

Energy & Sustainability Statement

117-119 Oxford Road, Reading, RG1 7UH

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1.0 Executive Summary

This report provides a detailed analysis of the energy & sustainability strategy for the proposed development at 117-119 Oxford Road, Reading, RG1 7UH, showing alignment with the required local and national planning policies. The proposal is for the development of **proposed demolition of existing building and construction of new residential development comprising 6no.New Build flats.**

This report outlines how the proposal has achieved a significant reduction in CO₂ emissions from the Part L 2021 baseline, which demonstrates the client and the design team's commitment to sustainability in the built environment.

The reduction in consumption and CO₂ emissions presented in this report have been achieved by following the energy hierarchy:

- Be Lean – Use less energy, by adopting sustainable design and construction measures
- Be Clean – Supply energy efficiently, in particular by prioritising decentralised energy generation
- Be Green – Using renewable and low/zero carbon technology

Energy modelling utilising approved compliance software for Part L 2021 has been undertaken to produce the figures outlined in table 1.1. This shows the reductions achieved at each step of the energy hierarchy, which is summarised as:

- Be Lean:
 - High levels of insulation to achieve low fabric U-Values
 - Low air permeability to reduce unwanted infiltration and exfiltration
 - Enhanced detailing to reduce losses via thermal bridging
 - Efficient sanitary ware to limit water usage to 105 l/person/day
 - Low energy lighting in all outlets
- Be Clean:
 - No 'Be Clean' strategies deemed feasible for this development
- Be Green:
 - High-efficiency air-to-water heat pumps to provide space heating and hot water, must be registered within the SAP database.

Table 1.1: Three-Step Hierarchy – Site-wide energy consumption and CO ₂ emissions				
	Energy Consumption [kWh/year]	Energy Consumption Savings [%]	CO ₂ Emissions [Tonnes CO ₂ /Year]	CO ₂ Emissions Savings [%]
Baseline	20735.03		4.71	
Be Lean	17633.71	14.96%	2.62	44.30%
Be Clean	17633.71	0.00%	2.62	0.00%
Be Green	14112.36	16.98%	2.14	10.24%
Total Reduction		31.94%		54.54%

The incorporation of the three step energy hierarchy results in a **54.54%** reduction in CO₂ emissions over the baseline, improving on the targets laid out in the relevant planning policy guidelines.

