	0.1500	27.0525			(29a)
Low Level Walls &Dormer Cheeks	28.8400	2.1600	26.6800	0.1500	4.0020			(29a)
Flat Roof over Ground Floor	28.8900	6.0000	22.8900	0.1300	2.9757			(30)
Cold Roof over First Floor	19.7700		19.7700	0.1000	1.9770			(30)
Sloping Ceilings	26.8300		26.8300	0.1300	3.4879			(30)
Flat Roof over Second Floor	32.6100		32.6100	0.1300	4.2393			(30)
Total net area of external elements Aum(A, m2)			457.9300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	108.1480			(33)

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)	24.9600	0.0280	0.6989
E3 Sill	17.2400	0.0240	0.4138

E4 Jamb	71.5000	0.0190	1.3585
E5 Ground floor (normal)	44.1500	0.0460	2.0309
E10 Eaves (insulation at ceiling level)	15.5600	0.0510	0.7936
E6 Intermediate floor within a dwelling	67.8800	0.0000	0.0000
E11 Eaves (insulation at rafter level)	7.8000	0.0180	0.1404
E12 Gable (insulation at ceiling level)	13.4200	0.0290	0.3892
E14 Flat roof	15.8600	0.0410	0.6503
E16 Corner (normal)	46.9600	0.0370	1.7375
E17 Corner (inverted - internal area greater than external area)	22.8800	-0.0790	-1.8075

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 6.4054 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 114.5534 (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	96.7670	96.4621	96.1632	94.7592	94.4965	93.2736	93.2736	93.0472	93.7446	94.4965	95.0279	95.5834	(38)
Heat transfer coeff	211.3204	211.0155	210.7166	209.3126	209.0499	207.8270	207.8270	207.6006	208.2981	209.0499	209.5813	210.1368	(39)

Average = Sum(39)m / 12 = 209.3113

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9180	0.9167	0.9154	0.9093	0.9082	0.9028	0.9028	0.9019	0.9049	0.9082	0.9105	0.9129	(40)
HLP (average)												0.9093	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.0412 (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	86.7689	85.4803	83.6656	80.3197	77.8143	75.0362	73.5356	75.3376	77.2996	80.2723	83.6871	86.4756	(42b)
Hot water usage for other uses	45.7747	44.1102	42.4456	40.7811	39.1166	37.4520	37.4520	39.1166	40.7811	42.4456	44.1102	45.7747	(42c)

Average daily hot water use (litres/day) 122.0618 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	132.5436	129.5904	126.1112	121.1008	116.9308	112.4882	110.9876	114.4541	118.0807	122.7179	127.7973	132.2503	(44)
Energy conte	209.9167	184.5350	193.8283	165.7809	157.4114	138.3174	134.2299	141.7181	145.6053	166.5270	182.0706	207.0720	(45)

Energy content (annual) Total = Sum(45)m = 2027.0125

Distribution loss (46)m = 0.15 x (45)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss	31.4875	27.6803	29.0742	24.8671	23.6117	20.7476	20.1345	21.2577	21.8408	24.9791	27.3106	31.0608	(46)

Water storage loss:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(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	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(64)

Total per year (kWh/year) = Sum(64)m = 2627.0125 (64)
12Total per year (kWh/year) 2627 (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	82.5370	72.8648	77.1876	67.4509	65.0790	58.3193	57.3712	59.8610	60.7425	68.1100	72.8672	81.5912	(65)

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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	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	203.8904	225.7358	203.8904	210.6868	203.8904	210.6868	203.8904	203.8904	210.6868	203.8904	210.6868	203.8904	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	398.9044	403.0438	392.6127	370.4061	342.3743	316.0283	298.4276	294.2882	304.7193	326.9259	354.9578	381.3037	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	(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)	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	(71)
Water heating gains (Table 5)	110.9369	108.4297	103.7468	93.6818	87.4718	80.9990	77.1118	80.4583	84.3646	91.5456	101.2045	109.6655	(72)
Total internal gains	785.3494	808.8270	771.8676	746.3924	705.3541	676.3318	648.0475	647.2546	668.3884	693.9796	738.4667	766.4773	(73)

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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	3.4600	11.2829	0.5000	0.7000	0.7700	9.4689	(75)
East	1.3700	19.6403	0.5000	0.7000	0.7700	6.5263	(76)
Southeast	8.9100	36.7938	0.5000	0.7000	0.7700	79.5159	(77)
South	1.3700	46.7521	0.5000	0.7000	0.7700	15.5354	(78)
Southwest	2.1600	36.7938	0.5000	0.7000	0.7700	19.2766	(79)
Northwest	19.2000	11.2829	0.5000	0.7000	0.7700	52.5442	(81)
Northwest	6.0000	26.0000	0.5000	0.7000	1.0000	49.1400	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	232.0073	434.7795	692.5487	1009.5808	1260.2324	1305.6835	1236.2851	1042.5083	802.0907	507.5795	285.2815	193.6698	(83)

