Integration

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68 Elsworthy Road
Energy & Sustainability Statement

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Project no	**Project**	**Client**	**In conjunction with:**
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Revision	**Date**	**Status**	**Prepared by**	**Checked by**
—	25.01.2024	Issue	Natasha Sidhu	Alan Harries

Contents

Executive Summary

This Energy and Sustainability Statement has been prepared by Integration Consultancy Limited in support of the full planning application for the proposed development at 68 Elsworthy Road in the London Borough of Camden. The existing unlisted 3 storey house has fallen into a state of disrepair and the proposed development comprises the refurbishment of the property together with a rear extension, to align with the development at no. 66, and a new basement.

CARBON

The local policy targets include a minimum onsite contribution of 35% below Part L and the minimum energy efficiency ("Be Lean") onsite contribution is 10%. For a deep refurbishment, local policy state that "deep refurbishments should also meet the London Plan carbon reduction targets for new buildings".

In relation to these targets, this development has been shown to have:

– 56% total onsite improvement in carbon dioxide (CO_2) emissions over the Target Emission Rate (TER) outlined in the national Building Regulations 2021 - compared to the target of 35%.

– 11% dwelling energy efficiency (Be Lean) contribution to the improvement in carbon dioxide (CO_2) emissions over the Be Lean Target Emission Rate (TER) - compared to the target of 10%.

The proposed design achieves this via the following strategies:

High-Efficiency Building (Be Lean)

The scheme uses high performance building fabric, passive low energy design and low energy building services systems such as mechanical ventilation with heat recovery (MVHR) and LED lighting.

Local Renewable Energy (Be Green)

Following a Low and Zero Carbon (LZC) Technology feasibility study it is proposed to provide:

- 2kWpeak of solar photovoltaic (PV) modules located at roof level.
- Space heating and hot water via ground source heat pumps which will be in part powered by the local solar PV array.

The table below shows the overall regulated and unregulated energy use.

Carbon dioxide emissions (Tonnes CO_2 per annum)	**Regulated**	**Unregulated**
Baseline: Part L 2021 (Building Regulations) Compliance	8.8	1.8
After "Be Lean" (energy demand reduction)	7.8	1.8
After "Be Clean" (heat network / CHP)	7.8	1.8
After "Be Green" (renewable energy)	3.9	1.8

Table 1: Summary of refurbishment carbon emissions

This performance can be expressed as savings between each stage in the energy hierarchy.

Regulated carbon dioxide savings	**(Tonnes CO_2 per annum)**	**(%)**
Savings from "Be Lean" (energy demand reduction)	1.0	11%
Savings from "Be Clean" (heat network / CHP)	0	0%
Savings from "Be Green" (renewable energy)	4.0	45%
Total cumulative on-site savings	4.9	56%
Shortfall to 100% below Part L (annual)	3.9	
Shortfall over 30 years	116	
Carbon Offset Fund (@£95/tonne)	£ 11,036	

Table 2: Regulated CO_2 emissions savings after each stage of the Energy Hierarchy

SUSTAINABILITY

In addition to the low energy performance set out above, the scheme benefits from several sustainability aspects. These include the use of water saving devices to achieve 105 litre per person per day. Health and wellbeing is supported by aspects such as high levels of fresh air provided by mechanical ventilation with heat recovery. In terms of sustainable travel, the dwelling is within walking distance from South Hempstead, Swiss Cottage and St John's Wood stations as well as local several bus stops. A residents' guide will be created to help residents reduce energy, water and waste, avoid overheating and keep air quality high. The development aims to support biodiversity e.g. through green roofs on the first floor extension and the garden room.

The scheme is also demand side response (DSR) enabled through the provision of a large centralised electric-powered heat pump systems with large energy storage vessels located in the basement plantroom in order to work with National Grid signalling / time of use tariffs. This supports the transition to low carbon electricity and reduces energy costs for residents.

1 Introduction

Integration Consultancy Limited has been appointed to undertake an Energy and Sustainability Statement in support of the full planning application for the proposed 68 Elsworthy Road refurbishment in the London Borough of Camden. The report is one of several that accompany the planning application and should be read in conjunction with these documents.

The importance of developing a robust well-considered energy and sustainability strategy cannot be overstated. This strategy sets out the roadmap for the entire project and ultimately the success of the strategy will translate into the success of the building's performance on practical completion and throughout its lifecycle.

Underpinning the energy strategy is the 'Be Lean', 'Be Clean 'and 'Be Green' design framework which has been adopted by the London Plan.

- 'Be Lean' (energy demand minimisation through 'passive' and 'active' design measures)
- 'Be Clean' (efficient energy supply)
- 'Be Green' (renewable energy generation)

This report sets out the scheme's energy and sustainability aspirations and demonstrates, via the approved calculation methodologies, how these will be achieved through the detailed design and construction stages.

As part of this exercise, the feasibility of implementing a variety of low carbon technologies and renewable energy systems is considered based on aspects such as site location and climate, potential carbon savings, economic viability, environmental impacts and practical aspects such as integration and maintenance considerations.

1.1 THE DEVELOPMENT SITE

The site is located at 68 Elsworthy Road, South Hampstead, London, NW3 3BP.

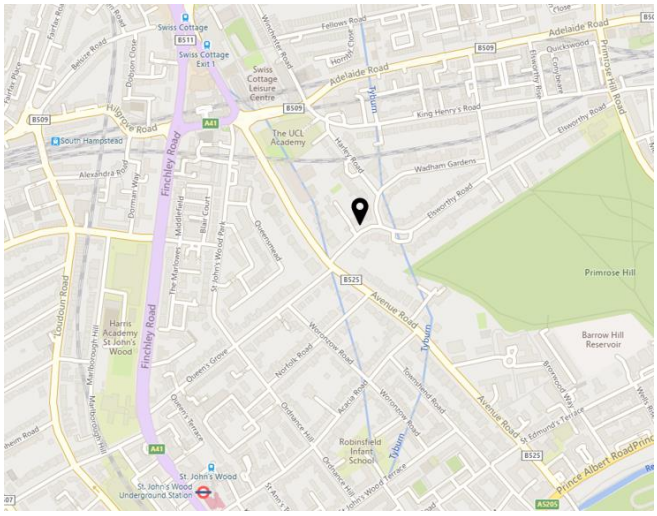

Figure 1: Site Location

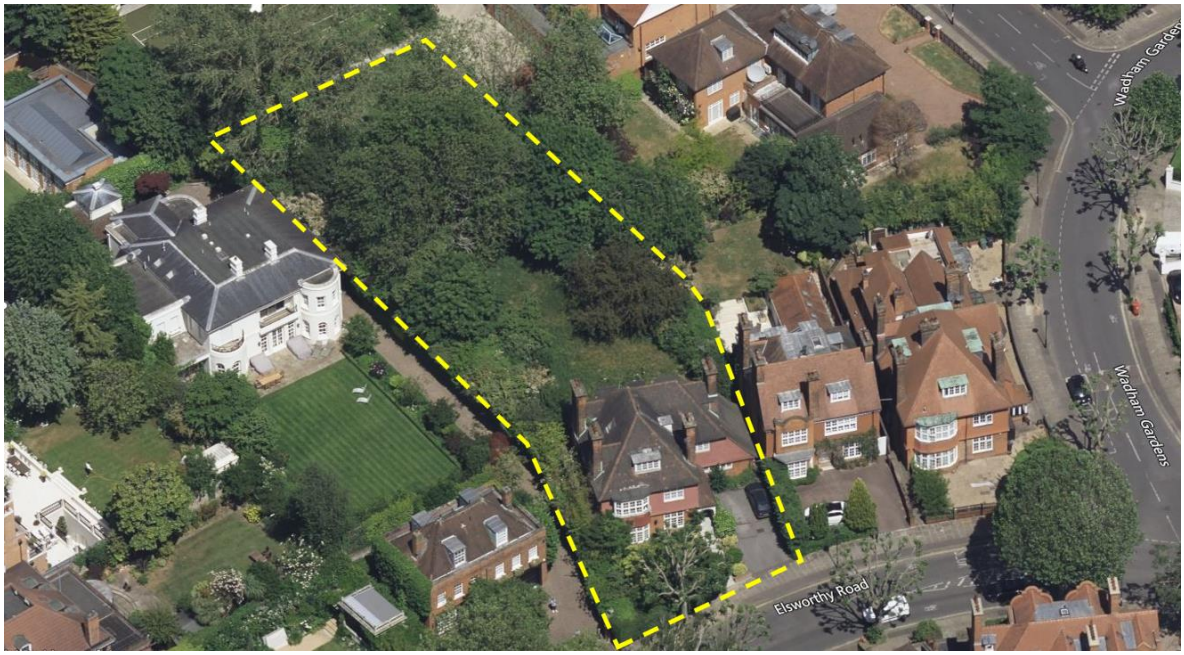

Figure 2: **Aerial view of site**

1.2 PROPOSED DEVELOPMENT OVERVIEW

The existing building is an unlisted 3 storey house, situated within the Elsworthy conservation area, which has fallen into a state of disrepair. The proposed development comprises a deep refurbishment and an extension to the rear to align with the development at no. 66 and a new basement. The demolition is kept to a minimum, only taking place where necessary for the extension, and where the existing structure is compromised.