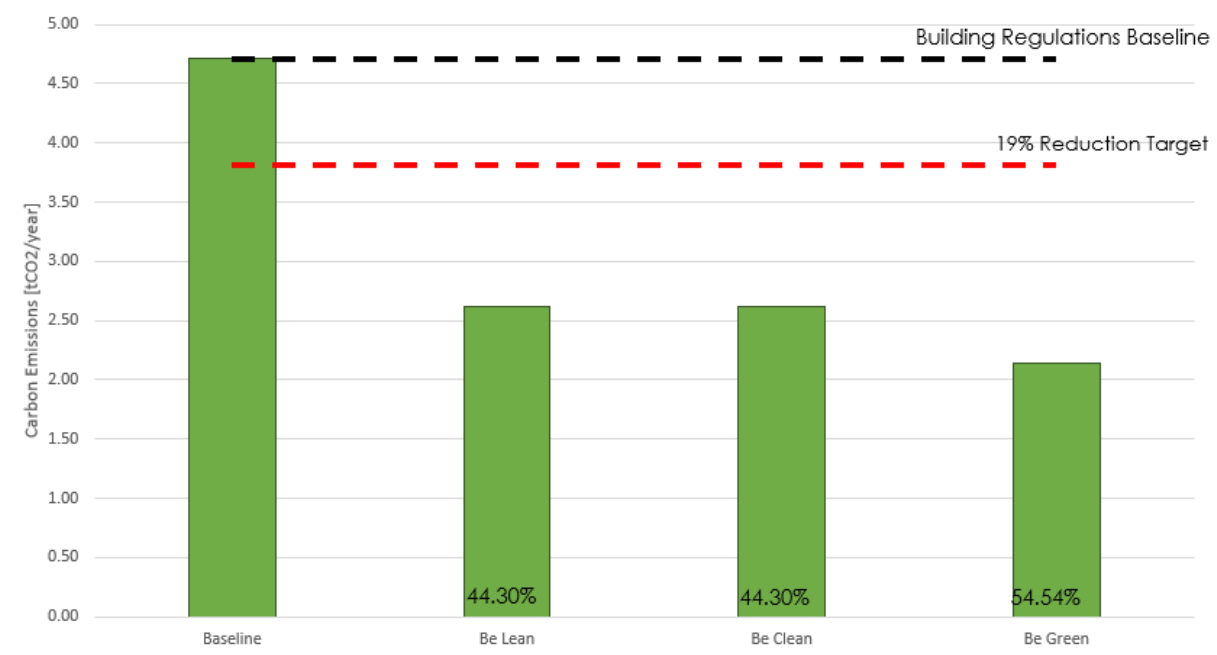


Figure 1.1: CO₂ Emission Reductions

2.0 Introduction

2.1 Site Location and Proposal

ERS Consultants Ltd has been appointed to prepare an Energy & Sustainability Statement and develop an energy strategy which supports the appropriate planning policies for the site located at **117-119 Oxford Road, Reading, RG1 7UH**.

The proposal is for the development of **proposed demolition of existing building and construction of new residential development comprising 6no.New Build flats**. This Energy & Sustainability Statement will demonstrate the sustainable measures implemented in order to lower energy demand and reduce CO₂ emissions in line with the applicable planning and regulation requirements.

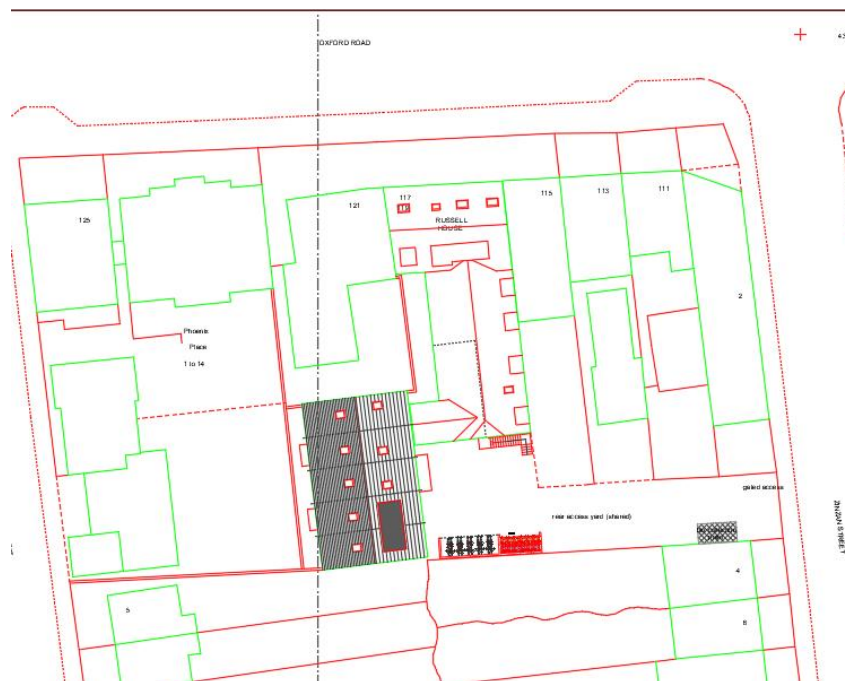


Figure 2.1: Site Location Plan

Proposed schedules of accommodation is provided in Table 2.1 below:

Table 2.1 Accommodation Schedule	
Space	Gross Internal Area [GIA - m ²]
Flat 1	74.92
Flat 2	62.00
Flat 3	46.50
Flat 4	40.82
Flat 5	49.80
Flat 6	61.96
Total	336.00

The figures outlined in this report have been produced using a sample of the conditioned areas summarised in the accommodation schedule. These have been scaled up on a pro rata basis to represent the whole site. The selected samples are as follows:

Residential spaces selected:

- Flat 1: 74.92m²
- Flat 4: 40.82m²

Combined Area of Sample: m² (34.45% of residential GIA)

2.2 Methodology

The methodology used within this energy statement to determine the regulated CO₂ emissions is in accordance with the recognised three-step energy hierarchy (Figure 2.2).