Total gains	1017.3567	1243.6065	1464.4163	1755.9732	1965.5865	1982.0153	1884.3325	1689.7629	1470.4791	1201.5591	1023.7482	960.1471	(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	75.6454	75.7547	75.8622	76.3710	76.4670	76.9169	76.9169	77.0008	76.7430	76.4670	76.2731	76.0715	
alpha	6.0430	6.0503	6.0575	6.0914	6.0978	6.1278	6.1278	6.1334	6.1162	6.0978	6.0849	6.0714	
util living area	0.9996	0.9985	0.9939	0.9644	0.8544	0.6507	0.4823	0.5576	0.8495	0.9878	0.9989	0.9997	(86)
MIT	19.7785	19.9516	20.2217	20.5913	20.8710	20.9803	20.9973	20.9938	20.9083	20.5191	20.0794	19.7490	(87)
Th 2	20.1522	20.1533	20.1544	20.1596	20.1606	20.1651	20.1651	20.1659	20.1633	20.1606	20.1586	20.1566	(88)
util rest of house	0.9995	0.9981	0.9917	0.9515	0.8100	0.5744	0.3924	0.4605	0.7866	0.9816	0.9984	0.9996	(89)
MIT 2	18.6965	18.9192	19.2649	19.7309	20.0502	20.1537	20.1642	20.1636	20.0968	19.6485	19.0872	18.6619	(90)
MIT	18.8148	19.0320	19.3695	19.8249	20.1399	20.2440	20.2552	20.2543	20.1855	19.7436	19.1956	18.7806	(92)
adjusted MIT	18.8148	19.0320	19.3695	19.8249	20.1399	20.2440	20.2552	20.2543	20.1855	19.7436	19.1956	18.7806	(93)

Living area fraction fLA = Living area / (4) = 0.1093 (91)

Temperature adjustment 0.0000

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9992	0.9971	0.9888	0.9451	0.8088	0.5819	0.4022	0.4710	0.7885	0.9773	0.9976	0.9994	(94)
Useful gains	1016.4930	1239.9495	1448.0816	1659.5888	1589.7426	1153.2780	757.9089	795.8320	1159.4700	1174.2359	1021.2928	959.5723	(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	3067.2644	2982.0702	2711.8096	2286.7243	1764.3573	1172.9840	759.6445	800.1515	1267.5990	1911.4692	2535.0156	3063.9317	(97)
Space heating kWh	1525.7739	1170.7051	940.2136	451.5376	129.9133	0.0000	0.0000	0.0000	0.0000	548.5015	1089.8804	1565.6435	(98a)
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)
Space heating kWh	1525.7739	1170.7051	940.2136	451.5376	129.9133	0.0000	0.0000	0.0000	0.0000	548.5015	1089.8804	1565.6435	(98c)

Space heating requirement - total per year (kWh/year) 7422.1689

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

Space heating requirement after solar contribution - total per year (kWh/year) 7422.1689

Space heating per m2 (98c) / (4) = 32.2437 (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	1525.7739	1170.7051	940.2136	451.5376	129.9133	0.0000	0.0000	0.0000	0.0000	548.5015	1089.8804	1565.6435	(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)	1704.7754	1308.0504	1050.5180	504.5112	145.1546	0.0000	0.0000	0.0000	0.0000	612.8509	1217.7435	1749.3223	(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	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(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	291.4811	257.6117	273.5052	240.3307	232.8159	209.6452	206.9149	215.2816	217.7881	243.0010	258.5315	288.3026	(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	3.4822	3.1452	3.4822	3.3699	3.4822	3.3699	3.4822	3.4822	3.3699	3.4822	3.3699	3.4822	(231)
Lighting	42.3644	33.9863	30.6009	22.4195	17.3175	14.1485	15.7976	20.5343	26.6720	34.9951	39.5269	43.5418	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-33.8411	-50.3571	-76.3159	-90.5560	-101.7319	-96.3339	-95.0469	-87.6463	-75.4092	-59.5457	-38.0970	-28.9497	(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	-11.8418	-25.4915	-51.8035	-79.5473	-106.9757	-108.2549	-107.0944	-89.9372	-64.8842	-37.1330	-16.0149	-9.3290	(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	8292.9261	(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	2935.2095	(219)
Space cooling fuel	0.0000	(221)

Electricity for pumps and fans:

central heating pump	41.0000	(230c)
Total electricity for the above, kWh/year	41.0000	(231)
Electricity for lighting (calculated in Appendix L)	341.9050	(232)

Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1542.1382	(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	10068.9024	(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	8292.9261	0.2100	1741.5145	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2935.2095	0.2100	616.3940	(264)
Space and water heating			2357.9085	(265)
Pumps, fans and electric keep-hot	41.0000	0.1387	5.6872	(267)
Energy for lighting	341.9050	0.1443	49.3475	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-833.8309	0.1335	-111.3240	
PV Unit electricity exported	-708.3073	0.1252	-88.6984	
Total			-200.0223	(269)
Total CO2, kg/year			2212.9208	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			9.6100	(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	8292.9261	1.1300	9371.0065	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2935.2095	1.1300	3316.7867	(278)
Space and water heating			12687.7933	(279)
Pumps, fans and electric keep-hot	41.0000	1.5128	62.0248	(281)
Energy for lighting	341.9050	1.5338	524.4253	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-833.8309	1.4934	-1245.2145	
PV Unit electricity exported	-708.3073	0.4596	-325.5594	
Total			-1570.7739	(283)
Total Primary energy kWh/year			11703.4694	(286)
Dwelling Primary energy Rate (DPER)			50.8400	(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	102.5800	(1b)	x	2.4200	(2b)	=	248.2436	(1b) - (3b)
First floor	73.6900	(1c)	x	2.4000	(2c)	=	176.8560	(1c) - (3c)
Second floor	53.9200	(1d)	x	2.1100	(2d)	=	113.7712	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 230.1900								(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	538.8708	(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	4 * 10 =	40.0000	(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) =	40.0000 / (5) =	0.0742	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3242	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2756	(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													