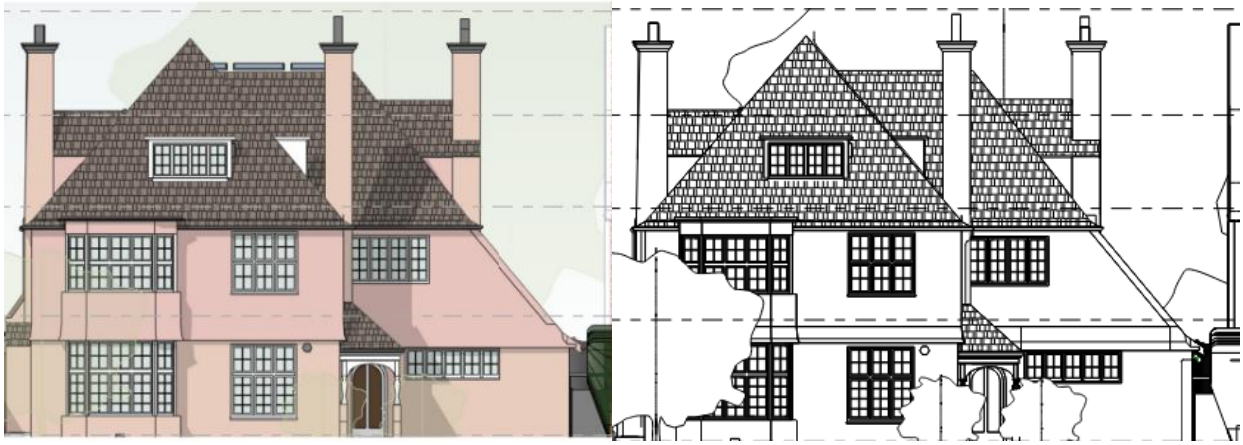

Figure 3: **Proposed and existing development scheme- front elevation**

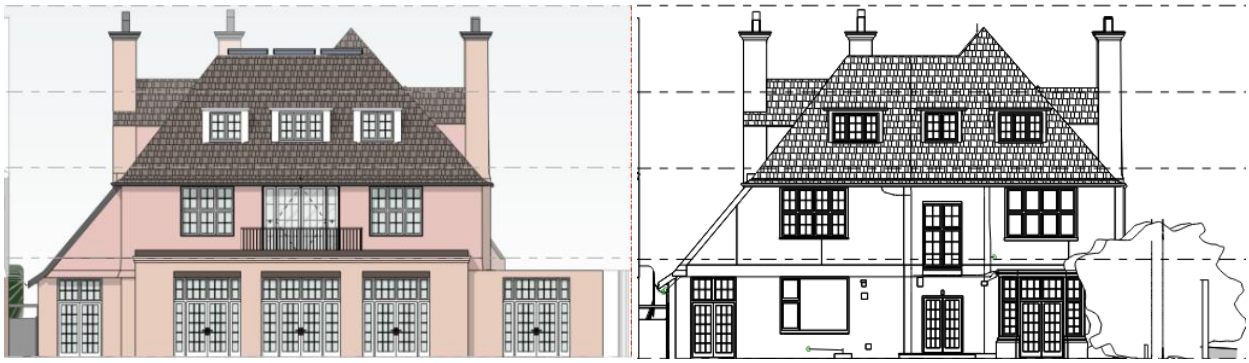

Figure 4: Proposed and existing development scheme- rear elevation

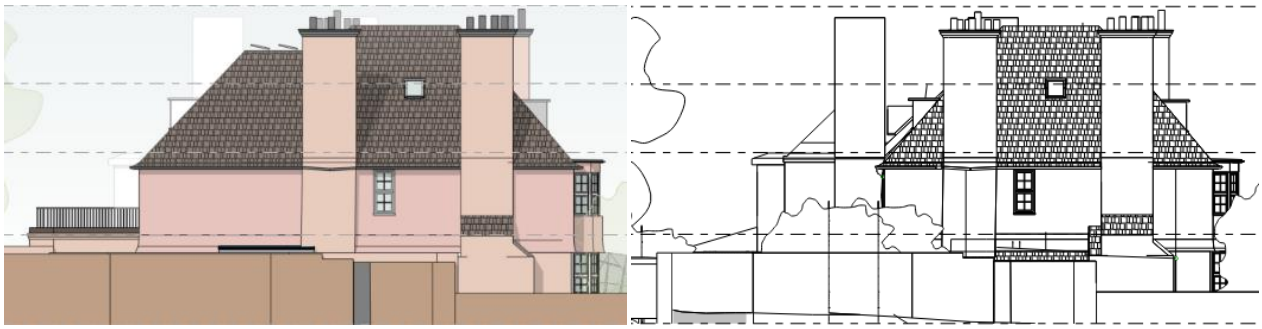

Figure 5: Proposed and existing development scheme- north elevation

Figure 6: Proposed and existing development scheme- south elevation

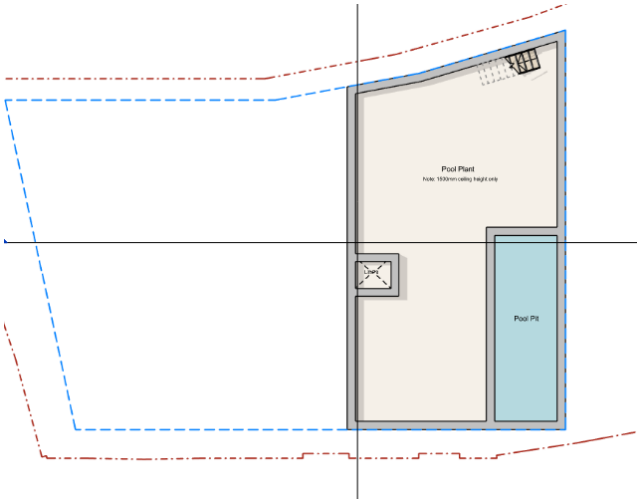

Figure 7: Proposed development scheme – new lower basement floor plan

Figure 8: Proposed development scheme – new basement floor plan

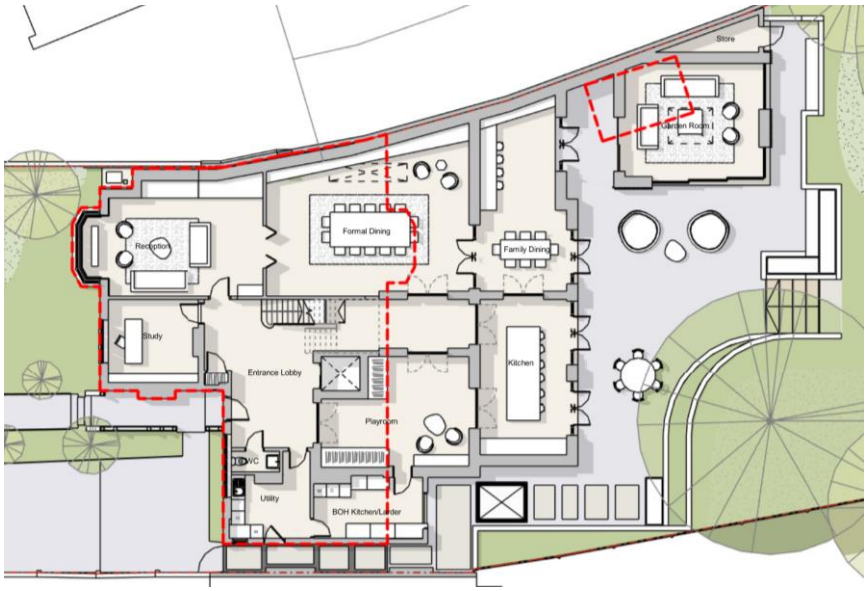

Figure 9: Proposed development scheme – Ground floor plan

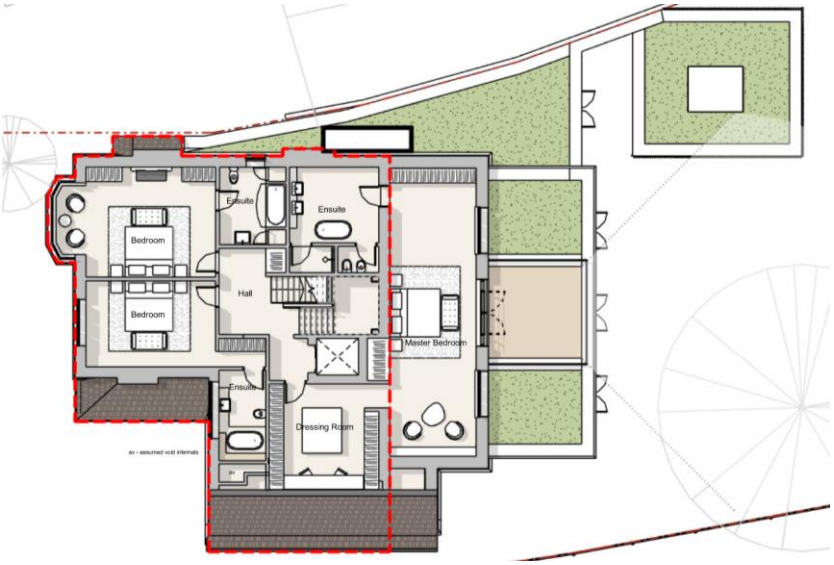

Figure 10: Proposed development scheme – First floor plan

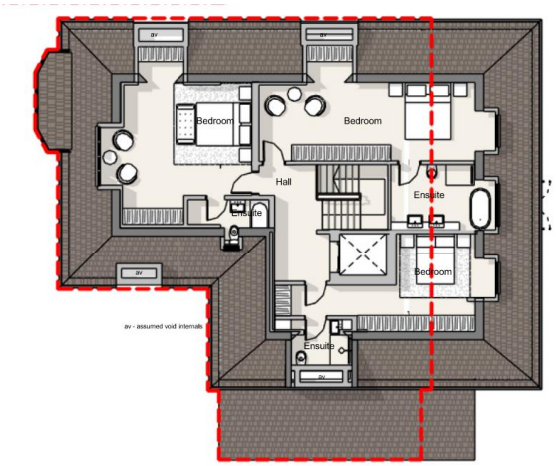

Figure 11: Proposed development scheme – Second floor plan

1.3 ENERGY AND SUSTAINABILITY ASPIRATIONS

The scheme has adopted energy and sustainability targets in line with the national and local policy as detailed in section 2. These include:

Zero CO_2 emissions: Achieve zero carbon (100% below Part L) with a minimum on-site contribution of 35% below Part L.

Energy Efficient: Achieve a minimum energy efficiency ("Be Lean") onsite contribution of 10%

Low Water Use: The development aims to meeting the London Plan target of achieving at least 105l/p/d.

Zero Fossil Fuels on site: In order to achieve zero carbon on-site by 2050 the scheme aims not to use any fossil fuels on site.

Biodiversity: The development aims to support biodiversity e.g. through green roofs.

2 Policy Review

2.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF – SEPTEMBER 2023)

Sustainable Development

The NPPF is very clear on the importance of sustainable development with the first line of the first main chapter stating "*The purpose of the planning system is to contribute to the achievement of sustainable development". Sustainable development meaning:*

- *economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;*
- *a social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering well-designed, beautiful and safe places, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and*
- *an environmental objective – to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.*

At the heart of the Framework is a presumption in favour of sustainable development.

Meeting the Challenge of Climate Change

Section 14 of the NPPF relates to the challenge of climate change. Paragraph 152 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."

The importance of renewable energy is also highlighted by paragraph 155 and 156.

National Carbon Targets

The UK government declared a Climate Emergency and amended the Climate Change Act in June 2019 to set a legally-binding carbon emission target for the UK of "at least 100% of 1990 levels by 2050" i.e. net zero carbon emissions[1]. Around 20% of the UK's emissions come directly from residential energy use and government has set out a consultation process leading up to the Future Homes Standard which will define how the housing sector will respond to the emergency. This will replace Building Regulations in 2025.

2.2 LONDON PLAN 2021

Regional policy in London is controlled by The Greater London Authority and is set out in The London Plan adopted on 2nd March 2021 which provides policy and guidance in the London context. One of the key overarching goals for London is to become a zero-carbon city by 2030.

The plan states that all 'major' developments (greater than 1,000m^2 or 10 units or more) must achieve net zero carbon (100% below Part L). The remaining regulated carbon dioxide emissions to 100% can be off-set using a cash-in-lieu contribution to the local borough, to secure carbon dioxide savings elsewhere.

[1] Climate Change Act 2008 (c. 27) as amended by The Climate Change Act 2008 (2050 Target Amendment) Order 2019 [SI 2019 No. 1056]

The details of the main London Plan policy requirement are given below:

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:*
   - *Be lean: use less energy and manage demand during operation*
   - *Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly*
   - *Be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site*
   - *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:*
   - *through a cash in lieu contribution to the borough's carbon offset fund, or*
   - *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.*

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:*
   - *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)*
   - *achieve at least the BREEAM excellent standard for the 'Wat 01' water category 160 or equivalent (commercial development)*
   - *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.*

2.3 LOCAL POLICY

Camden Relevant Policies

The borough of Camden emerging Local Plan comprises a number of policies related to sustainability such as CC1: Climate change mitigation, CC2: Adapting to climate change, CC4: Air quality and CC5: Policy D2: Heritage.

Clarity on the local carbon policy is provided by the "Camden Planning Guidance Energy efficiency and adaptation" document dated January 2021.

Table 2a, reproduced below, presents the energy reduction targets for domestic developments. As the scheme is >1000m^2 it has been assessed against the major scheme requirements highlighted yellow below. As such the Be Lean target for the new build elements is 10% below Part L1 and the overall carbon reduction targets are 35% below Part L1.

Table 2a states that refurbishment areas should achieve the greatest possible carbon reduction. However, The "Key Messages" from section 7 "Energy Reduction" states that "deep refurbishments" should also meet the London Plan carbon reduction targets for new buildings. Therefore, the refurbished areas have also been assessed under Part L1 with the aim of achieving 10% below Part L for Be Lean and 35% below Part L overall.

7. Energy reduction

KEY MESSAGES

- *All development in Camden is expected to reduce carbon dioxide emissions through the application of the energy hierarchy.*
- *All new build major development to demonstrate compliance with London Plan targets for carbon dioxide emissions.*
- *Deep refurbishments (i.e. refurbishments assessed under Building Regulations Part L1A/L2A) should also meet the London Plan carbon reduction targets for new buildings.*
- *All new build residential development (of 1 – 9 dwellings) must meet 19% carbon dioxide reduction; and*
- *Developments of five or more dwellings and/or more than 500sqm of any gross internal floorspace to achieve 20% reduction in carbon dioxide emissions from on-site renewable energy generation.*

Table 2a Energy reduction targets, domestic

Development should comply with these standards/provide this information	Residential New Build (assessed under L1A)			Residential Refurbishment (assessed under L1B)		
	Major (10+ units or >1,000 sqm new floor space)	Medium (5-9 units, >500sq.m and <1,000 sqm new floor space)	Minor All new dwellings (up to 4 units and <500 sqm new floor space)	Major (10+ units or >1,000 sqm)	Medium (5-9 units, >500sq.m and <1,000 sqm)	Minor (up to 4 units and <500 sqm)
Energy and carbon reduction targets						
Overall carbon reduction targets:	*Zero Carbon, minimum 35% reduction beyond Part L Building Regulations on site, with 10% reduction through on-site energy efficiency measures).*	*19% below Part L of 2013 Building Regulations (Local Plan*	*19% below Part L of 2013 Building Regulations (Local Plan*	*Greatest possible reduction - meeting Part L1B for retained thermal*	*Greatest possible reduction - meeting Part L1B for retained thermal*	*Greatest possible reduction - meeting Part L1B for retained thermal*
	(London Plan, Local Plan CC1)	*CC1)*	*CC1)*	*elements (London Plan 5.4, Local Plan CC1)*	*elements (London Plan 5.4, Local Plan CC1)*	*elements (London Plan 5.4, Local Plan CC1)*
Reduction in CO2 from onsite renewables (after all other energy efficiency measures have been incorporated)	*20% (London Plan, Local Plan CC1)*	*20% (London Plan, Local Plan CC1)*	Incorporate renewables where feasible	*20% (London Plan 5.4, 5.7, Local Plan CC1)*	*20% (London Plan 5.4, 5.7, Local Plan CC1)*	Incorporate renewables where feasible

Table 3: Camden reduction targets (Table 2a, Camden Planning Energy Guidance Energy efficiency and adaptation)

3 Design Approach - Sustainability

3.1 WATER USE

For accommodation areas the development adopts equipment specification in line with the higher water use standard of 105 l/p.day.

Fitting	Water Consumption
WC	4 / 2.6 litres dual flush
Shower	8 litres / minute
Washbasin	5 litres / minute
Kitchen sink	6 litres / minute
Dishwasher	1.25 litres/place setting
Washing machine	8.17 litres/kg

Table 4: Minimum water fitting standards for units.

3.2 AIR QUALITY

Air quality is a priority for London and Policy SI 1 "Improving Air" states that developments proposals must be at least Air Quality Neutral.

The scheme supports air quality by:

- The use of ground-source heat pumps for all space heating and hot water means no fossil fuel combustion on site.
- Mechanical ventilation with heat recovery (MVHR) offers a means for occupants to filter fresh air.
- Construction environmental management plan (CEMP) to incorporate best practice for air quality and dust control.

3.3 NOISE

Quality of life is improved by reducing the number of people adversely affected by noise and promoting more quiet and tranquil spaces. The scheme supports low noise impacts through high air tightness and MVHR reduces external noise ingress for occupants.

3.4 SUSTAINABLE MATERIALS & MINIMISING WASTE

New materials will be sustainably procured and using local supplies where feasible, following the BRE Green Guide to Specification[2].

The construction build-up for each element can be rated from A+ to E where A+ is least likely to affect the environment and E is the likely to have the most impact. The materials for the new extension will aim to achieve a rating between A to C.

All timber used during the site preparation and construction will be Forest Stewardship Council (FSC) certified or Programme for the Endorsement of Forestry Certification (PEFC) and all nontimber materials to be sourced from organisations with an environmental management system such as ISO 14001 or BES 6001. This standard enables construction product manufacturers to ensure and then prove that their products have been made with constituent materials that have been responsibly sourced. The standard describes a framework for the organisational governance, supply chain management and environmental and social aspects that must be addressed in order to ensure the responsible sourcing of construction products.

A construction waste recycling requirement will be included in the contractor specification to ensure a construction waste management plan is in place. This will include ways to design out waste, reduce amounts of packaging and to participate in

[2] *https://www.bregroup.com/greenguide/podpage.jsp?id=2126*

packaging take back schemes as well as ensuring that all waste is sent to private local dedicated construction waste plants with high landfill diversion rates.

The scheme has dedicated waste storage and segregation area.

3.5 BIODIVERSITY

The scheme has green roofs on both the first floor extension and the garden room.

Figure 12: Proposed development scheme- roof plan

3.6 SUSTAINABLE TRANSPORT

In terms of sustainable travel, the dwelling is within walking distance from South Hempstead, Swiss Cottage and St John's Wood stations as well as several local bus stops.

3.7 DEMAND SIDE RESPONSE

Demand-side response / flexibility initiatives are encouraged by the London Plan, as referred to in Policy SI 2 Minimising greenhouse gas emissions. Demand side flexibility refers to the ability of a system to reduce or increase energy consumption for a period of time in response to an external driver (e.g. energy prices or signals from network managers).

Smart buildings have been identified and acknowledged as key enablers of future energy systems for which there will be a larger share of distributed and renewable power and heat generation. Demand-side flexibility can allow demand/supply matching and make best use of existing network connections and local renewable energy generation capacity.