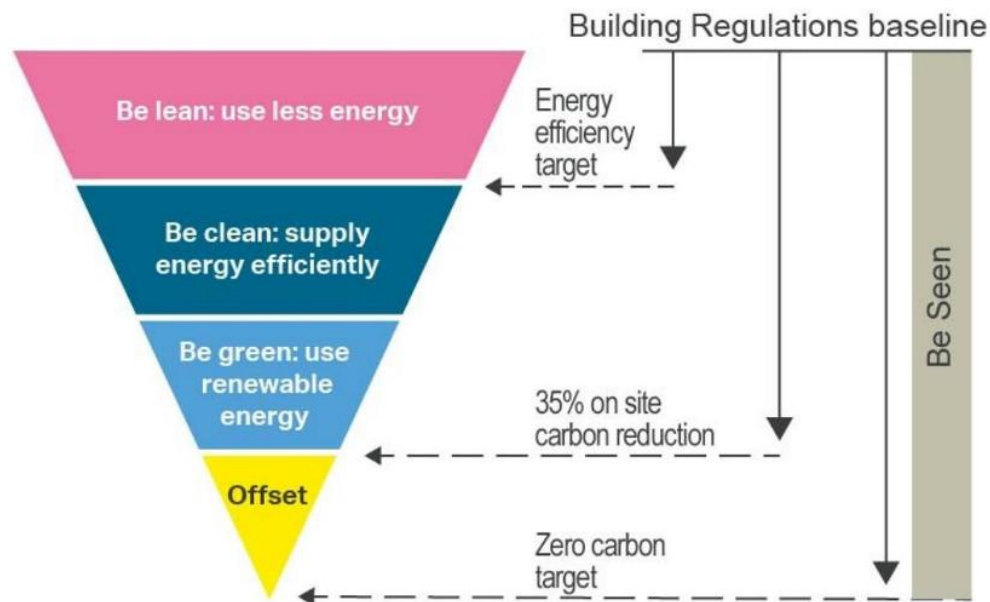


Figure 2.1: Three-step energy hierarchy

2.2.1 Be Lean – Reducing Demand

The first step of the energy hierarchy requires developments to use less energy and manage operational demand through fabric (passive) and servicing (active) improvements.

Passive Design Measures

The passive design of the building should aim to reduce energy demand through architectural and non-system measures, with an emphasis on a 'fabric-first' approach. This can include optimising orientation, site massing, fabric efficiency, maximising daylight and ventilation.

Active Design Measures

By implementing systems and services of higher efficiency and lower energy consumption, overall energy demand, CO₂ emissions and environmental impact can be reduced.

Ways of reducing energy consumption include installing A-Rated white goods, using sanitaryware that consumes less water, highly efficient lighting, careful planning of heating controls and heat recovery.

To ensure sufficient ventilation is provided, system specific guidance should be referred to. This is so an appropriate air permeability is targeted depending on the mechanical ventilation system type (continuous or intermittent). This guidance can be found in Section 1.45-1.73 in Part F, Volume 1, of the 2021 building regulations.

2.2.2 Be Clean – Heating Infrastructure

The second step of the energy hierarchy requires all planning applications to consider and demonstrate how local energy resources are to be exploited. This is to ensure the remaining energy demand is supplied as cleanly as possible to reduce CO₂ emissions and further reduce demand.

This includes assessing the feasibility of connecting to existing and planned heat networks, the provision of site-wide heat networks, the use of secondary heat, gas-engine Combined Heat & Power (CHP) and ultra-low NO_x gas boilers, and the provision of site wide heat networks.