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.3514	0.3445	0.3376	0.3032	0.2963	0.2618	0.2618	0.2549	0.2756	0.2963	0.3100	0.3238	(22b)
Effective ac	0.5617	0.5593	0.5570	0.5460	0.5439	0.5343	0.5343	0.5325	0.5380	0.5439	0.5481	0.5524	(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 Semi-glazed door			3.7500	1.0000	3.7500			(26a)
TER Opening Type (Uw = 1.20)			36.4700	1.1450	41.7595			(27)
Kitchen			6.0000	2.0221	12.1324			(27a)
Ground Floor			102.5800	0.1300	13.3354			(28a)
External Walls	218.4100	38.0600	180.3500	0.1800	32.4630			(29a)
Low Level Walls &Dormer Cheeks	28.8400	2.1600	26.6800	0.1800	4.8024			(29a)
Flat Roof over Ground Floor	28.8900	6.0000	22.8900	0.1100	2.5179			(30)
Cold Roof over First Floor	19.7700		19.7700	0.1100	2.1747			(30)
Sloping Ceilings	26.8300		26.8300	0.1100	2.9513			(30)
Flat Roof over Second Floor	32.6100		32.6100	0.1100	3.5871			(30)
Total net area of external elements Aum(A, m2)			457.9300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	119.4737			(33)

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)	24.9600	0.0500	1.2480
E3 Sill	17.2400	0.0500	0.8620
E4 Jamb	71.5000	0.0500	3.5750
E5 Ground floor (normal)	44.1500	0.1600	7.0640
E10 Eaves (insulation at ceiling level)	15.5600	0.0600	0.9336
E6 Intermediate floor within a dwelling	67.8800	0.0000	0.0000
E11 Eaves (insulation at rafter level)	7.8000	0.0400	0.3120
E12 Gable (insulation at ceiling level)	13.4200	0.0600	0.8052
E14 Flat roof	15.8600	0.0800	1.2688
E16 Corner (normal)	46.9600	0.0900	4.2264
E17 Corner (inverted - internal area greater than external area)	22.8800	-0.0900	-2.0592

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 18.2358 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 137.7095 (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	99.8919	99.4656	99.0477	97.0851	96.7179	95.0085	95.0085	94.6919	95.6669	96.7179	97.4607	98.2373	(38)
Heat transfer coeff	237.6014	237.1751	236.7572	234.7946	234.4274	232.7180	232.7180	232.4014	233.3764	234.4274	235.1702	235.9468	(39)
Average = Sum(39)m / 12 =												234.7928	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0322	1.0303	1.0285	1.0200	1.0184	1.0110	1.0110	1.0096	1.0138	1.0184	1.0216	1.0250	(40)
HLP (average)												1.0200	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.0412 (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	86.7689	85.4803	83.6656	80.3197	77.8143	75.0362	73.5356	75.3376	77.2996	80.2723	83.6871	86.4756	(42b)
Hot water usage for other uses	45.7747	44.1102	42.4456	40.7811	39.1166	37.4520	37.4520	39.1166	40.7811	42.4456	44.1102	45.7747	(42c)
Average daily hot water use (litres/day)												122.0618	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	132.5436	129.5904	126.1112	121.1008	116.9308	112.4882	110.9876	114.4541	118.0807	122.7179	127.7973	132.2503	(44)
Energy conte	209.9167	184.5350	193.8283	165.7809	157.4114	138.3174	134.2299	141.7181	145.6053	166.5270	182.0706	207.0720	(45)
Energy content (annual)										Total = Sum(45)m =		2027.0125	
Distribution loss (46)m = 0.15 x (45)m	31.4875	27.6803	29.0742	24.8671	23.6117	20.7476	20.1345	21.2577	21.8408	24.9791	27.3106	31.0608	(46)
Water storage loss: Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(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	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(64)