The scheme facilitates the use of Demand Side Response and reduces peak energy demand by:

- The use of electrical equipment such as heat pumps which can be turned up/down.
- A large central energy store integrated into the centralised heat pumps system
- Additional energy storage capacity via exposed thermal mass.
- The installation of smart meters
- The use of on-site generation, solar PV.

4 Design Approach - Energy

4.1 THE ENERGY HIERARCHY

The energy hierarchy, as referred to in the London Plan and illustrated below, sets out a hierarchical approach to strategic decision-making for the reduction of energy and associated greenhouse gas emissions. The evaluation of the scheme's carbon emissions, as presented in the subsequent sections, follows this structure.

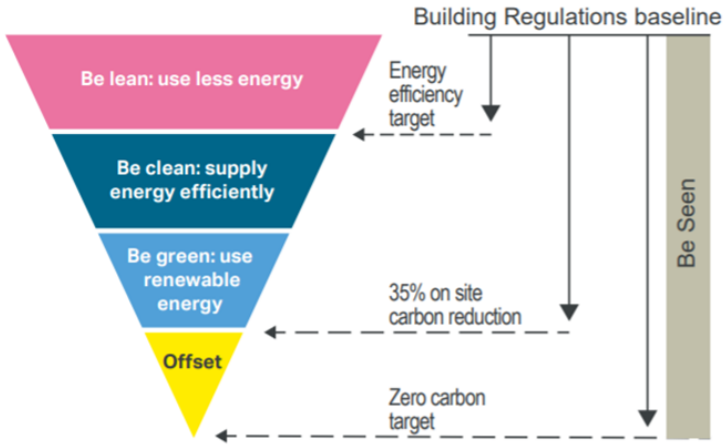

Figure 13: Energy Hierarchy Methodology

BE LEAN - Minimise Energy Demand
Passive design such as optimising form, orientation and site layout, natural ventilation with thermal mass, daylight and solar shading as well as active design measures such as LED lighting and efficient mechanical ventilation with heat recovery.

BE CLEAN - Deliver Energy Efficiently
Efficient energy provision for space heating and cooling infrastructure e.g. high efficiency cooling plant, combined heat and power (CHP) or, if available, connection to a district heating/cooling network.

BE GREEN - Use Renewable Energy
Energy supply derived from local renewable resources including solar irradiation, wind energy, hydropower and local heat sources such as geothermal energy. Provision of non-local options can also be considered.

4.2 CLIMATE ANALYSIS

The London climate is heating dominated, hence the key passive measure to be implemented are high levels of insulation and air-tightness. Temperatures in the summer can occasionally rise above comfortable levels and this will tend to intensify as a consequence of climate change and further urbanisation.

The diurnal temperature variations are high with an average daily temperature swing of 8-10°C even during peak summer. This creates potential for passive summertime cooling using night-time cooling via openable windows or mechanical ventilation.

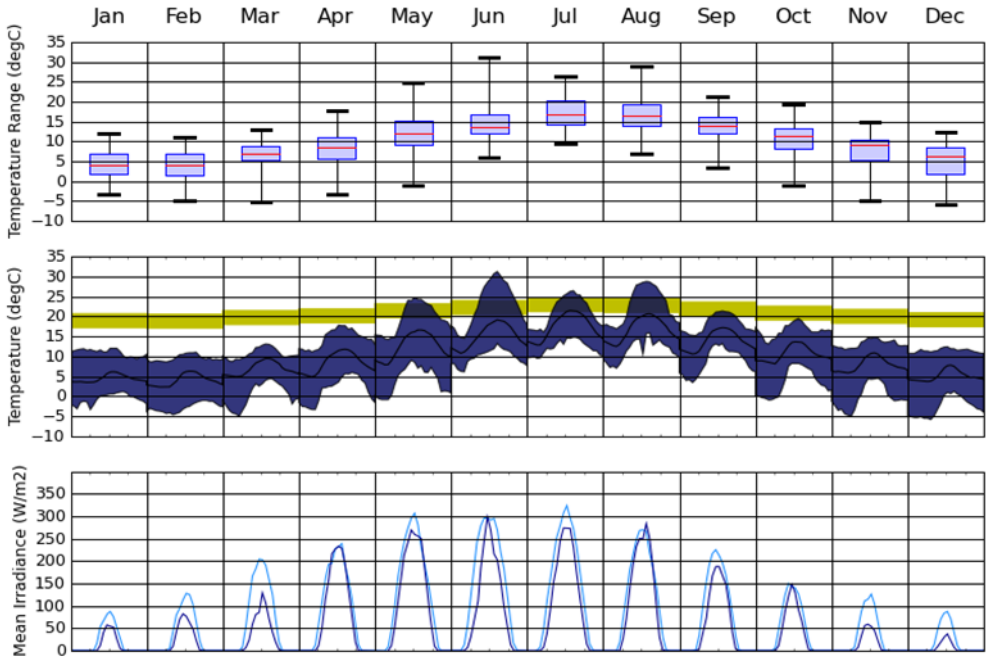

Figure 14: Average historic climate data for London

4.3 BUILDING FABRIC PERFORMANCE & INSULATION

High levels of insulation are proposed as summarised later in this section. The thermal performance of all exposed elements equals or exceeds the minimum requirements for Building Regulations 2021. This will significantly reduce energy consumption and ensure optimum occupant comfort all year round by retaining heat in the winter and reducing heat gains in the summer.

This is particularly relevant for glazed surfaces that can be a cause of overheating in summer or overcooling and condensation formation in winter. As such all glazing will be replaced with high-performance unit. This will also improve occupant comfort by reducing radiant temperature asymmetry which can be a comfort issue especially during the winter months.

4.4 AIR TIGHTNESS, INFILTRATION AND THERMAL BRIDGING

A high target air-permeability rate has been selected as summarised later in this section. The key to achieving high levels of airtightness is the build quality of construction.

Minimising thermal bridging is an important aspect of the design. The approach to limiting thermal bridging is to implement a level similar to Accredited Details[3] where possible.

[3] www.planningportal.co.uk/info/200135/approved_documents/74/part_l_-_conservation_of_fuel_and_power/6

4.5 NATURAL VENTILATION & THERMAL MASS

Daytime natural ventilation can assist in removing excess heat during the mid-season and summer months and enables the provision of high air quality. When used in combination with exposed thermal mass, natural ventilation will reduce high internal daily temperature fluctuations and minimise the overheating risk in the summer. Therefore, occupant comfort can be maintained with reduced reliance on mechanical cooling systems.

The summer ventilation strategy includes large openable areas for windows/doors to allow for good natural ventilation. Secure openable windows allow for night ventilation to pre-cool thermal mass.

4.6 SOLAR EXPOSURE & DAYLIGHT

Maximising exposure to solar energy and daylight is essential to reduce reliance on artificial lighting, reducing winter daytime heating requirements and to contribute to the general wellbeing of occupants.

The site has access to solar energy and natural daylight. This makes the development roof suitable for solar energy harvesting.

Fenestration on the facades maximises natural daylight to provide amenity and reduce artificial lighting energy use. Internal shading can be incorporated to minimise the risk of overheating and glare without overly compromising daylight availability.

4.7 ACTIVE BUILDING SERVICES SYSTEMS

Space heating and hot water will be provided via a high-efficiency ground-source heat pump system in conjunction with underfloor heating. The GSHP will be located in the basement supported by eight boreholes 6m apart.

Energy use associated with domestic hot water (DHW) will be minimised by the use of water efficient fittings together with optimised hot water temperatures.

High-efficiency mechanical ventilation will be used with heat recovery. The system will have a summer bypass to support night-time free cooling of thermal mass.

Low-energy fixed lighting, generally comprising of high-efficiency LED fittings, will be installed throughout the development.

All building services systems will be in accordance with and exceed the efficiency requirements outlined in the Building Service Compliance Guide.

4.8 COOLING & OVERHEATING

The cooling and overheating strategies are summarised in the table below using the cooling hierarchy which has been applied to the design.

Hierarchy Measure	Application to proposed development
1. Minimise Internal Heat Gains	- Low energy LED lighting.
2. Minimise External Heat Gains	-High level of insulation -Low G-value windows (0.5 for windows and 0.4 for rooflights) -Green roof to minimise solar gains through the roof and add to green mass (external greenery) which helps creates a cool microclimate through evapotranspiration. -Internal blinds with light coloured external facing surfaces (with relatively high reflective properties).
3 & 4 Heat Management and Passive Ventilation	-High openable window area with general high exposure to prevailing south-westerly winds -Night time ventilation strategy
5. Mechanical Ventilation	- Mechanical Ventilation with Heat Recovery (MVHR) is specified.
6. Active Cooling Ensuring they are the lowest carbon options	-No active cooling

Table 5: Cooling hierarchy

5 Carbon Emissions

5.1 BASELINE

Energy demand and annual carbon emissions are calculated using BRE accredited energy compliance SAP 10.2 software.

The amount of carbon emission reductions achieved by the proposed scheme is compared to the notional Target Emission Rate (TER) which forms the baseline comparison target. This notional building/dwelling is produced by the energy model and intends to replicate the actual building in terms of area, form, orientation and usage. The fabric parameters and system efficiencies for this notional building meets and, in some parts, exceeds the minimum requirements for compliance with Part L of the 2021 Building Regulations as summarised in the table below.

For dwellings, within Part L1 of the Building Regulations (2021), the Target Fabric Energy Efficiency (TFEE) sits alongside the TER. The TFEE is the minimum fabric energy performance requirement for a new dwelling. The Dwelling Fabric Energy Efficiency (DFEE) rate is the actual fabric energy performance of the new dwelling. The DFEE must not exceed the TFEE. It is expressed as the amount of energy demand in kWh/(m^2.year). The notional dwelling is not prescriptive, and specifications can be varied provided that the TFEE and TER rate is achieved or bettered. To prevent poor performance of individual elements, limiting fabric values set out in approved document Part L1 and limiting building services efficiencies set out in the Domestic Building Services Compliance Guide, have been followed.

The Notional Building baseline values, which apply to new build residential areas, are:

Building Regulations 2021

Element	U Value (W/m2K)	G Value
External Walls	0.18	-
Floor	0.13	-
Roof	0.11	-
Windows	1.2	0.63 (0.4)
External opaque doors	1.0	-
External glazed doors	1.2	-
Air tightness	5.0 $m^3/m^2/h$ @50Pa	
Liner thermal transmittance	Standardised psi values SAP Appendix R	
Ventilation type	Natural with intermittent extract fans	
Air-conditioning	None	
Heating source	Mains Gas (89.5% SEDBUK 2009)	
Heating emitters and controls	Radiators. Time and temperature zone control. Weather compensation. Boiler interlock.	
Hot water storage	If cylinder, declared loss factor = 0.85 ´ (0.2 + 0.051 V2/3) kWh/day where V is the volume of the cylinder in litres. Separate time control.	
Wastewater heat recovery (WWHR)	All showers connected to WWHR, including showers over baths. Instantaneous WWHR with 36% recovery efficiency utilisation of 0.98.	
Lighting	100% low energy lighting, (80lm/W)	
Photovoltaic (PV) system	For houses: kWp = 40% of ground floor area, including unheated spaces / 6.5 For flats: kWp = 40% of dwelling floor area / (6.5 ´ number of storeys in block) System facing south-east or south-west	

Table 6: Notional Dwelling (Building) Specification (Table 4 SAP 10.2)

5.2 "BE LEAN EMISSIONS"

As part of the "Be Lean" approach, seeking to minimise energy demand, the building fabric has been specified to meet or exceed the minimum fabric parameters outlined in Part L of the Building Regulation 2021 as per table below.

Element	Proposed residential development
External walls U value	0.15 W/m²/°C for new elements Minimum of 0.30 W/m²/°C for existing elements
Floor U value	0.13 W/m²/°C
Roof U value	0.11 W/m²/°C
Windows U value	1.0 W/m²/°C 0.5 G-value
Roof light U Value	1.0 W/m²/°C 0.4 G-value
Doors	1.0 W/m²/°C
Air tightness	3.0 m³/m²/h @50Pa
Ventilation type	MVHR (0.77 SFP, heat recovery 87%)
Heating	Central gas-fired boiler Note 'Be Green' use a GSHP
Hot water	Central gas-fired boiler Note 'Be Green' uses a GSHP
Lighting	100% low energy lighting
Liner thermal transmittance	See psi values in Appendix B

Table 7: Proposed residential development and baseline comparison "Notional" building – Be Lean

5.3 "BE LEAN" TOTAL CARBON EMISSIONS

The "Be Lean" CO_2 emissions associated with regulated energy consumption; the Dwelling Emissions Rate (DER) are given below in relation to the baseline TER (Target Emission Rate). Using the GLA spreadsheet which removes the solar PV component from the notional building the result is a 11% saving.

Unit type	Area (m²)	TER (kg.CO_2/m²/yr.)	DER (kg.CO_2/m²/yr.)	GLA adjusted DER (kg.CO_2/m²/yr.)	GLA adjusted saving
68 Elsworthy Road	1149	7.67	7.74	6.82	11%

Table 8: Be Lean regulated Emissions for dwellings

5.4 "BE CLEAN" EMISSIONS

5.4.1 Connection to Third Party Heat Networks

Heat networks are encouraged by the London Plan

The London Heat Map tool[4] shows that the site is within the heat network priority area and that it is over 1.5km from the nearest potential heat network area. Therefore, currently a connection to third party heat networks is not considered viable for this development.