2.2.3 Be Green – Renewable Energy

The final step of the energy hierarchy asks that the remaining energy demand and CO₂ reductions are made using renewable energy sources. Typically, this includes Photovoltaic panels (PV), solar thermal water heating, wind turbines and biomass boilers. Also, while not strictly in the category of renewable technology, decentralised low/zero carbon technologies such as heat pumps should be considered at the 'Be Green' stage.

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3.0 Regulation and Policy Guidance

This section presents the key relevant planning requirements and guidance which have been followed to produce the energy strategy. The most relevant applicable energy policies in the context of the proposed development are presented below.

3.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) was updated December 2024 as a response to the Levelling-up and Regeneration Bill. This Policy sets out the Governments planning policies for the whole of England to meet sustainable developments. This framework influences local planning policies and guidance.

The NPPF has three core objectives to sustainable development; Economic, Social, and Environmental. These objectives should be accounted for simultaneously.

The Framework details positive improvements that planning policies should aim towards. These include:

- Delivering a sufficient supply of homes
- Building a strong, competitive economy
- Ensuring the vitality of town centre
- Promoting healthy and safe communities
- Promoting sustainable transport
- Supporting high quality communications
- Making effective use of land
- Achieving well-designed and beautiful places
- Protecting Green Belt land
- Meeting the challenge of climate change, flooding and coastal change
- Conserving and enhancing the natural and historic environment
- Facilitating the sustainable use of minerals.

3.2 Local Planning Policy

CC2: Sustainable Design and Construction

This policy seeks improved sustainability performance of buildings by setting out BREEAM requirements for non-residential developments conversions to residential. It also sets out the general principles of sustainability in new development that applies to both residential and non-residential uses. Requiring the specified BREEAM levels will significantly contribute to achieving Reading's emissions targets, as well as mitigating the effects of climate change

CC3: Adaptation to Climate Change

This identifies measures including building orientation, shading, heating, ventilation, green or brown roofs and walls, planting and surface water run-off to deal with the effects of climate change. Where these measures are not appropriately incorporated, planners will consider whether or not this is a reason for refusal. This policy will ensure that development within the Borough is resilient in the face of climate change.

H5: Standards for New Housing

This policy outlines standards for new-build housing, including those for sustainable design and construction. All new-build housing must be built to the higher water efficiency standard under the Building Regulations. All major new-build residential should achieve zero carbon homes and all other new-build housing must achieve a minimum 19% improvement over the 2013 Building Regulations target. This policy will help to deliver high-quality new homes and achieve Reading's emissions targets, as well as mitigate the effects of climate change.

3.3 Part L 2021

The Approved Document Part L, 2021, details the conservation of fuel and power in; Volume 1 – Dwellings, and Volume 2 – Buildings other than dwellings.

Guidance is provided within these documents that outline how to comply with the minimum regulatory standards surrounding energy efficiency.

Compliance is then defined by the following metrics:

- Domestic (Part L, Volume 1)
 - o Emission Rate (TER>DER)
 - o Primary Energy Rate (TPER>DPER)
 - o Fabric Energy Efficiency (TFEE>DFEE)
- Non-Domestic (Part L, Volume 2)
 - o Emission Rate (TER>BER)
 - o Primary Energy Rate (TPER>BPER)

In these metrics, domestic compliance refers to dwellings (D), where non-domestic refers to buildings (B).

There are also minimum standards that relate to individual elements within a property's specification. The following are examples of elements where a minimum standard for compliance applies irrespective of whether compliance on the main three metrics is achieved:

- U-Values of building constructions
 - o Constructions in new builds
 - o New constructions in existing buildings
 - o Existing constructions requiring improvement
- Efficiency of building services
 - o Heating system coefficient of performance (COP)
 - o Cooling system energy efficiency ratio (EER)
 - o Ventilation system specific fan power (SFP)
 - o Heat recovery efficiency
- Air permeability
 - o Maximum permissible score for all new builds
 - o Requirement for testing of all new builds

3.4 Part O 2021

Approved Document Part O 2021 details the regulations applicable to overheating, and mitigating the risk of this occurring in new-build residential dwellings.