Total per year (kWh/year) = Sum(64)m = 2627.0125 (64)
12Total per year (kWh/year) 2627 (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	82.5370	72.8648	77.1876	67.4509	65.0790	58.3193	57.3712	59.8610	60.7425	68.1100	72.8672	81.5912	(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	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	203.8904	225.7358	203.8904	210.6868	203.8904	210.6868	203.8904	203.8904	210.6868	203.8904	210.6868	203.8904	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	398.9044	403.0438	392.6127	370.4061	342.3743	316.0283	298.4276	294.2882	304.7193	326.9259	354.9578	381.3037	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	(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)	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	(71)
Water heating gains (Table 5)	110.9369	108.4297	103.7468	93.6818	87.4718	80.9990	77.1118	80.4583	84.3646	91.5456	101.2045	109.6655	(72)
Total internal gains	785.3494	808.8270	771.8676	746.3924	705.3541	676.3318	648.0475	647.2546	668.3884	693.9796	738.4667	766.4773	(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	3.4600	11.2829	0.6300	0.7000	0.7700	11.9308	(75)
East	1.3700	19.6403	0.6300	0.7000	0.7700	8.2232	(76)
Southeast	8.9100	36.7938	0.6300	0.7000	0.7700	100.1900	(77)
South	1.3700	46.7521	0.6300	0.7000	0.7700	19.5746	(78)
Southwest	2.1600	36.7938	0.6300	0.7000	0.7700	24.2885	(79)
Northwest	19.2000	11.2829	0.6300	0.7000	0.7700	66.2057	(81)
Northwest	6.0000	26.0000	0.6300	0.7000	1.0000	61.9164	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	292.3292	547.8222	872.6114	1272.0718	1587.8928	1645.1612	1557.7192	1313.5604	1010.6343	639.5502	359.4547	244.0239	(83)
Total gains	1077.6786	1356.6492	1644.4790	2018.4642	2293.2469	2321.4930	2205.7667	1960.8151	1679.0227	1333.5298	1097.9214	1010.5012	(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	67.2783	67.3992	67.5182	68.0826	68.1892	68.6901	68.6901	68.7837	68.4963	68.1892	67.9738	67.7501	
alpha	5.4852	5.4933	5.5012	5.5388	5.5459	5.5793	5.5793	5.5856	5.5664	5.5459	5.5316	5.5167	
util living area	0.9994	0.9978	0.9908	0.9512	0.8250	0.6211	0.4608	0.5367	0.8294	0.9837	0.9984	0.9996	(86)
MIT	19.6242	19.8266	20.1411	20.5607	20.8625	20.9773	20.9964	20.9920	20.8961	20.4627	19.9640	19.5924	(87)
Th 2	20.0566	20.0581	20.0596	20.0667	20.0680	20.0742	20.0742	20.0753	20.0718	20.0680	20.0653	20.0625	(88)
util rest of house	0.9992	0.9970	0.9875	0.9340	0.7742	0.5399	0.3657	0.4332	0.7592	0.9755	0.9977	0.9995	(89)
MIT 2	18.4280	18.6882	19.0902	19.6159	19.9539	20.0616	20.0730	20.0725	19.9989	19.5055	18.8700	18.3915	(90)
Living area fraction									fLA = Living area / (4) =			0.1093	(91)
MIT	18.5587	18.8126	19.2050	19.7191	20.0532	20.1616	20.1739	20.1729	20.0969	19.6101	18.9895	18.5227	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.5587	18.8126	19.2050	19.7191	20.0532	20.1616	20.1739	20.1729	20.0969	19.6101	18.9895	18.5227	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9987	0.9955	0.9833	0.9261	0.7733	0.5478	0.3760	0.4444	0.7613	0.9697	0.9965	0.9991	(94)
Useful gains	1076.3049	1350.5766	1617.0400	1869.2637	1773.3048	1271.8161	829.4648	871.3986	1278.3056	1293.1795	1094.1258	1009.5934	(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	3387.8803	3299.7238	3008.0104	2540.2607	1958.2203	1294.2879	831.7128	876.8363	1399.5381	2112.2135	2796.0582	3379.3976	(97)
Space heating kWh	1719.8121	1309.8269	1034.8820	483.1179	137.5771	0.0000	0.0000	0.0000	0.0000	609.3613	1225.3914	1763.1343	(98a)
Space heating requirement - total per year (kWh/year)												8283.1030	
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	1719.8121	1309.8269	1034.8820	483.1179	137.5771	0.0000	0.0000	0.0000	0.0000	609.3613	1225.3914	1763.1343	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												8283.1030	
Space heating per m2										(98c) / (4) =		35.9838	(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	1719.8121	1309.8269	1034.8820	483.1179	137.5771	0.0000	0.0000	0.0000	0.0000	609.3613	1225.3914	1763.1343	(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)	1861.2685	1417.5616	1120.0022	522.8549	148.8930	0.0000	0.0000	0.0000	0.0000	659.4819	1326.1811	1908.1541	(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	260.8756	230.5624	244.7872	215.0959	208.3703	187.6324	185.1888	192.6770	194.9204	217.4859	231.3857	258.0309	(64)
Efficiency of water heater												80.3000	(216)
(217)m	87.6634	87.4974	87.1153	86.0606	83.5128	80.3000	80.3000	80.3000	80.3000	86.4643	87.4130	87.7009	(217)
Fuel for water heating, kWh/month	297.5877	263.5078	280.9922	249.9355	249.5069	233.6643	230.6212	239.9465	242.7402	251.5326	264.7039	294.2169	(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	42.3644	33.9863	30.6009	22.4195	17.3175	14.1485	15.7976	20.5343	26.6720	34.9951	39.5269	43.5418	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-86.7327	-117.8434	-163.2339	-176.5059	-184.3999	-169.7705	-167.3635	-160.6469	-148.2872	-131.0217	-93.6281	-75.4885	(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	-63.4646	-131.5332	-257.9996	-382.7633	-501.7931	-502.8807	-497.2409	-423.2159	-312.9724	-186.8406	-84.2821	-50.3648	(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	8964.3972	(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	3098.9557	(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)	341.9050	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-5070.2735	(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	7420.9844	(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	8964.3972	0.2100	1882.5234	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3098.9557	0.2100	650.7807	(264)
Space and water heating			2533.3041	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	341.9050	0.1443	49.3475	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1674.9223	0.1354	-226.8430	
PV Unit electricity exported	-3395.3513	0.1262	-428.6615	
Total			-655.5045	(269)
Total CO2, kg/year			1939.0763	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			8.4200	(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	8964.3972	1.1300	10129.7688	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3098.9557	1.1300	3501.8200	(278)
Space and water heating			13631.5888	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	341.9050	1.5338	524.4253	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1674.9223	1.5006	-2513.3747	
PV Unit electricity exported	-3395.3513	0.4634	-1573.5329	
Total			-4086.9075	(283)
Total Primary energy kWh/year			10199.2073	(286)
Target Primary Energy Rate (TPER)			44.3100	(287)