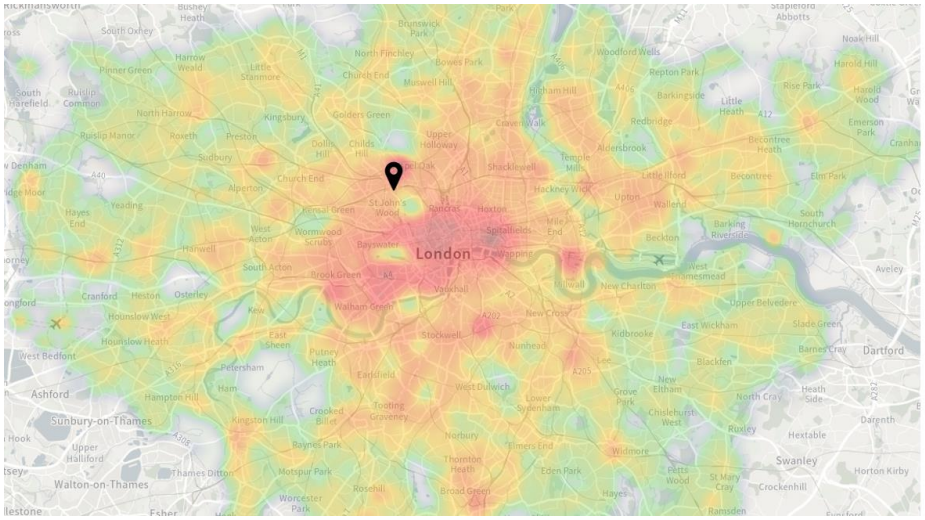

Figure 15: London Heat Map tool showing the heat network priority areas in relation to the proposed scheme

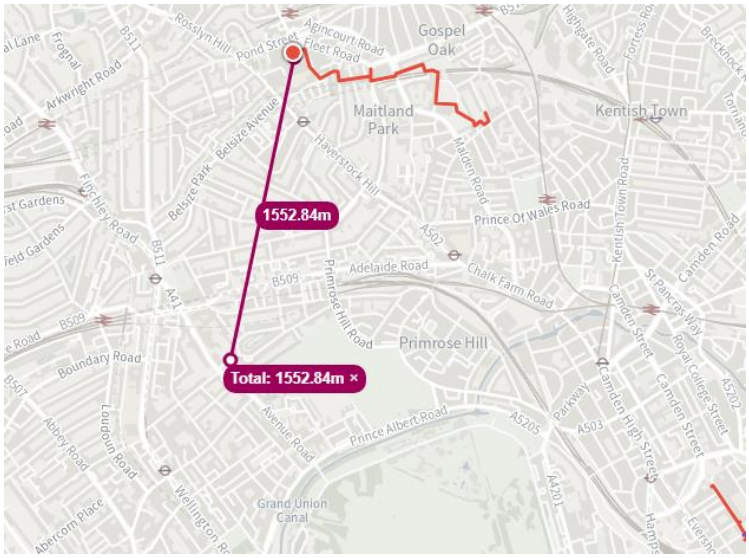

Figure 16: London Heat Map tool showing live networks (red), proposed heat networks (purple) and potential heat supply sites (orange)

5.4.2 CHP Combined Heat and Power

The London Plan limits the role of CHP to low-emission CHP and only in instances where it can support the delivery of an area-wide heat network at large, strategic sites, according to the Energy Assessment Guidance Greater London Authority guidance on preparing energy assessments as part of planning applications. Therefore, CHP has not been adopted.

[4] https://www.london.gov.uk/what-we-do/environment/energy/london-heat-map/view-london-heat-map

5.5 "BE GREEN" EMISSIONS

A renewable energy feasibility exercise has been carried out in order to determine the most viable option(s) for the development (see Appendix A). The viable technology options, ground source heat pumps and solar PV, are presented below.

5.5.1 Ground Source Heat Pumps

Ground source heat pumps (GSHP) extract heat energy from the ground and can create around 3-4 kW of renewable energy for every 1kW of electrical power it consumes, which makes it one of the lowest carbon reliable heating technologies available.

Heat pumps are most efficient when used in conjunction with low temperature heat delivery systems such as underfloor heating. As such the proposed heat pump will work well with the proposed underfloor heating system.

5.5.2 Photovoltaic (PV) panels

The image below shows the amount of roof that is available within the development and that will be used to install photovoltaic modules.

Total installed capacity of the system: 2 (kWp)

Panel inclination: 15 °

Panel orientation: South

Energy generation: 1727.24 kWh/a

Carbon emission reduction: 0.23 tonnes of CO_2/y

Local shading is considered to be very low.

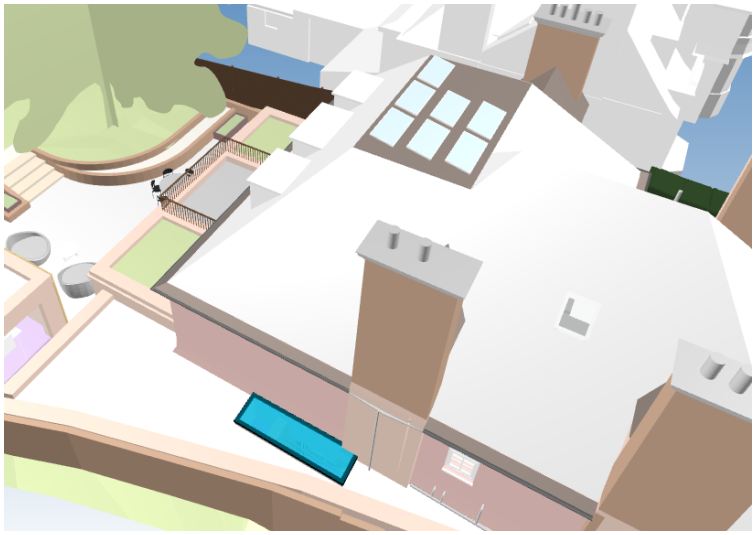

Figure 17: Indicative Solar PV layout

5.5.3 "Be Green" Total Carbon Emissions

The CO_2 emissions associated with regulated energy consumption are given below.

Unit type	Area (m^2)	TER (kg.CO_2/m^2/yr.)	DER (kg.CO_2/m^2/yr.)
68 Elsworthy Road	1149	7.64	2.36

Table 9: Be Green Carbon Emissions

6 Summary

6.1 SUSTAINABILITY SUMMARY

In addition to the low energy performance set out below, the scheme benefits from several sustainability aspects. These include the use of water saving devices to achieve 105 litre per person per day. Health and wellbeing is supported by aspects such as high levels of fresh air provided by mechanical ventilation with heat recovery. In terms of sustainable travel, the dwelling is within walking distance from South Hempstead, Swiss Cottage and St John's Wood stations as well as local several bus stops. A residents' guide will be created to help residents reduce energy, water and waste, avoid overheating and keep air quality high. The development aims to support biodiversity e.g. through green roofs on the first floor extension and the garden room.

The scheme is also demand side response (DSR) enabled through the provision of a large centralised electric-powered heat pump systems with large energy storage vessels located in the basement plantroom in order to work with National Grid signalling / time of use tariffs. This supports the transition to low carbon electricity and reduces energy costs for residents.

6.2 CARBON EMISSIONS SUMMARY

The predicted total annual CO_2 emissions of the proposed development following the introduction of energy efficiency measures, passive and active design (Be Lean), Low carbon supply technologies (Be Clean) and renewable energy systems (Be Green) are summarised below in the format recommended by the GLA.

The table below shows the total regulated and unregulated energy use.

Carbon dioxide emissions (Tonnes CO_2 per annum)	**Regulated**	**Unregulated**
Baseline: Part L 2021 (Building Regulations) Compliance	8.8	1.8
After "Be Lean" (energy demand reduction)	7.8	1.8
After "Be Clean" (heat network / CHP)	7.8	1.8
After "Be Green" (renewable energy)	3.9	1.8

Table 10: Summary of new build carbon emissions for new build dwelling areas

This performance can be expressed as savings between each stage in the energy hierarchy.

Regulated carbon dioxide savings	**(Tonnes CO_2 per annum)**	**(%)**
Savings from "Be Lean" (energy demand reduction)	1.0	11
Savings from "Be Clean" (heat network / CHP)	0	0
Savings from "Be Green" (renewable energy)	4.0	45
Total cumulative on-site savings	4.9	56
Shortfall to 100% below Part L (annual)	3.9	
Shortfall over 30 years	116	
Carbon Offset Fund (@£95/tonne)	£11,036	

Table 11: Residential regulated CO_2 emissions savings after each stage of the Energy Hierarchy

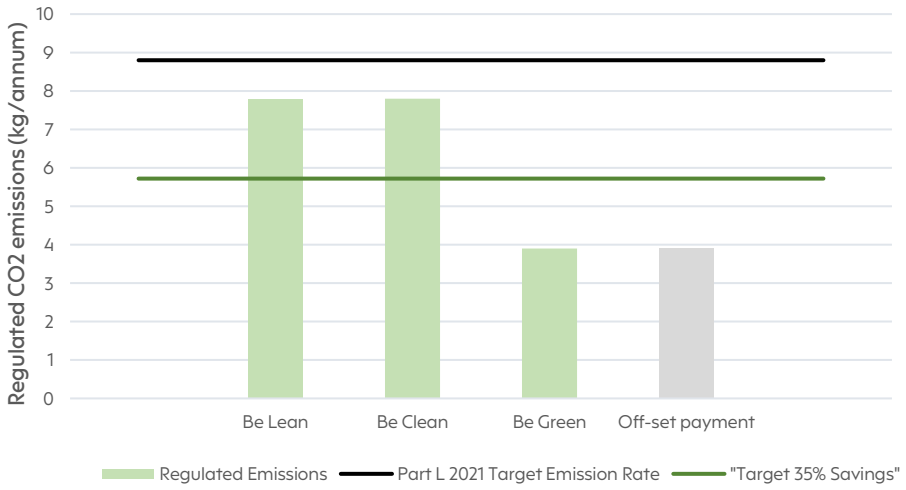

Figure 18: Summary of target and energy savings for each stage of the energy hierarchy

6.3 FUTURE PROOFING TO 2050 SUMMARY

The site has been future proofed to achieve zero carbon on-site emissions by 2050 through several mechanisms. The main strategy is by avoiding fossil fuels on site and use electricity for 100% of energy requirements. This means that as the UK electricity grid continues its decarbonisation towards the 2050 goal of net zero, the scheme will be able supplied by zero carbon electricity.

6.4 COST OF ENERGY SUMMARY

The scheme aims to protect the consumer from high prices by:

- Reducing energy demands.
- Generating energy onsite via solar PV.
- Monitoring energy demand.
- Creating building user guides to help occupants to reduce energy bills.
- Promoting the use of smart energy tariff such to provide cheaper electricity during non-peak times. This means buffer vessel energy stores can be charged at night by the heat pump when electricity costs are much lower.

Appendix A: Technology Feasibility Study Summary

The overall summary of the feasibility exercise is presented below.

Technology		Assessment/Viability	
	Wind Power	Wind turbine installed on the roof of the development.	Due to the high cost per kW for smaller building-mounted turbines and the impacts in terms of visual, noise and shadow flicker, wind turbines are not considered a viable technology for the development. CONCLUSION: NOT CONSIDERED FEASIBLE
	Ground Source Heat Pumps	Open or closed loop GSHP system requiring extraction of ground water and / or deep boreholes.	Ground-source heat pumps are one of the lowest carbon methods of providing reliable low-carbon heat and require low maintenance. The new basement allows space for bore holes. **CONCLUSION: CONSIDERED FEASIBLE**
	Air Source Heat Pumps	Electric powered external plant serving each unit providing heating and hot water	Air-source heat pumps are one of the lowest carbon methods of providing reliable low-carbon heat. They require low maintenance. However, they can raise noise concerns and impact the external view of the building. CONCLUSION: NOT CONSIDERED FEASIBLE
	Solar Thermal Collectors	Roof-mounted solar thermal panels providing hot water heating	Roof areas have some potential for solar thermal energy collection. However, the integration with a heat pump would result is a complex system. Therefore, solar PV is preferred over solar thermal technology. CONCLUSION: NOT CONSIDERED FEASIBLE
	Solar Photovoltaic Panels	Roof mounted Photovoltaic panels (PV) provide electricity directly to the scheme, exporting any surplus production to the grid.	The roof has some potential for solar PV. This technology also supports air source heat pumps. **CONCLUSION: CONSIDERED FEASIBLE**
	Combined Heat & Power (CHP)	Gas powered turbine generating electricity on site. Waste heat is also made available for on-site use	Carbon offsetting potential of CHP is significantly reduced now that the UK's electricity grid is much cleaner after the increase in renewable energy deployment and decrease in coal generation. CONCLUSION: NOT CONSIDERED FEASIBLE
	Energy Storage	Energy Storage e.g. batteries	Battery scheme is not considered beneficial as the proposed solar array is relatively small in relation daytime energy use on site. **CONCLUSION: NOT CONSIDERED FEASIBLE**
	Biomass Heating	Biomass-fired community heating system.	Biomass heating is an established technology but has high maintenance requirements, fuel storage and delivery issues and is a source of increase in pollution, notably particulates (PM10), SO2 and NOX emissions. CONCLUSION: NOT CONSIDERED FEASIBLE

Table A1: Summary of Low and Zero Carbon Study Analysis Results

Appendix B: Psi Values

Junction	Junction Name	Psi Value (W/mK)
E2	Lintels	0.3
E3	Sill	0.04
E4	Jamb	0.05
E5	Ground Floor	0.07, for new junctions, 0.32 for existing junctions
E20	Exposed Floor	0.32
E21	Exposed Floor (inverted)	0.32
E22	Basement Floor	0.07
E6	Intermediate floor within a dwelling	0.07
E24	Eaves	0.04
E14	Flat roof	0.16
E15	Flat roof with parapet	0.3
E16	Corner (normal)	0.09
E17	Corner (inverted)	0
R1	Head of roof window	0.24
R2	Sill of roof window	0.24
R3	Jamb of roof window	0.24
R4	Ridge (vaulted ceiling)	0.08
R5	Ridge (inverted)	0.04
R7	Flat ceiling	0.04
R9	Roof to wall	0.04

Table B1: Summary of Psi Values

Appendix C: SAP and GLA Datasheets

This appendix contains the SAP datasheets for both 'Be Lean' and 'Be Green' and the GLA spreadsheet, which has been used to calculate the carbon emissions.