Properties within the scope of Part O include:

- Residential (dwellings):
 - o Dwellings, which includes both dwellinghouses and flats.
- Residential (institutional):
 - o Home, school or other similar establishment, where people sleep on the premises. The building may be living accommodation for the care or maintenance of any of the following:
 - Older and disabled people, due to illness or other physical or mental condition.
 - People under the age of 5 years.
- Residential (other):
 - o Residential college, hall of residence and other student accommodation, and living accommodation for children aged 5 years and older.

Requirement O1 states that reasonable provision must be made in any applicable property to (a) 'limit solar gains in summer' and (b) 'provide adequate means to remove heat from the indoor environment'.

In meeting these obligations, other factors must be considered. These are that (a) 'account must be taken of the safety of any occupant, and their reasonable enjoyment of the property' and (b) 'mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it'.

3.5 Part F 2021

Approved Document Part F 2021 details the regulations relating to ventilation in; Volume 1 – Dwellings, and Volume 2 – Buildings other than dwellings.

These documents provide guidance on the means of providing adequate ventilation for people in buildings, and specifically applies to occupied areas.

With regards to sustainability, Part F offers guidance on providing sufficient mechanical ventilation in properties that aim to be air tight. As sustainability targets are tightened, the design of buildings tends toward passive standards that seeks to reduce infiltration and exfiltration.

In cases where low air permeability is targeted, system specific guidance should be sought in order to ensure sustainability targets don't compromise comfort and, as with Part O, occupants' comfort isn't compromised.

3.8 Emission Factors

These factors assist in calculating a property regulated emissions, and are used in all calculations in this document. They assume that for every kWh consumed, that a specified number of emissions are released in order to produce that energy. These differ depending on the fuel type. These are presented in Table 3.1 below:

Table 3.1 Carbon Emission Factors for selected fuel type		
Fuel	Carbon Factor	Primary Energy Factor
Mains Gas	0.210	1.130
Bulk/Bottled LPG	0.241	1.141
Liquid Fuels	0.024	1.286
Heating Oil	0.298	1.180
Wood Pellets	0.053	1.325
Grid Electricity	0.136	1.501

** Table extracted from the document SAP Version 10.2 (21-04-2022). Table 12: Fuel prices, emission factors and primary energy factors, Page 182. this can be found in the appendix of the report.*

3.6 Approved Compliance Software

The approved compliance software for residential buildings used for modelling is Elmhurst Design SAP 10.2, and has therefore been used to assess the CO₂ emissions and energy consumption in the residential properties.

4.0 The Energy Hierarchy

The following section details the reductions in CO₂ emissions and energy consumption at each stage of the energy hierarchy, and the strategies implemented at each stage to achieve those figures.

4.1 Baseline CO₂ Emissions

Before the three-step energy hierarchy is implemented, the notional CO₂ emissions must be established. This figure forms the baseline, which all further steps will be compared against to quantify the reduction in CO₂ emissions.

For new-build developments, the baseline is equivalent to the Target Emission Rate (TER), which is calculated using the notional specification outlined in Table 1.1 of The Approved Part L 2021 Document for residential properties, and by the *National Calculation Methodology Modelling Guide* for non-residential properties.

The baseline figures can be seen in Table 4.1 for the residential results:

Table 4.1: Baseline energy consumption and CO ₂ emissions - Residential				
	Energy Consumption [kWh/year]	Energy Consumption Savings [%]	CO ₂ Emissions [Tonnes CO ₂ /Year]	CO ₂ Emissions Savings [%]
Baseline	20735.03	-	4.71	-

While only a sample of the proposed units have been modelled, the figures quoted in Tables 4.1-has been generated by scaling up the results from those units according to the overall gross internal area (GIA) of the development.

5.0 Be Lean – Reducing Demand

At the 'Be Lean' stage, passive and active measures are proposed to reduce the energy consumption of the dwelling as a way of lowering CO₂ emissions.