Appendix 2 – DER Worksheets for the Proposed House for the Be Green scenario

Full SAP Calculation Printout

elmhurst energy

Property Reference	Atbara 4BH DET 230 - Be Green	Issued on Date	01/07/2024
Assessment Reference	Atbara 4BH DET 230 - Be Green	Prop Type Ref	Atbara 4BH DET 230 - Be Green
Property	99, Atbara Road, Teddington, London, TW11 9PA		

SAP Rating	89 B	DER	1.89	TER	8.35
Environmental	98 A	% DER < TER			77.37
CO_2 Emissions (t/year)	0.35	DFEE	35.23	TFEE	39.53
Compliance Check	See BREL	% DFEE < TFEE			10.87
% DPER < TPER	51.09	DPER	21.49	TPER	43.94

Assessor Details	Mr. Ivan Ball	Assessor ID	DE88-0001
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	102.5800 (1b)	x	2.4200 (2b)	=	248.2436 (1b) - (3b)
First floor	73.6900 (1c)	x	2.4000 (2c)	=	176.8560 (1c) - (3c)
Second floor	53.9200 (1d)	x	2.1100 (2d)	=	113.7712 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 230.1900					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	538.8708 (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	4 * 10 =	40.0000 (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) =	40.0000 / (5) =	0.0742 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		4.0000 (17)
Infiltration rate		0.2742 (18)
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2331 (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	0.2972	0.2914	0.2855	0.2564	0.2506	0.2214	0.2214	0.2156	0.2331	0.2506	0.2622	0.2739	(22b)
Effective ac	0.5442	0.5424	0.5408	0.5329	0.5314	0.5245	0.5245	0.5232	0.5272	0.5314	0.5344	0.5375	(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	
Windows & Glazed Doors (Uw = 1.20)			36.4700	1.1450	41.7595			(27)
Doors			3.7500	1.2000	4.5000			(26a)
Kitchen			6.0000	1.1450	6.8702			(27a)
Ground Floor			102.5800	0.1100	11.2838			(28a)
External Walls	218.4100	38.0600	180.3500	0.1500	27.0525			(29a)
Low Level Walls &Dormer Cheeks	28.8400	2.1600	26.6800	0.1500	4.0020			(29a)
Flat Roof over Ground Floor	28.8900	6.0000	22.8900	0.1300	2.9757			(30)
Cold Roof over First Floor	19.7700		19.7700	0.1000	1.9770			(30)
Sloping Ceilings	26.8300		26.8300	0.1300	3.4879			(30)
Flat Roof over Second Floor	32.6100		32.6100	0.1300	4.2393			(30)
Total net area of external elements Aum(A, m2)			457.9300					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	108.1480			(33)

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)	24.9600	0.0280	0.6989
E3 Sill	17.2400	0.0240	0.4138

E4 Jamb	71.5000	0.0190	1.3585		
E5 Ground floor (normal)	44.1500	0.0460	2.0309		
E10 Eaves (insulation at ceiling level)	15.5600	0.0510	0.7936		
E6 Intermediate floor within a dwelling	67.8800	0.0000	0.0000		
E11 Eaves (insulation at rafter level)	7.8000	0.0180	0.1404		
E12 Gable (insulation at ceiling level)	13.4200	0.0290	0.3892		
E14 Flat roof	15.8600	0.0410	0.6503		
E16 Corner (normal)	46.9600	0.0370	1.7375		
E17 Corner (inverted - internal area greater than external area)	22.8800	-0.0790	-1.8075		
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				6.4054	(36)
Point Thermal bridges			(36a) =	0.0000	
Total fabric heat loss			(33) + (36) + (36a) =	114.5534	(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	96.7670	96.4621	96.1632	94.7592	94.4965	93.2736	93.2736	93.0472	93.7446	94.4965	95.0279	95.5834	(38)
Heat transfer coeff	211.3204	211.0155	210.7166	209.3126	209.0499	207.8270	207.8270	207.6006	208.2981	209.0499	209.5813	210.1368	(39)
Average = Sum(39)m / 12 =												209.3113	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9180	0.9167	0.9154	0.9093	0.9082	0.9028	0.9028	0.9019	0.9049	0.9082	0.9105	0.9129	(40)
HLP (average)												0.9093	
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												3.0412	(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	86.7689	85.4803	83.6656	80.3197	77.8143	75.0362	73.5356	75.3376	77.2996	80.2723	83.6871	86.4756	(42b)
Hot water usage for other uses	45.7747	44.1102	42.4456	40.7811	39.1166	37.4520	37.4520	39.1166	40.7811	42.4456	44.1102	45.7747	(42c)
Average daily hot water use (litres/day)												122.0618	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	132.5436	129.5904	126.1112	121.1008	116.9308	112.4882	110.9876	114.4541	118.0807	122.7179	127.7973	132.2503	(44)
Energy conte	209.9167	184.5350	193.8283	165.7809	157.4114	138.3174	134.2299	141.7181	145.6053	166.5270	182.0706	207.0720	(45)
Energy content (annual)										Total = Sum(45)m =		2027.0125	
Distribution loss (46)m = 0.15 x (45)m	31.4875	27.6803	29.0742	24.8671	23.6117	20.7476	20.1345	21.2577	21.8408	24.9791	27.3106	31.0608	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.4000	(48)
Temperature factor from Table 2b												0.7800	(49)
Enter (49) or (54) in (55)												1.0920	(55)
Total storage loss	33.8520	30.5760	33.8520	32.7600	33.8520	32.7600	33.8520	33.8520	32.7600	33.8520	32.7600	33.8520	(56)
If cylinder contains dedicated solar storage	33.8520	30.5760	33.8520	32.7600	33.8520	32.7600	33.8520	33.8520	32.7600	33.8520	32.7600	33.8520	(57)
Primary loss	106.3213	96.0322	106.3213	102.8916	106.3213	36.0948	37.2980	37.2980	36.0948	106.3213	102.8916	106.3213	(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	350.0900	311.1432	334.0016	301.4325	297.5847	207.1722	205.3799	212.8681	214.4601	306.7003	317.7222	347.2453	(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	350.0900	311.1432	334.0016	301.4325	297.5847	207.1722	205.3799	212.8681	214.4601	306.7003	317.7222	347.2453	(64)
								Total per year (kWh/year) = Sum(64)m =				3405.8000	(64)
12Total per year (kWh/year)												3406	(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	154.8544	138.1836	149.5050	137.4354	137.3963	74.8664	74.4698	76.9596	77.2896	140.4273	142.8518	153.9085	(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	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	152.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	203.8904	225.7358	203.8904	210.6868	203.8904	210.6868	203.8904	203.8904	210.6868	203.8904	210.6868	203.8904	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	398.9044	403.0438	392.6127	370.4061	342.3743	316.0283	298.4276	294.2882	304.7193	326.9259	354.9578	381.3037	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	38.2059	(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)	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	-121.6471	(71)
Water heating gains (Table 5)	208.1376	205.6304	200.9475	190.8825	184.6725	103.9811	100.0938	103.4404	107.3467	188.7464	198.4052	206.8662	(72)
Total internal gains	879.5501	903.0277	866.0683	840.5931	799.5549	699.3138	671.0295	670.2367	691.3704	788.1803	832.6674	860.6780	(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	3.4600	11.2829	0.5000	0.7000	0.7700	9.4689	(75)
East	1.3700	19.6403	0.5000	0.7000	0.7700	6.5263	(76)
Southeast	8.9100	36.7938	0.5000	0.7000	0.7700	79.5159	(77)
South	1.3700	46.7521	0.5000	0.7000	0.7700	15.5354	(78)
Southwest	2.1600	36.7938	0.5000	0.7000	0.7700	19.2766	(79)
Northwest	19.2000	11.2829	0.5000	0.7000	0.7700	52.5442	(81)