RESIDENTIAL CO_2 ANALYSIS (PART L1)																						
				Baseline		'Be Lean'	'Be Clean'	'Be Green'	Fabric Energy Efficiency (FEE)		Baseline		'Be Lean'			'Be Clean'			'Be Green'		
Unit identifier (e.g. plot number, dwelling)	Model total floor area	Number of units	Total area represented by model	TER	Energy saving/generation technologies (-)	DER	DER	DER	Target Fabric Energy Efficiency	Dwelling Fabric Energy Efficiency	Part L 2021 CO_2 emissions	Energy saving/generation technologies	Part L 2021 CO_2 emissions	Part L 2021 CO_2 emissions with Notional PV savings included	'Be Lean' savings	Part L 2021 CO_2 emissions	Part L 2021 CO_2 emissions with Notional PV savings included	'Be Clean' savings	Part L 2021 CO_2 emissions	'Be Green' savings
	(m^2) (Row 4)		(m^2)	($kgCO_2$ / m^2) (Row 273)	($kgCO_2$ p.a.) (Row 269)	($kgCO_2$ / m^2) (Row 273 or 384)	($kgCO_2$ / m^2) (Row 273 or 384)	($kgCO_2$ / m^2) (Row 273 or 384)	(kWh/m²)	(kWh/m²)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)	($kgCO_2$ p.a.)
68 Elsworthy	1149		1149	7.67	-1057.27	7.74	7.74	3.37			8,813	-1,057	8,893	7,836	977	8,893	7,836	0	3,872	3,964

Table C1: GLA spreadsheet part L outputs

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for residential buildings

	Carbon Dioxide Emissions for residential buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2021 of the Building Regulations Compliant Development	8.8	1.8
After energy demand reduction (be lean)	7.8	1.8
After heat network connection (be clean)	7.8	1.8
After renewable energy (be green)	3.9	1.8

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for residential buildings

	Regulated residential carbon dioxide savings	
	onnes CO_2 per annur	(%)
Be lean: savings from energy demand reduction	1.0	11%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	4.0	45%
Cumulative on site savings	**4.9**	**56%**
Annual savings from off-set payment	3.9	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**116**	-
Cash in-lieu contribution (£)	**11,036**	

* carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the

Table C2: GLA Summary tables

Full SAP Calculation Printout

Property Reference	68 Elsworthy Road	**Issued on Date**	18/01/2024
Assessment Reference	Be Lean	**Prop Type Ref**	
Property	68 Elsworthy Road		

SAP Rating	89 B	**DER**	7.74	**TER**	7.67
Environmental	90 B	**% DER < TER**			-0.91
CO_2 Emissions (t/year)	7.65	**DFEE**	36.08	**TFEE**	36.64
Compliance Check	See BREL	**% DFEE < TFEE**			1.52
% DPER < TPER	-9.90	**DPER**	44.69	**TPER**	40.66

Assessor Details	Dr. Alan Harries	**Assessor ID**	BC24-0001
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	165.3300	(1a)	x 1.5000	(2a) =	247.9950	(1a) - (3a)
Ground floor	389.0000	(1b)	x 2.5000	(2b) =	972.5000	(1b) - (3b)
First floor	295.5000	(1c)	x 2.6700	(2c) =	788.9850	(1c) - (3c)
Second floor	191.4000	(1d)	x 2.0500	(2d) =	392.3700	(1d) - (3d)
Third floor	107.8000	(1e)	x 3.3500	(2e) =	361.1300	(1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1149.0300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		2762.9800	(5)

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2. Ventilation rate

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		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	0 * 10 =	0.0000	(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) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.1500	(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) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	69.6000 (23c)

Effective ac	0.3146	0.3114	0.3082	0.2923	0.2891	0.2731	0.2731	0.2699	0.2795	0.2891	0.2954	0.3018	(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	
door			2.7700	1.0000	2.7700			(26)
Window (Uw = 1.00)			83.9000	0.9615	80.6731			(27)
Basement Skylight			4.1400	0.9615	3.9808			(27a)
dining room Skylight			3.7800	0.9615	3.6346			(27a)
roof Skylight			0.8000	0.9615	0.7692			(27a)
Heatloss Floor 1			389.0000	0.1300	50.5700	110.0000	42790.0000	(28)
Basement	211.0000		211.0000	0.1500	31.6500	110.0000	23210.0000	(29a)
GF	172.0000	51.1000	120.9000	0.1500	18.1350	110.0000	13299.0000	(29a)
1F	112.0000	35.5700	76.4300	0.1500	11.4645	110.0000	8407.3000	(29a)
Dormer windows	26.3000		26.3000	0.1500	3.9450	110.0000	2893.0000	(29a)
2f	56.9900		56.9900	0.1500	8.5485	110.0000	6268.9000	(29a)

lower basement	81.0000		81.0000	0.1500	12.1500	110.0000	8910.0000	(29a)
GF Old wall	80.1000		80.1000	0.3000	24.0300	110.0000	8811.0000	(29a)
1F Old wall	94.8000		94.8000	0.3000	28.4400	110.0000	10428.0000	(29a)
2f old wall	53.0100		53.0100	0.3000	15.9030	150.0000	7951.5000	(29a)
Roof	107.8000	4.9400	102.8600	0.1100	11.3146	9.0000	925.7400	(30)
GF roof	54.8100	3.7800	51.0300	0.1100	5.6133	9.0000	459.2700	(30)
Total net area of external elements Aum(A, m2)			1438.8100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		313.5916			(33)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 134353.7100 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 116.9279 (35)
List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	49.6000	0.0700	3.4720
E6 Intermediate floor within a dwelling	17.5000	0.1400	2.4500
E22 Basement floor	30.2000	0.0700	2.1140
E15 Flat roof with parapet	45.0000	0.3000	13.5000
E14 Flat roof	9.2000	0.1600	1.4720
E24 Eaves (insulation at ceiling level - inverted)	24.3000	0.0400	0.9720
E16 Corner (normal)	67.9600	0.0900	6.1164
E17 Corner (inverted - internal area greater than external area)	14.8200	0.0000	0.0000
R1 Head of roof window	0.8000	0.2400	0.1920
R2 Sill of roof window	0.8000	0.2400	0.1920
R3 Jamb of roof window	1.9400	0.2400	0.4656
R4 Ridge (vaulted ceiling)	39.9600	0.0800	3.1968
R5 Ridge (inverted)	7.0000	0.0400	0.2800
R7 Flat ceiling (inverted)	16.6800	0.0400	0.6672
R9 Roof to wall (flat ceiling)	144.3100	0.0400	5.7724
E20 Exposed floor (normal)	37.4000	0.3200	11.9680
E21 Exposed floor (inverted)	15.5000	0.3200	4.9600
E16 Corner (normal)	46.0200	0.1800	8.2836
E17 Corner (inverted - internal area greater than external area)	32.8400	0.0000	0.0000
E5 Ground floor (normal)	28.2000	0.3200	9.0240
E2 Other lintels (including other steel lintels)	45.3300	0.3000	13.5990
E3 Sill	44.1500	0.0400	1.7660
E4 Jamb	106.1000	0.0500	5.3050

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 95.7680 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 409.3596 (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	286.8129	283.9066	281.0002	266.4687	263.5624	249.0308	249.0308	246.1245	254.8435	263.5624	269.3750	275.1876	(38)
Heat transfer coeff	696.1725	693.2661	690.3598	675.8283	672.9220	658.3904	658.3904	655.4841	664.2031	672.9220	678.7346	684.5472	(39)
Average = Sum(39)m / 12 =												675.1017	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6059	0.6033	0.6008	0.5882	0.5856	0.5730	0.5730	0.5705	0.5781	0.5856	0.5907	0.5958	(40)
HLP (average)												0.5875	
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 4.2357 (42)
Hot water usage for mixer showers

95.2385	93.8072	91.7216	87.7312	84.7863	81.5023	79.6356	81.7054	83.9743	87.5004	91.5766	94.8736	(42a)

Hot water usage for baths

41.0789	40.4688	39.6097	38.0256	36.8395	35.5243	34.8138	35.6669	36.5958	38.0032	39.6198	40.9400	(42b)

Hot water usage for other uses

58.0075	55.8981	53.7888	51.6794	49.5700	47.4607	47.4607	49.5700	51.6794	53.7888	55.8981	58.0075	(42c)

Average daily hot water use (litres/day) 178.6273 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.3248	190.1741	185.1200	177.4362	171.1958	164.4872	161.9101	166.9424	172.2496	179.2923	187.0945	193.8210	(44)
Energy conte	307.7630	270.8054	284.5226	242.9012	230.4625	202.2562	195.8162	206.7096	212.4009	243.2980	266.5505	303.4769	(45)
Energy content (annual)										Total = Sum(45)m =		2966.9631	
Distribution loss (46)m = 0.15 x (45)m	46.1645	40.6208	42.6784	36.4352	34.5694	30.3384	29.3724	31.0064	31.8601	36.4947	39.9826	45.5215	(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	0.3982	0.4066	0.4991	0.5194	0.5647	0.5634	0.5707	0.5504	0.5092	0.4976	0.4412	0.4003	(61)
Total heat required for water heating calculated for each month	308.1612	271.2120	285.0216	243.4206	231.0272	202.8196	196.3869	207.2600	212.9102	243.7957	266.9917	303.8772	(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	308.1612	271.2120	285.0216	243.4206	231.0272	202.8196	196.3869	207.2600	212.9102	243.7957	266.9917	303.8772	(64)
									Total per year (kWh/year) = Sum(64)m =			2972.8838	(64)
12Total per year (kWh/year)												2973	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
									Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =			0.0000	(64a)
Heat gains from water heating, kWh/month	102.4307	90.1444	94.7285	80.8945	76.7700	67.3910	65.2516	68.8685	70.7506	81.0210	88.7383	101.0061	(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	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	587.1589	650.0688	587.1589	606.7308	587.1589	606.7308	587.1589	587.1589	606.7308	587.1589	606.7308	587.1589	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	995.0542	1005.3797	979.3596	923.9660	854.0416	788.3224	744.4180	734.0925	760.1125	815.5061	885.4306	951.1497	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	(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)													
	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	(71)
Water heating gains (Table 5)													
	137.6757	134.1435	127.3233	112.3535	103.1854	93.5987	87.7037	92.5652	98.2647	108.8992	123.2477	135.7609	(72)
Total internal gains													
	1809.4238	1879.1270	1783.3768	1732.5854	1633.9209	1575.1870	1505.8156	1500.3516	1551.6431	1601.0992	1704.9441	1763.6046	(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	
North	1.1900	10.6334	0.5000	0.8000	0.7700	3.5076	(74)
East	50.2500	19.6403	0.5000	0.8000	0.7700	273.5751	(76)
South	0.9900	46.7521	0.5000	0.8000	0.7700	12.8301	(78)
West	31.4700	19.6403	0.5000	0.8000	0.7700	171.3315	(80)
East	8.7200	26.0000	0.4000	0.8000	1.0000	65.2954	(82)

Solar gains	526.5397	1033.6608	1712.5595	2515.6522	3100.2160	3181.5184	3025.6721	2587.2844	1997.4634	1229.1149	657.1563	432.6186	(83)
Total gains	2335.9635	2912.7878	3495.9364	4248.2376	4734.1369	4756.7054	4531.4877	4087.6360	3549.1065	2830.2141	2362.1004	2196.2232	(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	53.6081	53.8328	54.0595	55.2218	55.4603	56.6844	56.6844	56.9357	56.1884	55.4603	54.9854	54.5185	
alpha	4.5739	4.5889	4.6040	4.6815	4.6974	4.7790	4.7790	4.7957	4.7459	4.6974	4.6657	4.6346	
util living area													
	0.9995	0.9984	0.9949	0.9770	0.9175	0.7733	0.6099	0.6834	0.9129	0.9915	0.9988	0.9996	(86)
MIT	19.1945	19.3947	19.7282	20.2122	20.6251	20.8947	20.9738	20.9563	20.7362	20.1790	19.6172	19.1849	(87)
Th 2	20.4247	20.4270	20.4293	20.4407	20.4429	20.4544	20.4544	20.4567	20.4498	20.4429	20.4384	20.4338	(88)
util rest of house													
	0.9994	0.9982	0.9939	0.9726	0.9009	0.7303	0.5440	0.6190	0.8889	0.9894	0.9986	0.9996	(89)
MIT 2	18.6970	18.8988	19.2336	19.7232	20.1260	20.3795	20.4401	20.4313	20.2411	19.6942	19.1300	18.6943	(90)
Living area fraction										fLA = Living area / (4) =		0.0522	(91)
MIT	18.7230	18.9247	19.2594	19.7487	20.1521	20.4064	20.4680	20.4587	20.2669	19.7195	19.1554	18.7199	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7230	18.9247	19.2594	19.7487	20.1521	20.4064	20.4680	20.4587	20.2669	19.7195	19.1554	18.7199	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9990	0.9972	0.9914	0.9658	0.8908	0.7263	0.5457	0.6192	0.8795	0.9856	0.9978	0.9993	(94)
Useful gains	2333.6888	2904.6970	3465.8299	4102.8477	4217.2239	3454.6577	2472.9781	2531.2621	3121.3374	2789.5041	2356.9929	2194.6583	(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													
	10040.8773	9722.8257	8808.5669	7331.8608	5687.5915	3822.8865	2546.6382	2660.4053	4096.0942	6136.7357	8182.4265	9939.5481	(97)
Space heating kWh													
	5734.1483	4581.7825	3974.9963	2324.8894	1093.9535	0.0000	0.0000	0.0000	0.0000	2490.3403	4194.3122	5762.1980	(98a)
Space heating requirement - total per year (kWh/year)												30156.6204	
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													
	5734.1483	4581.7825	3974.9963	2324.8894	1093.9535	0.0000	0.0000	0.0000	0.0000	2490.3403	4194.3122	5762.1980	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												30156.6204	
Space heating per m2											(98c) / (4) =	26.2453	(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 %)												84.0000	(206)
Efficiency of main space heating system 2 (in %)												0.0000	(207)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	5734.1483	4581.7825	3974.9963	2324.8894	1093.9535	0.0000	0.0000	0.0000	0.0000	2490.3403	4194.3122	5762.1980	(98)
Space heating efficiency (main heating system 1)													
	84.0000	84.0000	84.0000	84.0000	84.0000	0.0000	0.0000	0.0000	0.0000	84.0000	84.0000	84.0000	(210)
Space heating fuel (main heating system)													
	6826.3670	5454.5029	4732.1384	2767.7255	1302.3256	0.0000	0.0000	0.0000	0.0000	2964.6909	4993.2288	6859.7595	(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													
	308.1612	271.2120	285.0216	243.4206	231.0272	202.8196	196.3869	207.2600	212.9102	243.7957	266.9917	303.8772	(64)
Efficiency of water heater												83.8000	(216)
(217)m	88.7192	88.6924	88.6320	88.4796	88.0474	83.8000	83.8000	83.8000	83.8000	88.5103	88.6707	88.7242	(217)
Fuel for water heating, kWh/month													
	347.3443	305.7893	321.5786	275.1149	262.3897	242.0282	234.3520	247.3270	254.0694	275.4434	301.1047	342.4964	(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	282.8584	255.4850	282.8584	273.7339	282.8584	273.7339	282.8584	282.8584	273.7339	282.8584	273.7339	282.8584	(231)
Lighting	152.4228	122.2792	110.0989	80.6632	62.3066	50.9050	56.8381	73.8803	95.9633	125.9090	142.2139	156.6591	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													