5.1 Fabric Improvements

At this stage, a fabric first approach is taken to ensure energy consumption is reduced. The key elements of the specification are outlined in Table 5.1 below for each use type

This includes proposals for U-Values beyond notional standards where practicably possible, as well as ultra-low air permeability targets and enhanced thermal bridging.

Table 5.1: Fabric Performance for Residential Areas			
	Part L 2021 Minimum Standard	Part L 2021 Notional Standard	Proposed Figures
Floor U-Values	0.18 W/m ² K	0.13 W/m ² K	0.12 W/m ² K
Wall U-Values	0.26 W/m ² K	0.18 W/m ² K	0.18 W/m ² K
Roof U-Values	0.16 W/m ² K	0.11 W/m ² K	0.11-0.15 W/m ² K
Window U-Values	1.60 W/m ² K	1.20 W/m ² K	1.20 W/m ² K
Roof Window/Light U-Values	2.20 W/m ² K	1.20 W/m ² K	1.20 W/m ² K
Opaque Doors	1.60 W/m ² K	1.00 W/m ² K	1.40 W/m ² K
Air Permeability	8.00 m ³ /m ² /hr @ 50Pa	5.00 m ³ /m ² /hr @ 50Pa	5.00 m ³ /m ² /hr @ 50Pa
Thermal Bridging Y-Value	-	-	Fully Calculated with Calculated PSI Values

5.2 Building Services

Once fabric first measures are implemented, the 'Be Lean' stage looks to reduce energy demand through the use of efficient services. This includes heating, ventilation & air conditioning (HVAC) systems as well as lighting. Heating also includes provision for space and hot water requirements across the residential and non-residential spaces.

5.2.1 Residential Building Services

For the residential areas, the specification used for modelling in SAP 10.2 is outlined in Table 5.3.

Table 5.3: Residential Building Services					
Space Heating					
Main Heating System		High Efficiency-Direct Electric Panel Heaters			
Secondary Heating System		Dimplex EDEL 200 exhaust air heat pump to provide heating to hot water only; or similar			
Control Strategy		Programmer and appliance thermostats			
Water Heating					
Hot Water System		Dimplex Exhaust air heat pump or similar			
Shower(s)		8l/min; Unvented cylinder			
Water Usage		105 l/person/day; See appendix for sample calculation;			
Lighting					
Power [W]	5	Efficacy [lm/W]	105	Capacity [lm]	525
Ventilation					
Ventilation Type		Natural ventilations and intermittent extract fans in wet-rooms and kitchen			

To minimise energy consumption from lighting, the building is designed to maximise natural lighting, thus reducing the reliance on artificial lighting. The number of fittings will also be limited, so they are only installed where necessary. High efficacy lighting will support this.

The heating control strategy is designed to reduce energy consumption. Time and temperature zoning controls are proposed which will allow for fully programmable heating in multiple zones across the building. This can be achieved using multiple room thermostats, programmers with multiple channels and other devices such as smart TRVs fitted directly to emitters.

An exhaust air heat pump (EAHP) will be installed as part of the dwelling's heating strategy. This low-carbon system recovers heat from the extracted indoor air to provide efficient domestic hot water heating, reducing the dwelling's overall carbon emissions. As the unit is installed entirely within the building, with no external condenser or fan unit, it eliminates the potential for external noise impacts, making it particularly suitable for developments where environmental acoustic constraints are a consideration.

While not a direct contributor to the CO₂ emissions and energy consumption calculated in the approved compliance software for Part L, limiting water usage is important in order to reduce a developments environmental impact. This is assessed in accordance with Approved Document Part G, and in accordance with the highest

national standard for water usage, 105 l/s/day is targeted. This is achieved using efficient sanitary ware, and a sample calculation outlining how this is to be achieved is attached as an appendix.

5.3 Lean Reduction

With the implementation of all lean measures, there have been measurable reductions in energy demand and carbon emissions. This can be seen in table 5.5.