Northwest	6.0000	26.0000	0.5000	0.7000	1.0000	49.1400	(82)

Solar gains	232.0073	434.7795	692.5487	1009.5808	1260.2324	1305.6835	1236.2851	1042.5083	802.0907	507.5795	285.2815	193.6698	(83)
Total gains	1111.5574	1337.8072	1558.6170	1850.1739	2059.7872	2004.9973	1907.3146	1712.7450	1493.4611	1295.7598	1117.9489	1054.3478	(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	75.6454	75.7547	75.8622	76.3710	76.4670	76.9169	76.9169	77.0008	76.7430	76.4670	76.2731	76.0715	
alpha	6.0430	6.0503	6.0575	6.0914	6.0978	6.1278	6.1278	6.1334	6.1162	6.0978	6.0849	6.0714	
util living area	0.9994	0.9978	0.9916	0.9554	0.8331	0.6443	0.4767	0.5506	0.8425	0.9823	0.9982	0.9995	(86)
Living	20.0668	20.1964	20.3979	20.6696	20.8657	20.9353	20.9474	20.9450	20.8838	20.6198	20.2926	20.0449	
Non living	19.0384	19.2053	19.4631	19.8047	20.0252	20.0920	20.0994	20.0993	20.0511	19.7498	19.3332	19.0139	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.5226	20.1964	20.3979	20.6696	20.8657	20.9353	20.9474	20.9450	20.8838	20.6198	20.2926	20.1785	(87)
Th 2	20.1522	20.1533	20.1544	20.1596	20.1606	20.1651	20.1651	20.1659	20.1633	20.1606	20.1586	20.1566	(88)
util rest of house	0.9991	0.9971	0.9887	0.9400	0.7862	0.5683	0.3877	0.4544	0.7785	0.9738	0.9974	0.9994	(89)
MIT 2	19.7082	19.2053	19.4631	19.8047	20.0252	20.0920	20.0994	20.0993	20.0511	19.7498	19.3332	19.2198	(90)
Living area fraction									fLA = Living area / (4) =			0.1093	(91)
MIT	19.7972	19.3136	19.5652	19.8992	20.1170	20.1841	20.1921	20.1917	20.1421	19.8448	19.4380	19.3246	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7972	19.3136	19.5652	19.8992	20.1170	20.1841	20.1921	20.1917	20.1421	19.8448	19.4380	19.3246	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9990	0.9961	0.9859	0.9342	0.7835	0.5701	0.3906	0.4575	0.7766	0.9694	0.9965	0.9992	(94)
Useful gains	1110.4851	1332.5842	1536.6716	1728.4087	1613.7808	1143.0403	745.0757	783.5347	1159.8456	1256.1400	1114.0790	1053.4795	(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	3274.8661	3041.4890	2753.0514	2302.2699	1759.5814	1160.5371	746.5265	787.1628	1258.5548	1932.6284	2585.8099	3178.2276	(97)
Space heating kWh	1610.2994	1148.3841	904.9865	413.1800	108.4756	0.0000	0.0000	0.0000	0.0000	503.3074	1059.6462	1580.8126	(98a)
Space heating requirement - total per year (kWh/year)												7329.0919	
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	1610.2994	1148.3841	904.9865	413.1800	108.4756	0.0000	0.0000	0.0000	0.0000	503.3074	1059.6462	1580.8126	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												7329.0919	
Space heating per m2											(98c) / (4) =	31.8393	(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 %)	371.7337	(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	1610.2994	1148.3841	904.9865	413.1800	108.4756	0.0000	0.0000	0.0000	0.0000	503.3074	1059.6462	1580.8126	(98)
Space heating efficiency (main heating system 1)	371.7337	371.7337	371.7337	371.7337	371.7337	0.0000	0.0000	0.0000	0.0000	371.7337	371.7337	371.7337	(210)
Space heating fuel (main heating system)	433.1863	308.9266	243.4502	111.1495	29.1810	0.0000	0.0000	0.0000	0.0000	135.3946	285.0552	425.2541	(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	350.0900	311.1432	334.0016	301.4325	297.5847	207.1722	205.3799	212.8681	214.4601	306.7003	317.7222	347.2453	(64)
Efficiency of water heater												174.3693	(216)
(217)m	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	174.3693	(217)
Fuel for water heating, kWh/month	200.7750	178.4392	191.5484	172.8701	170.6634	118.8123	117.7844	122.0789	122.9919	175.8912	182.2122	199.1436	(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	42.3644	33.9863	30.6009	22.4195	17.3175	14.1485	15.7976	20.5343	26.6720	34.9951	39.5269	43.5418	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-37.4533	-57.1308	-88.0562	-104.1652	-115.6144	-106.0854	-104.7351	-96.2435	-81.8331	-67.0447	-42.4261	-31.8521	(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	-8.2297	-18.7178	-40.0632	-65.9382	-93.0931	-98.5034	-97.4062	-81.3400	-58.4604	-29.6340	-11.6858	-6.4265	(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	1971.5976	(211)
Space heating fuel - main system 2	0.0000	(213)

Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	174.3693	
Water heating fuel used	1953.2106	(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)	341.9050	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1542.1382	(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	2724.5750	(238)

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

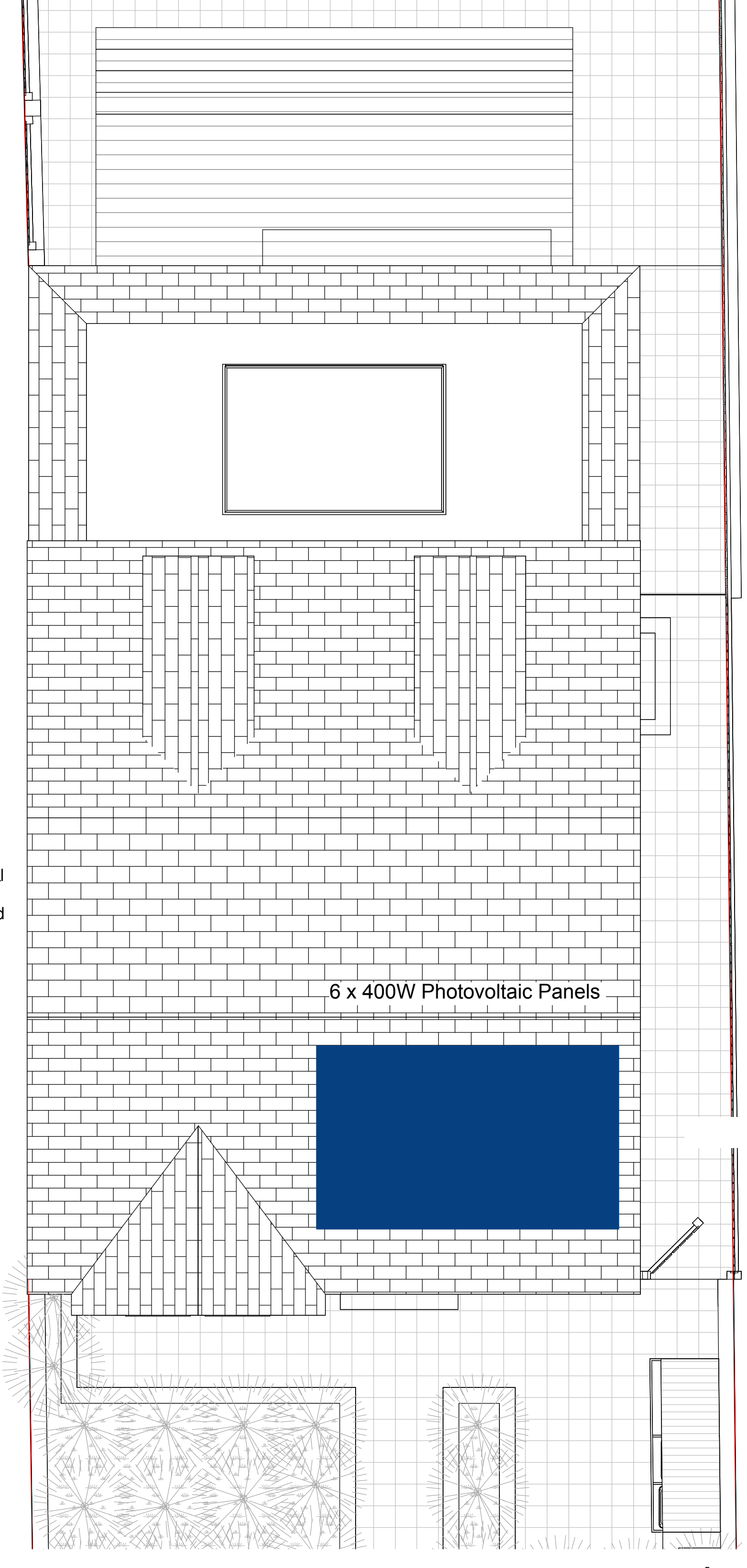
	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1971.5976	0.1561	307.8052	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1953.2106	0.1422	277.7365	(264)
Space and water heating			585.5417	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	341.9050	0.1443	49.3475	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-932.6398	0.1337	-124.7102	
PV Unit electricity exported	-609.4983	0.1231	-75.0064	
Total			-199.7166	(269)
Total CO2, kg/year			435.1726	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			1.8900	(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	1971.5976	1.5780	3111.1225	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1953.2106	1.5259	2980.3614	(278)
Space and water heating			6091.4839	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	341.9050	1.5338	524.4253	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-932.6398	1.4942	-1393.5126	
PV Unit electricity exported	-609.4983	0.4516	-275.2221	
Total			-1668.7347	(283)
Total Primary energy kWh/year			4947.1745	(286)
Dwelling Primary energy Rate (DPER)			21.4900	(287)