(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	35900.7386	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	83.8000	
Water heating fuel used	3409.0377	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.9625)		
mechanical ventilation fans (SFP = 0.9625)	3244.4293	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	3330.4293	(231)
Electricity for lighting (calculated in Appendix L)	1230.1394	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	43870.3450	(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	35900.7386	0.2100	7539.1551	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3409.0377	0.2100	715.8979	(264)
Space and water heating			8255.0530	(265)
Pumps, fans and electric keep-hot	3330.4293	0.1387	461.9716	(267)
Energy for lighting	1230.1394	0.1443	177.5471	(268)
Total CO2, kg/year			8894.5718	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			7.7400	(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	35900.7386	1.1300	40567.8346	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3409.0377	1.1300	3852.2126	(278)
Space and water heating			44420.0473	(279)
Pumps, fans and electric keep-hot	3330.4293	1.5128	5038.2734	(281)
Energy for lighting	1230.1394	1.5338	1886.8289	(282)
Total Primary energy kWh/year			51345.1496	(286)
Dwelling Primary energy Rate (DPER)			44.6900	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	165.3300 (1a)	x	1.5000 (2a)	=	247.9950	(1a) - (3a)
Ground floor	389.0000 (1b)	x	2.5000 (2b)	=	972.5000	(1b) - (3b)
First floor	295.5000 (1c)	x	2.6700 (2c)	=	788.9850	(1c) - (3c)
Second floor	191.4000 (1d)	x	2.0500 (2d)	=	392.3700	(1d) - (3d)
Third floor	107.8000 (1e)	x	3.3500 (2e)	=	361.1300	(1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1149.0300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	2762.9800	(5)

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2. Ventilation rate

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		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) =	0.0145 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.2645 (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) =	0.2248 (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	0.2866	0.2810	0.2754	0.2473	0.2417	0.2136	0.2136	0.2079	0.2248	0.2417	0.2529	0.2641	(22b)
Effective ac	0.5411	0.5395	0.5379	0.5306	0.5292	0.5228	0.5228	0.5216	0.5253	0.5292	0.5320	0.5349	(25)

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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 Opaque door			2.7700	1.0000	2.7700			(26)
TER Opening Type (Uw = 1.20)			83.9000	1.1450	96.0687			(27)
Basement Skylight			4.1400	2.0221	8.3713			(27a)
dining room Skylight			3.7800	2.0221	7.6434			(27a)
roof Skylight			0.8000	2.0221	1.6176			(27a)
Heatloss Floor 1			389.0000	0.1300	50.5700			(28)
Basement	211.0000		211.0000	0.1800	37.9800			(29a)
GF	172.0000	51.1000	120.9000	0.1800	21.7620			(29a)
1F	112.0000	35.5700	76.4300	0.1800	13.7574			(29a)
Dormer windows	26.3000		26.3000	0.1800	4.7340			(29a)
2f	56.9900		56.9900	0.1800	10.2582			(29a)
lower basement	81.0000		81.0000	0.1800	14.5800			(29a)
GF Old wall	80.1000		80.1000	0.1800	14.4180			(29a)
1F Old wall	94.8000		94.8000	0.1800	17.0640			(29a)
2f old wall	53.0100		53.0100	0.1800	9.5418			(29a)
Roof	107.8000	4.9400	102.8600	0.1100	11.3146			(30)
GF roof	54.8100	3.7800	51.0300	0.1100	5.6133			(30)
Total net area of external elements Aum(A, m2)			1438.8100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		328.0644			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	116.9279 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	49.6000	0.1600	7.9360
E6	Intermediate floor within a dwelling	17.5000	0.0000	0.0000
E22	Basement floor	30.2000	0.0700	2.1140
E15	Flat roof with parapet	45.0000	0.5600	25.2000
E14	Flat roof	9.2000	0.0800	0.7360
E24	Eaves (insulation at ceiling level - inverted)	24.3000	0.2400	5.8320
E16	Corner (normal)	67.9600	0.0900	6.1164
E17	Corner (inverted - internal area greater than external area)	14.8200	-0.0900	-1.3338
R1	Head of roof window	0.8000	0.0800	0.0640
R2	Sill of roof window	0.8000	0.0600	0.0480
R3	Jamb of roof window	1.9400	0.0800	0.1552
R4	Ridge (vaulted ceiling)	39.9600	0.0800	3.1968
R5	Ridge (inverted)	7.0000	0.0400	0.2800
R7	Flat ceiling (inverted)	16.6800	0.0400	0.6672
R9	Roof to wall (flat ceiling)	144.3100	0.0400	5.7724
E20	Exposed floor (normal)	37.4000	0.3200	11.9680
E21	Exposed floor (inverted)	15.5000	0.3200	4.9600
E16	Corner (normal)	46.0200	0.0900	4.1418
E17	Corner (inverted - internal area greater than external area)	32.8400	-0.0900	-2.9556
E5	Ground floor (normal)	28.2000	0.1600	4.5120
E2	Other lintels (including other steel lintels)	45.3300	0.0500	2.2665
E3	Sill	44.1500	0.0500	2.2075
E4	Jamb	106.1000	0.0500	5.3050

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		89.1894 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	417.2538 (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	493.3455	491.8911	490.4656	483.7697	482.5169	476.6850	476.6850	475.6050	478.9313	482.5169	485.0512	487.7008	(38)
Heat transfer coeff	910.5993	909.1449	907.7193	901.0234	899.7706	893.9387	893.9387	892.8588	896.1851	899.7706	902.3050	904.9546	(39)
Average = Sum(39)m / 12 =												901.0174	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7925	0.7912	0.7900	0.7842	0.7831	0.7780	0.7780	0.7771	0.7799	0.7831	0.7853	0.7876	(40)
HLP (average)												0.7842	
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		4.2357 (42)

Hot water usage for mixer showers

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
95.2385	93.8072	91.7216	87.7312	84.7863	81.5023	79.6356	81.7054	83.9743	87.5004	91.5766	94.8736	(42a)

Hot water usage for baths

41.0789	40.4688	39.6097	38.0256	36.8395	35.5243	34.8138	35.6669	36.5958	38.0032	39.6198	40.9400	(42b)

Hot water usage for other uses

58.0075	55.8981	53.7888	51.6794	49.5700	47.4607	47.4607	49.5700	51.6794	53.7888	55.8981	58.0075	(42c)

Average daily hot water use (litres/day)	178.6273 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.3248	190.1741	185.1200	177.4362	171.1958	164.4872	161.9101	166.9424	172.2496	179.2923	187.0945	193.8210	(44)
Energy conte	307.7630	270.8054	284.5226	242.9012	230.4625	202.2562	195.8162	206.7096	212.4009	243.2980	266.5505	303.4769	(45)

Energy content (annual) Total = Sum(45)m = 2966.9631
Distribution loss (46)m = 0.15 x (45)m

46.1645	40.6208	42.6784	36.4352	34.5694	30.3384	29.3724	31.0064	31.8601	36.4947	39.9826	45.5215	(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

358.7219	316.8328	335.4815	292.2163	281.4214	251.5713	246.7751	257.6685	261.7160	294.2569	315.8655	354.4358	(62)
WWHRS -43.5390	-38.5063	-40.3216	-33.3879	-31.1163	-26.6264	-24.9580	-26.5404	-27.5487	-32.4769	-36.7924	-42.7328	(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

315.1829	278.3265	295.1599	258.8285	250.3051	224.9448	221.8171	231.1281	234.1673	261.7800	279.0731	311.7030	(64)

Total per year (kWh/year) = Sum(64)m = 3162.4164 (64)
12Total per year (kWh/year) 3162 (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

115.0709	101.5497	107.3435	93.0934	89.3685	79.5789	77.8486	81.4707	82.9521	93.6363	100.9568	113.6458	(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	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

602.8057	667.3920	602.8057	622.8992	602.8057	622.8992	602.8057	602.8057	622.8992	602.8057	622.8992	602.8057	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

995.0542	1005.3797	979.3596	923.9660	854.0416	788.3224	744.4180	734.0925	760.1125	815.5061	885.4306	951.1497	(68)

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

44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	(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)

-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	(71)

Water heating gains (Table 5)

154.6652	151.1156	144.2789	129.2964	120.1190	110.5263	104.6352	109.5036	115.2112	125.8553	140.2178	152.7497	(72)
Total internal gains 1842.0601	1913.4223	1815.9792	1765.6967	1666.5012	1608.2830	1538.3940	1532.9367	1584.7580	1633.7021	1738.0826	1796.2402	(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	
North	1.1900	10.6334	0.6300	0.7000	0.7700	3.8671	(74)
East	50.2500	19.6403	0.6300	0.7000	0.7700	301.6166	(76)
South	0.9900	46.7521	0.6300	0.7000	0.7700	14.1452	(78)
West	31.4700	19.6403	0.6300	0.7000	0.7700	188.8930	(80)
East	8.7200	26.0000	0.6300	0.7000	1.0000	89.9852	(82)

Solar gains	598.5071	1176.9895	1954.5475	2877.3356	3550.8893	3646.0628	3466.6281	2961.1555	2281.8057	1400.7839	747.3572	491.4981	(83)
Total gains	2440.5671	3090.4118	3770.5267	4643.0323	5217.3905	5254.3457	5005.0220	4494.0922	3866.5636	3034.4860	2485.4398	2287.7383	(84)

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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	40.9845	41.0501	41.1146	41.4201	41.4778	41.7484	41.7484	41.7989	41.6437	41.4778	41.3613	41.2402	
alpha	3.7323	3.7367	3.7410	3.7613	3.7652	3.7832	3.7832	3.7866	3.7762	3.7652	3.7574	3.7493	
util living area													
	0.9991	0.9976	0.9933	0.9764	0.9289	0.8232	0.6870	0.7541	0.9288	0.9902	0.9982	0.9993	(86)
MIT	18.6828	18.9023	19.2896	19.8408	20.3589	20.7454	20.9098	20.8689	20.5275	19.8433	19.1695	18.6518	(87)
Th 2	20.2598	20.2609	20.2620	20.2671	20.2680	20.2724	20.2724	20.2733	20.2707	20.2680	20.2661	20.2641	(88)
util rest of house													
	0.9989	0.9972	0.9921	0.9715	0.9120	0.7766	0.6031	0.6775	0.9049	0.9876	0.9978	0.9992	(89)
MIT 2	17.4433	17.7254	18.2223	18.9285	19.5785	20.0407	20.2106	20.1764	19.7956	18.9357	18.0716	17.4062	(90)
Living area fraction									fLA = Living area / (4) =			0.0522	(91)
MIT	17.5081	17.7869	18.2780	18.9761	19.6193	20.0775	20.2471	20.2126	19.8338	18.9831	18.1289	17.4713	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5081	17.7869	18.2780	18.9761	19.6193	20.0775	20.2471	20.2126	19.8338	18.9831	18.1289	17.4713	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9979	0.9949	0.9868	0.9591	0.8929	0.7622	0.5999	0.6702	0.8862	0.9804	0.9959	0.9984	(94)
Useful gains	2435.5095	3074.7385	3720.7083	4453.1236	4658.8098	4004.7580	3002.5525	3011.9700	3426.4236	2974.8755	2475.2676	2284.0420	(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													
	12027.2515	11716.0425	10691.1621	9078.8081	7125.5333	4896.5570	3260.2827	3404.1025	5138.5814	7542.8893	9951.4557	12009.8859	(97)
Space heating kWh													
	7136.2561	5806.9563	5186.0176	3330.4928	1835.2423	0.0000	0.0000	0.0000	0.0000	3398.6023	5382.8555	7236.0279	(98a)
Space heating requirement - total per year (kWh/year)												39312.4507	
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													
	7136.2561	5806.9563	5186.0176	3330.4928	1835.2423	0.0000	0.0000	0.0000	0.0000	3398.6023	5382.8555	7236.0279	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												39312.4507	

Space heating per m2 (98c) / (4) = 34.2136 (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													
	7136.2561	5806.9563	5186.0176	3330.4928	1835.2423	0.0000	0.0000	0.0000	0.0000	3398.6023	5382.8555	7236.0279	(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)													
	7723.2208	6284.5848	5612.5732	3604.4294	1986.1929	0.0000	0.0000	0.0000	0.0000	3678.1410	5825.6012	7831.1990	(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													
	315.1829	278.3265	295.1599	258.8285	250.3051	224.9448	221.8171	231.1281	234.1673	261.7800	279.0731	311.7030	(64)
Efficiency of water heater												80.3000	(216)
(217)m	88.4991	88.4667	88.3902	88.2187	87.7718	80.3000	80.3000	80.3000	80.3000	88.2243	88.4332	88.5085	(217)
Fuel for water heating, kWh/month													
	356.1425	314.6118	333.9282	293.3941	285.1772	280.1305	276.2355	287.8308	291.6155	296.7211	315.5752	352.1729	(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	125.2511	100.4811	90.4721	66.2837	51.1995	41.8304	46.7059	60.7100	78.8563	103.4638	116.8621	128.7322	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-155.5531	-219.6397	-315.7679	-354.4734	-380.9005	-354.1375	-349.0761	-329.9947	-296.4940	-250.3656	-170.8869	-134.3886	(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	-86.5226	-182.2850	-363.1416	-546.9107	-725.0488	-729.9862	-722.0784	-611.0274	-446.9263	-261.9386	-115.8542	-68.4515	(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 42545.9424 (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 3683.5353 (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) 1010.8482 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation -8171.8495 (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 39154.4764 (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	42545.9424	0.2100	8934.6479	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3683.5353	0.2100	773.5424	(264)
Space and water heating			9708.1903	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1010.8482	0.1443	145.8966	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-3311.6782	0.1346	-445.9132	
PV Unit electricity exported	-4860.1713	0.1258	-611.3600	
Total			-1057.2732	(269)
Total CO2, kg/year			8808.7430	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			7.6700	(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	42545.9424	1.1300	48076.9149	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3683.5353	1.1300	4162.3949	(278)
Space and water heating			52239.3098	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1010.8482	1.5338	1550.4728	(282)
Energy saving/generation technologies				

PV Unit electricity used in dwelling	-3311.6782	1.4976	-4959.7125	
PV Unit electricity exported	-4860.1713	0.4617	-2244.0750	
Total			-7203.7875	(283)
Total Primary energy kWh/year			46716.0958	(286)
Target Primary Energy Rate (TPER)			40.6600	(287)

Full SAP Calculation Printout

Property Reference	68 Elsworthy Road	**Issued on Date**	19/01/2024
Assessment Reference	Be Green	**Prop Type Ref**	
Property	68 Elsworthy Road		

SAP Rating	79 C	**DER**	3.37	**TER**	7.64
Environmental	96 A	**% DER < TER**			55.89
CO_2 Emissions (t/year)	3.33	**DFEE**	36.08	**TFEE**	36.64
Compliance Check	See BREL	**% DFEE < TFEE**			1.52
% DPER < TPER	13.55	**DPER**	35.04	**TPER**	40.53

Assessor Details	Dr. Alan Harries	**Assessor ID**	BC24-0001
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	165.3300 (1a)	x	1.5000 (2a)	=	247.9950	(1a) - (3a)
Ground floor	389.0000 (1b)	x	2.5000 (2b)	=	972.5000	(1b) - (3b)
First floor	295.5000 (1c)	x	2.6700 (2c)	=	788.9850	(1c) - (3c)
Second floor	191.4000 (1d)	x	2.0500 (2d)	=	392.3700	(1d) - (3d)
Third floor	107.8000 (1e)	x	3.3500 (2e)	=	361.1300	(1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1149.0300					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	2762.9800	(5)

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2. Ventilation rate

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		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	0 * 10 =	0.0000	(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) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.1500	(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) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	69.6000 (23c)

Effective ac	0.3146	0.3114	0.3082	0.2923	0.2891	0.2731	0.2731	0.2699	0.2795	0.2891	0.2954	0.3018	(25)

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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	
door			2.7700	1.0000	2.7700			(26)
Window (Uw = 1.00)			83.9000	0.9615	80.6731			(27)
Basement Skylight			4.1400	0.9615	3.9808			(27a)
dining room Skylight			3.7800	0.9615	3.6346			(27a)
roof Skylight			0.8000	0.9615	0.7692			(27a)
Heatloss Floor 1			389.0000	0.1300	50.5700	110.0000	42790.0000	(28)
Basement	211.0000		211.0000	0.1500	31.6500	110.0000	23210.0000	(29a)
GF	172.0000	51.1000	120.9000	0.1500	18.1350	110.0000	13299.0000	(29a)
1F	112.0000	35.5700	76.4300	0.1500	11.4645	110.0000	8407.3000	(29a)
Dormer windows	26.3000		26.3000	0.1500	3.9450	110.0000	2893.0000	(29a)
2f	56.9900		56.9900	0.1500	8.5485	110.0000	6268.9000	(29a)

lower basement	81.0000		81.0000	0.1500	12.1500	110.0000	8910.0000	(29a)
GF Old wall	80.1000		80.1000	0.3000	24.0300	110.0000	8811.0000	(29a)
1F Old wall	94.8000		94.8000	0.3000	28.4400	110.0000	10428.0000	(29a)
2f old wall	53.0100		53.0100	0.3000	15.9030	150.0000	7951.5000	(29a)
Roof	107.8000	4.9400	102.8600	0.1100	11.3146	9.0000	925.7400	(30)
GF roof	54.8100	3.7800	51.0300	0.1100	5.6133	9.0000	459.2700	(30)
Total net area of external elements Aum(A, m2)			1438.8100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		313.5916			(33)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 134353.7100 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 116.9279 (35)
List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	49.6000	0.0700	3.4720
E6	Intermediate floor within a dwelling	17.5000	0.1400	2.4500
E22	Basement floor	30.2000	0.0700	2.1140
E15	Flat roof with parapet	45.0000	0.3000	13.5000
E14	Flat roof	9.2000	0.1600	1.4720
E24	Eaves (insulation at ceiling level - inverted)	24.3000	0.0400	0.9720
E16	Corner (normal)	67.9600	0.0900	6.1164
E17	Corner (inverted - internal area greater than external area)	14.8200	0.0000	0.0000
R1	Head of roof window	0.8000	0.2400	0.1920
R2	Sill of roof window	0.8000	0.2400	0.1920
R3	Jamb of roof window	1.9400	0.2400	0.4656
R4	Ridge (vaulted ceiling)	39.9600	0.0800	3.1968
R5	Ridge (inverted)	7.0000	0.0400	0.2800
R7	Flat ceiling (inverted)	16.6800	0.0400	0.6672
R9	Roof to wall (flat ceiling)	144.3100	0.0400	5.7724
E20	Exposed floor (normal)	37.4000	0.3200	11.9680
E21	Exposed floor (inverted)	15.5000	0.3200	4.9600
E16	Corner (normal)	46.0200	0.1800	8.2836
E17	Corner (inverted - internal area greater than external area)	32.8400	0.0000	0.0000
E5	Ground floor (normal)	28.2000	0.3200	9.0240
E2	Other lintels (including other steel lintels)	45.3300	0.3000	13.5990
E3	Sill	44.1500	0.0400	1.7660
E4	Jamb	106.1000	0.0500	5.3050

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 95.7680 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 409.3596 (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	286.8129	283.9066	281.0002	266.4687	263.5624	249.0308	249.0308	246.1245	254.8435	263.5624	269.3750	275.1876	(38)
Heat transfer coeff	696.1725	693.2661	690.3598	675.8283	672.9220	658.3904	658.3904	655.4841	664.2031	672.9220	678.7346	684.5472	(39)
Average = Sum(39)m / 12 =												675.1017	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6059	0.6033	0.6008	0.5882	0.5856	0.5730	0.5730	0.5705	0.5781	0.5856	0.5907	0.5958	(40)
HLP (average)												0.5875	
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 4.2357 (42)
Hot water usage for mixer showers

95.2385	93.8072	91.7216	87.7312	84.7863	81.5023	79.6356	81.7054	83.9743	87.5004	91.5766	94.8736	(42a)

Hot water usage for baths

41.0789	40.4688	39.6097	38.0256	36.8395	35.5243	34.8138	35.6669	36.5958	38.0032	39.6198	40.9400	(42b)

Hot water usage for other uses

58.0075	55.8981	53.7888	51.6794	49.5700	47.4607	47.4607	49.5700	51.6794	53.7888	55.8981	58.0075	(42c)

Average daily hot water use (litres/day) 178.6273 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.3248	190.1741	185.1200	177.4362	171.1958	164.4872	161.9101	166.9424	172.2496	179.2923	187.0945	193.8210	(44)
Energy conte	307.7630	270.8054	284.5226	242.9012	230.4625	202.2562	195.8162	206.7096	212.4009	243.2980	266.5505	303.4769	(45)
Energy content (annual)										Total = Sum(45)m =		2966.9631	
Distribution loss (46)m = 0.15 x (45)m	46.1645	40.6208	42.6784	36.4352	34.5694	30.3384	29.3724	31.0064	31.8601	36.4947	39.9826	45.5215	(46)

Water storage loss:
Store volume 175.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 2.0000 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 1.0800 (55)
Total storage loss

33.4800	30.2400	33.4800	32.4000	33.4800	32.4000	33.4800	33.4800	32.4000	33.4800	32.4000	33.4800	(56)

If cylinder contains dedicated solar storage

33.4800	30.2400	33.4800	32.4000	33.4800	32.4000	33.4800	33.4800	32.4000	33.4800	32.4000	33.4800	(57)
Primary loss 23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Total heat required for water heating calculated for each month

364.5054	322.0566	341.2650	297.8132	287.2049	257.1682	252.5586	263.4520	267.3129	300.0404	321.4625	360.2193	(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

364.5054	322.0566	341.2650	297.8132	287.2049	257.1682	252.5586	263.4520	267.3129	300.0404	321.4625	360.2193	(64)
									Total per year (kWh/year) = Sum(64)m =		3635.0591	(64)
12Total per year (kWh/year)											3635	(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

147.7251	131.0438	139.9977	124.6943	122.0227	111.1798	110.5028	114.1248	114.5529	126.2905	132.5576	146.3000	(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	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	587.1589	650.0688	587.1589	606.7308	587.1589	606.7308	587.1589	587.1589	606.7308	587.1589	606.7308	587.1589	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													

	995.0542	1005.3797	979.3596	923.9660	854.0416	788.3224	744.4180	734.0925	760.1125	815.5061	885.4306	951.1497	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	(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)													
	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	(71)
Water heating gains (Table 5)													
	198.5553	195.0056	188.1689	173.1865	164.0090	154.4164	148.5253	153.3936	159.1013	169.7453	184.1078	196.6398	(72)
Total internal gains													
	1867.3033	1936.9891	1841.2225	1790.4184	1691.7445	1636.0047	1566.6372	1561.1800	1612.4796	1658.9453	1762.8043	1821.4834	(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	
North	1.1900	10.6334	0.5000	0.8000	0.7700	3.5076	(74)
East	50.2500	19.6403	0.5000	0.8000	0.7700	273.5751	(76)
South	0.9900	46.7521	0.5000	0.8000	0.7700	12.8301	(78)
West	31.4700	19.6403	0.5000	0.8000	0.7700	171.3315	(80)
East	8.7200	26.0000	0.4000	0.8000	1.0000	65.2954	(82)

Solar gains	526.5397	1033.6608	1712.5595	2515.6522	3100.2160	3181.5184	3025.6721	2587.2844	1997.4634	1229.1149	657.1563	432.6186	(83)
Total gains	2393.8430	2970.6499	3553.7820	4306.0706	4791.9605	4817.5231	4592.3093	4148.4644	3609.9430	2888.0602	2419.9606	2254.1020	(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	53.6081	53.8328	54.0595	55.2218	55.4603	56.6844	56.6844	56.9357	56.1884	55.4603	54.9854	54.5185	
alpha	4.5739	4.5889	4.6040	4.6815	4.6974	4.7790	4.7790	4.7957	4.7459	4.6974	4.6657	4.6346	
util living area													
	0.9994	0.9983	0.9945	0.9759	0.9144	0.7674	0.6031	0.6758	0.9083	0.9908	0.9987	0.9996	(86)
Living	19.5866	19.7369	19.9872	20.3506	20.6586	20.8589	20.9165	20.9042	20.7427	20.3265	19.9050	19.5803	
Non living	19.0697	19.2218	19.4735	19.8438	20.1445	20.3355	20.3794	20.3740	20.2331	19.8235	19.3992	19.0708	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	31	30	31	31	30	31	30	31	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.4247	20.4270	20.4293	20.4407	20.4429	20.4544	20.4544	20.4567	20.4498	20.4429	20.4384	20.4338	(88)
util rest of house													
	0.9993	0.9980	0.9935	0.9713	0.8974	0.7240	0.5376	0.6115	0.8835	0.9885	0.9984	0.9995	(89)
MIT 2	20.4247	20.4270	20.4293	20.4407	20.4429	20.4544	20.4544	20.4567	20.4498	20.4429	20.4384	20.4338	(90)
Living area fraction									fLA = Living area / (4) =			0.0522	(91)
MIT	20.4548	20.4569	20.4591	20.4699	20.4720	20.4829	20.4829	20.4850	20.4785	20.4720	20.4677	20.4634	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.4548	20.4569	20.4591	20.4699	20.4720	20.4829	20.4829	20.4850	20.4785	20.4720	20.4677	20.4634	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9993	0.9980	0.9936	0.9715	0.8983	0.7265	0.5411	0.6150	0.8849	0.9886	0.9985	0.9995	(94)
Useful gains	2392.2510	2964.8474	3530.9851	4183.4312	4304.7590	3499.7248	2485.0561	2551.3735	3194.5724	2855.1522	2416.2327	2253.0054	(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													
	11246.4939	10785.0780	9636.7779	7819.2413	5902.8895	3873.2159	2556.4351	2677.6687	4236.6332	6643.1037	9073.1219	11133.0526	(97)
Space heating kWh													
	6587.5567	5255.1950	4542.7098	2617.7833	1189.0091	0.0000	0.0000	0.0000	0.0000	2818.2360	4792.9602	6606.7551	(98a)
Space heating requirement - total per year (kWh/year)												34410.2052	
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													
	6587.5567	5255.1950	4542.7098	2617.7833	1189.0091	0.0000	0.0000	0.0000	0.0000	2818.2360	4792.9602	6606.7551	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												34410.2052	
Space heating per m2											(98c) / (4) =	29.9472	(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 %)	178.6713 (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													
	6587.5567	5255.1950	4542.7098	2617.7833	1189.0091	0.0000	0.0000	0.0000	0.0000	2818.2360	4792.9602	6606.7551	(98)
Space heating efficiency (main heating system 1)													
	178.6713	178.6713	178.6713	178.6713	178.6713	0.0000	0.0000	0.0000	0.0000	178.6713	178.6713	178.6713	(210)
Space heating fuel (main heating system)													
	3686.9692	2941.2638	2542.4952	1465.1390	665.4728	0.0000	0.0000	0.0000	0.0000	1577.3297	2682.5571	3697.7143	(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													
	364.5054	322.0566	341.2650	297.8132	287.2049	257.1682	252.5586	263.4520	267.3129	300.0404	321.4625	360.2193	(64)
Efficiency of water heater												104.5200	(216)
(217)m	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	104.5200	(217)

Fuel for water heating, kWh/month

	348.7423	308.1292	326.5069	284.9342	274.7846	246.0469	241.6367	252.0589	255.7529	287.0651	307.5607	344.6415 (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	275.5543	248.8877	275.5543	266.6654	275.5543	266.6654	275.5543	275.5543	266.6654	275.5543	266.6654	275.5543 (231)
Lighting	152.4228	122.2792	110.0989	80.6632	62.3066	50.9050	56.8381	73.8803	95.9633	125.9090	142.2139	156.6591 (232)

Electricity generated by PVs (Appendix M) (negative quantity)