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

Roof material to be gray slate with red ridge tiles



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): 99 Atbara Road, Teddington
Application No. (if known):

Address (include. postcode): 99 Atbara Road, Teddington
Completed by: Ivan Ball

For Non-Residential
Size of development (m2):

For Residential
Number of dwellings: 1

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 — 77.55 %
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 — 19.66 %
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? — 57.89 %

What is the total remaining carbon to be offset — 0.435 Tonne
Policy LP 22 B. and Draft London Plan Policy 9.2.4 require Major developments to achieve Zero Carbon after offsetting.

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

What is the total predicted cost of offset? — N/A £
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. — *1* — **TRUE**
110l/p/d Required for new dwellings under Policy LP22 A 2 105l/p/d required under Draft London Plan Policy SI5

Subtotal 1

2. ENERGY USE AND POLLUTION

2.1 Need for Cooling

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

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**

	Score	
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

	Score	
Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site?	*3*	**FALSE**
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	**16**	

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		
a.	Does your development provide opportunities for occupants to use innovative travel technologies?			FALSE
	Please explain:			
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		TRUE
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?		2	
	Is this shown on the site plans?			TRUE
	See Local Plan Appendix 3			
f.	Will the development create or improve links with local and wider transport networks? If yes, please provide details.	2		FALSE
		Subtotal	**9**	

Please give any additional relevant comments to the Transport Section below

A car charging will be provided. Cycle storage is provided.

4 BIODIVERSITY

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

a.	Does your development involve the loss of an ecological feature or habitat, including a loss of garden or other green space? (Indicate if yes)			-2	FALSE
	If so, please state how much in sqm?			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)				TRUE
c.	Does your development plan to add (and not remove) any tree(s) on site? (Indicate if yes)				FALSE
d.	Please indicate which features and/or habitats that your development will incorporate to improve on site biodiversity:				
	Pond, reedbed or extensive native planting	6	Area provided:	sqm	FALSE
	An extensive green roof	5	Area provided:	sqm	FALSE
	An intensive green roof	4	Area provided:	sqm	FALSE
	Garden space	4	Area provided:	89.86 sqm	TRUE
	Additional native and/or wildlife friendly planting to peripheral areas	3	Area provided:	sqm	TRUE
	Additional planting to peripheral areas	2	Area provided:	sqm	FALSE
	A living wall	2	Area provided:	sqm	FALSE
	Bat boxes	0.5			TRUE
	Bird boxes	0.5			TRUE
	Swift boxes	0.5			FALSE
	Other	0.5			FALSE
e.	Does your development use at least 70% of available roof plate as green/brown roof			1	FALSE
	Policy LP 17 requires 70%				
				Subtotal	**8**

Please give any additional relevant comments to the Biodiversity Section below

It is assumed Bat boxes, Bird boxes and Swift boxes will be installed.

5 FLOODING AND DRAINAGE

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

a.	Is your site located in a high flood risk zone (Zone 3)? (Indicate if yes)	-2		TRUE
	Have you submitted a Flood Risk Assessment? (Indicate if yes)			TRUE
b.	Which of the following measures of the drainage hierarchy are incorporated onto your site? (tick all that apply)			
	Store rainwater for later use	5		TRUE
	Use of infiltration techniques such as porous surfacing materials to allow drainage on-site	3		TRUE
	Attenuate rainwater in ponds or open water features	4		FALSE
	Store rainwater in tanks for gradual release to a watercourse	3		TRUE
	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)			TRUE
	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:	-38	sqm	
	Please provide details of the permeable surfacing below	*please represent a loss in permeable area as a negative number*		
		Subtotal	**9**	

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

Rainwater butts will be provided to store rainwater for landscape irrigation. Geocellular attenuation wil be provided to allow controlled release to the public sewer. A SuDS Strategy has been prepared and supports the planning application.

6 IMPROVING RESOURCE EFFICIENCY

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

a.	Will demolition be required on your site prior to construction? *[Points will only be awarded if 10% or greater of demolition waste is reused/recycled]*	1		TRUE
	If so, what percentage of demolition waste will be reused in the new development?	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*** ***49***

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** ____________________