(233a)m	-45.6699	-73.2609	-119.0570	-149.0712	-170.3854	-154.5450	-152.7144	-137.3609	-112.6509	-89.1558	-52.9975	-38.5148 (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	-4.4166	-10.3191	-23.2893	-41.7008	-65.2973	-77.1687	-75.9371	-62.4131	-43.8122	-17.6900	-6.4123	-3.3991 (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	19258.9411 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	104.5200
Water heating fuel used	3477.8598 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.9625)	
mechanical ventilation fans (SFP = 0.9625)	3244.4293 (230a)
Total electricity for the above, kWh/year	3244.4293 (231)
Electricity for lighting (calculated in Appendix L)	1230.1394 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-1727.2394 (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	25484.1302 (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	19258.9411	0.1547	2980.2476	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3477.8598	0.1411	490.5572	(264)
Space and water heating			3470.8048	(265)
Pumps, fans and electric keep-hot	3244.4293	0.1387	450.0423	(267)
Energy for lighting	1230.1394	0.1443	177.5471	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1295.3837	0.1329	-172.2200	
PV Unit electricity exported	-431.8557	0.1197	-51.6899	
Total			-223.9098	(269)
Total CO2, kg/year			3874.4845	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			3.3700	(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	19258.9411	1.5729	30292.6727	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3477.8598	1.5216	5291.7886	(278)
Space and water heating			35584.4613	(279)
Pumps, fans and electric keep-hot	3244.4293	1.5128	4908.1726	(281)
Energy for lighting	1230.1394	1.5338	1886.8289	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1295.3837	1.4913	-1931.7781	
PV Unit electricity exported	-431.8557	0.4389	-189.5314	
Total			-2121.3095	(283)
Total Primary energy kWh/year			40258.1533	(286)
Dwelling Primary energy Rate (DPER)			35.0400	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	165.3300	(1a)	x 1.5000	(2a)	= 247.9950	(1a) - (3a)
Ground floor	389.0000	(1b)	x 2.5000	(2b)	= 972.5000	(1b) - (3b)
First floor	295.5000	(1c)	x 2.6700	(2c)	= 788.9850	(1c) - (3c)
Second floor	191.4000	(1d)	x 2.0500	(2d)	= 392.3700	(1d) - (3d)
Third floor	107.8000	(1e)	x 3.3500	(2e)	= 361.1300	(1e) - (3e)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 1149.0300 (4)
Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 2762.9800 (5)

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2. Ventilation rate

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		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) =	0.0145	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2645	(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) =	0.2248	(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	0.2866	0.2810	0.2754	0.2473	0.2417	0.2136	0.2136	0.2079	0.2248	0.2417	0.2529	0.2641	(22b)
Effective ac	0.5411	0.5395	0.5379	0.5306	0.5292	0.5228	0.5228	0.5216	0.5253	0.5292	0.5320	0.5349	(25)

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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 Opaque door			2.7700	1.0000	2.7700			(26)
TER Opening Type (Uw = 1.20)			83.9000	1.1450	96.0687			(27)
Basement Skylight			4.1400	2.0221	8.3713			(27a)
dining room Skylight			3.7800	2.0221	7.6434			(27a)
roof Skylight			0.8000	2.0221	1.6176			(27a)
Heatloss Floor 1			389.0000	0.1300	50.5700			(28)
Basement	211.0000		211.0000	0.1800	37.9800			(29a)
GF	172.0000	51.1000	120.9000	0.1800	21.7620			(29a)
1F	112.0000	35.5700	76.4300	0.1800	13.7574			(29a)
Dormer windows	26.3000		26.3000	0.1800	4.7340			(29a)
2f	56.9900		56.9900	0.1800	10.2582			(29a)
lower basement	81.0000		81.0000	0.1800	14.5800			(29a)
GF Old wall	80.1000		80.1000	0.1800	14.4180			(29a)
1F Old wall	94.8000		94.8000	0.1800	17.0640			(29a)
2f old wall	53.0100		53.0100	0.1800	9.5418			(29a)
Roof	107.8000	4.9400	102.8600	0.1100	11.3146			(30)
GF roof	54.8100	3.7800	51.0300	0.1100	5.6133			(30)
Total net area of external elements Aum(A, m2)			1438.8100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		328.0644			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 116.9279 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	49.6000	0.1600	7.9360
E6	Intermediate floor within a dwelling	17.5000	0.0000	0.0000
E22	Basement floor	30.2000	0.0700	2.1140
E15	Flat roof with parapet	45.0000	0.5600	25.2000
E14	Flat roof	9.2000	0.0800	0.7360
E24	Eaves (insulation at ceiling level - inverted)	24.3000	0.2400	5.8320
E16	Corner (normal)	67.9600	0.0900	6.1164
E17	Corner (inverted - internal area greater than external area)	14.8200	-0.0900	-1.3338
R1	Head of roof window	0.8000	0.0800	0.0640
R2	Sill of roof window	0.8000	0.0600	0.0480
R3	Jamb of roof window	1.9400	0.0800	0.1552
R4	Ridge (vaulted ceiling)	39.9600	0.0800	3.1968
R5	Ridge (inverted)	7.0000	0.0400	0.2800
R7	Flat ceiling (inverted)	16.6800	0.0400	0.6672
R9	Roof to wall (flat ceiling)	144.3100	0.0400	5.7724
E20	Exposed floor (normal)	37.4000	0.3200	11.9680
E21	Exposed floor (inverted)	15.5000	0.3200	4.9600
E16	Corner (normal)	46.0200	0.0900	4.1418
E17	Corner (inverted - internal area greater than external area)	32.8400	-0.0900	-2.9556
E5	Ground floor (normal)	28.2000	0.1600	4.5120
E2	Other lintels (including other steel lintels)	45.3300	0.0500	2.2665
E3	Sill	44.1500	0.0500	2.2075
E4	Jamb	106.1000	0.0500	5.3050

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 89.1894 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 417.2538 (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	493.3455	491.8911	490.4656	483.7697	482.5169	476.6850	476.6850	475.6050	478.9313	482.5169	485.0512	487.7008	(38)
Heat transfer coeff	910.5993	909.1449	907.7193	901.0234	899.7706	893.9387	893.9387	892.8588	896.1851	899.7706	902.3050	904.9546	(39)

Average = Sum(39)m / 12 = 901.0174

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7925	0.7912	0.7900	0.7842	0.7831	0.7780	0.7780	0.7771	0.7799	0.7831	0.7853	0.7876	(40)
HLP (average)												0.7842	
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 4.2357 (42)

Hot water usage for mixer showers

	95.2385	93.8072	91.7216	87.7312	84.7863	81.5023	79.6356	81.7054	83.9743	87.5004	91.5766	94.8736 (42a)

Hot water usage for baths

	41.0789	40.4688	39.6097	38.0256	36.8395	35.5243	34.8138	35.6669	36.5958	38.0032	39.6198	40.9400 (42b)

Hot water usage for other uses

	58.0075	55.8981	53.7888	51.6794	49.5700	47.4607	47.4607	49.5700	51.6794	53.7888	55.8981	58.0075 (42c)

Average daily hot water use (litres/day) 178.6273 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.3248	190.1741	185.1200	177.4362	171.1958	164.4872	161.9101	166.9424	172.2496	179.2923	187.0945	193.8210	(44)
Energy conte	307.7630	270.8054	284.5226	242.9012	230.4625	202.2562	195.8162	206.7096	212.4009	243.2980	266.5505	303.4769	(45)

Energy content (annual) Total = Sum(45)m = 2966.9631

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

	46.1645	40.6208	42.6784	36.4352	34.5694	30.3384	29.3724	31.0064	31.8601	36.4947	39.9826	45.5215 (46)

Water storage loss:

Store volume 175.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.5263 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8242 (55)

Total storage loss

	25.5498	23.0773	25.5498	24.7257	25.5498	24.7257	25.5498	25.5498	24.7257	25.5498	24.7257	25.5498 (56)

If cylinder contains dedicated solar storage

	25.5498	23.0773	25.5498	24.7257	25.5498	24.7257	25.5498	25.5498	24.7257	25.5498	24.7257	25.5498 (57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624 (59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (61)

Total heat required for water heating calculated for each month

	356.5752	314.8939	333.3348	290.1389	279.2747	249.4938	244.6285	255.5218	259.6386	292.1103	313.7881	352.2892 (62)
WWHRS	-43.5390	-38.5063	-40.3216	-33.3879	-31.1163	-26.6264	-24.9580	-26.5404	-27.5487	-32.4769	-36.7924	-42.7328 (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

	313.0362	276.3876	293.0133	256.7510	248.1585	222.8674	219.6705	228.9815	232.0899	259.6334	276.9957	309.5564 (64)

Total per year (kWh/year) = Sum(64)m = 3137.1413 (64)

12Total per year (kWh/year) 3137 (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

	141.3810	125.3136	133.6536	118.5548	115.6786	105.0403	104.1587	107.7807	108.4134	119.9464	126.4182	139.9559 (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	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	211.7834	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

	602.8057	667.3920	602.8057	622.8992	602.8057	622.8992	602.8057	602.8057	622.8992	602.8057	622.8992	602.8057	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

	995.0542	1005.3797	979.3596	923.9660	854.0416	788.3224	744.4180	734.0925	760.1125	815.5061	885.4306	951.1497	(68)

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

	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	44.1783	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)

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

	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	-169.4268	(71)

Water heating gains (Table 5)

	190.0282	186.4785	179.6419	164.6594	155.4820	145.8893	139.9982	144.8666	150.5742	161.2183	175.5808	188.1127	(72)

Total internal gains

	1877.4231	1948.7853	1851.3422	1801.0597	1701.8642	1643.6460	1573.7570	1568.2997	1620.1209	1669.0651	1773.4456	1831.6032	(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	
North	1.1900	10.6334	0.6300	0.7000	0.7700	3.8671	(74)
East	50.2500	19.6403	0.6300	0.7000	0.7700	301.6166	(76)
South	0.9900	46.7521	0.6300	0.7000	0.7700	14.1452	(78)
West	31.4700	19.6403	0.6300	0.7000	0.7700	188.8930	(80)
East	8.7200	26.0000	0.6300	0.7000	1.0000	89.9852	(82)

Solar gains	598.5071	1176.9895	1954.5475	2877.3356	3550.8893	3646.0628	3466.6281	2961.1555	2281.8057	1400.7839	747.3572	491.4981	(83)
Total gains	2475.9301	3125.7748	3805.8897	4678.3953	5252.7535	5289.7087	5040.3850	4529.4552	3901.9266	3069.8490	2520.8028	2323.1013	(84)

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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	40.9845	41.0501	41.1146	41.4201	41.4778	41.7484	41.7484	41.7989	41.6437	41.4778	41.3613	41.2402	
alpha	3.7323	3.7367	3.7410	3.7613	3.7652	3.7832	3.7832	3.7866	3.7762	3.7652	3.7574	3.7493	
util living area	0.9990	0.9975	0.9931	0.9759	0.9277	0.8208	0.6838	0.7507	0.9271	0.9898	0.9981	0.9993	(86)
MIT	18.6892	18.9086	19.2959	19.8466	20.3636	20.7483	20.9112	20.8710	20.5322	19.8494	19.1759	18.6582	(87)
Th 2	20.2598	20.2609	20.2620	20.2671	20.2680	20.2724	20.2724	20.2733	20.2707	20.2680	20.2661	20.2641	(88)
util rest of house	0.9989	0.9971	0.9918	0.9708	0.9105	0.7739	0.5999	0.6739	0.9027	0.9871	0.9977	0.9991	(89)
MIT 2	17.4515	17.7336	18.2303	18.9358	19.5842	20.0437	20.2117	20.1782	19.8011	18.9436	18.0798	17.4144	(90)

Living area fraction fLA = Living area / (4) = 0.0522 (91)

MIT	17.5162	17.7949	18.2859	18.9833	19.6249	20.0805	20.2482	20.2144	19.8393	18.9909	18.1370	17.4794	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5162	17.7949	18.2859	18.9833	19.6249	20.0805	20.2482	20.2144	19.8393	18.9909	18.1370	17.4794	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9978	0.9947	0.9864	0.9583	0.8914	0.7596	0.5968	0.6668	0.8839	0.9797	0.9957	0.9983	(94)
Useful gains	2470.5474	3109.3345	3754.1776	4483.1693	4682.0945	4018.0266	3008.0104	3020.2407	3449.0475	3007.4831	2510.0010	2319.1485	(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	12034.6271	11723.3532	10698.3016	9085.3113	7130.5853	4899.2627	3261.3076	3405.7060	5143.4635	7549.8449	9958.7446	12017.2367	(97)
Space heating kWh	7115.6753	5788.6206	5166.4283	3313.5423	1821.6772	0.0000	0.0000	0.0000	0.0000	3379.5172	5363.0954	7215.3776	(98a)
Space heating requirement - total per year (kWh/year)												39163.9339	
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	7115.6753	5788.6206	5166.4283	3313.5423	1821.6772	0.0000	0.0000	0.0000	0.0000	3379.5172	5363.0954	7215.3776	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												39163.9339	
Space heating per m2											(98c) / (4) =	34.0843	(99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	7115.6753	5788.6206	5166.4283	3313.5423	1821.6772	0.0000	0.0000	0.0000	0.0000	3379.5172	5363.0954	7215.3776	(98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)	7709.2907	6271.5283	5597.4304	3589.9700	1973.6481	0.0000	0.0000	0.0000	0.0000	3661.4488	5810.5042	7817.3105	(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	313.0362	276.3876	293.0133	256.7510	248.1585	222.8674	219.6705	228.9815	232.0899	259.6334	276.9957	309.5564	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.3800	88.3459	88.2657	88.0856	87.6153	79.8000	79.8000	79.8000	79.8000	88.0912	88.3109	88.3899	(217)
Fuel for water heating, kWh/month	354.1936	312.8470	331.9672	291.4791	283.2365	279.2825	275.2763	286.9442	290.8394	294.7325	313.6599	350.2169	(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	125.2511	100.4811	90.4721	66.2837	51.1995	41.8304	46.7059	60.7100	78.8563	103.4638	116.8621	128.7322	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-155.5531	-219.6397	-315.7679	-354.4734	-380.9005	-354.1375	-349.0761	-329.9947	-296.4940	-250.3656	-170.8869	-134.3886	(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	-86.5226	-182.2850	-363.1416	-546.9107	-725.0488	-729.9862	-722.0784	-611.0274	-446.9263	-261.9386	-115.8542	-68.4515	(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	42431.1309	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	79.8000	
Water heating fuel used	3664.6750	(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)	1010.8482	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-8171.8495	(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	39020.8047	(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	42431.1309	0.2100	8910.5375	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3664.6750	0.2100	769.5818	(264)
Space and water heating			9680.1193	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1010.8482	0.1443	145.8966	(268)

Energy saving/generation technologies

PV Unit electricity used in dwelling	-3311.6782	0.1346	-445.9132	
PV Unit electricity exported	-4860.1713	0.1258	-611.3600	
Total			-1057.2732	(269)
Total CO2, kg/year			8780.6720	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			7.6400	(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	42431.1309	1.1300	47947.1780	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3664.6750	1.1300	4141.0828	(278)
Space and water heating			52088.2608	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1010.8482	1.5338	1550.4728	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-3311.6782	1.4976	-4959.7125	
PV Unit electricity exported	-4860.1713	0.4617	-2244.0750	
Total			-7203.7875	(283)
Total Primary energy kWh/year			46565.0468	(286)
Target Primary Energy Rate (TPER)			40.5300	(287)