- Passive Measures:
 - o Low U-Values
 - o Low air permeability targets
 - o Enhanced thermal bridging
- Active Measures:
 - o Efficient sanitary ware

Table 5.5: 'Be Lean' energy consumption and CO ₂ emissions - Residential				
	Energy Consumption [kWh/year]	Energy Consumption Savings [%]	CO ₂ Emissions [Tonnes CO ₂ /Year]	CO ₂ Emissions Savings [%]
Baseline	20735.03		4.71	
Be Lean	17633.71	14.96%	2.62	44.30%
Total Reduction		14.96%		44.30%

6.0 Be Clean – Heating Infrastructure

The second step of the energy hierarchy seeks a reduction in CO₂ emissions by improving the energy heating infrastructure. This includes heat networks (existing and proposed), secondary heat, combined heat & power (CHP) and heating systems with low local emissions of pollutants such as NO_x.

6.1 Connection to Local Existing or Planned Heat Networks

Within the 'Be Clean' stage, connection to heat networks must be considered. This includes existing networks, or planned ones, with the facility to connect in the future incorporated.

There are currently no existing heat networks within Reading that are suitable for connection to the proposed development. Although Reading Borough Council is progressing plans for a future district heat network, no operational network is currently available to serve the site, and any future provision remains outside the timescale of this development.

Furthermore, the site has insufficient space to accommodate the plant and infrastructure required to facilitate a heat network connection, such as an energy centre, heat interface equipment and associated distribution infrastructure. Consequently, connection to a heat network is not considered technically or commercially feasible for this development and has therefore not been incorporated into the proposed energy strategy.

6.2 Use of Zero-emission and/or Local Secondary Heat Sources

In addition to heat networks, secondary heat sources should be reviewed at the 'Be Clean' stage. Secondary heat can be taken from the following sources:

- Environmental sources:
 - o Ground source
 - o Air source
 - o Water source
- Process sources:
 - o Power station rejection
 - o Building cooling system heat rejection
 - o Industrial sources (e.g., incinerators)
 - o Commercial buildings non-HVAC (e.g., data centres)
 - o Water treatment works (e.g., sewage plants)
- Infrastructure sources:
 - o Metro tunnels (e.g., London underground and Crossrail)
 - o National Grid electrical infrastructure
 - o Sewer heat mining

Often these secondary heat sources are considered 'low-grade' (i.e., below 30°C), and can be 'upgraded' via heat pumps for use as main heating and hot water systems. The upgrade can happen either at source, before entering a network or at the direct point of use.

While secondary heat from the air could be utilised on site, due to lack of space for plant equipment, this is not possible on a communal scale. This means that no secondary heat is to be implemented at the 'Be Clean' stage

6.3 Low-emission Combined Heat & Power (CHP)

CHP units have previously been the primary facilitator of communal and district heating networks in large scale developments. This was due to it producing fewer CO₂ emissions compared to tradition gas-fired boilers due to the favorable carbon factor of the electricity generated over that of the gas consumed.

However, changes to the carbon factor of grid electricity contained within the latest Building Regulations has meant that although still energy efficient the previously favoured system of CHP has become much less carbon efficient, with greater carbon emissions now seen compared with conventional gas-fired boilers due to their lower efficiency in heating and the reduced saving in CO₂ due to the electricity generation.

In addition to no longer providing CO₂ savings there are also concerns regarding local air quality. This is because gas-fired systems omit NO_x particulates, which is unwanted, especially in dense urban environments.

In light of this, CHP will not be incorporated into this proposal.

6.4 Use Ultra-low NO_x Gas Boilers

When selecting the main heating system at the 'Be Clean' stage, as well as considering savings in CO₂ emissions and reductions in overall consumption, it is important to consider local emissions.

All combustion processes where a fuel is burnt emit particulate matter potentially harmful to health. This can contribute to poor air quality in urban environments, where it is important to consider the impact of pollution on occupants of the development and the local area.

In this development, no fossil fuel-based systems are to be incorporated, such as mains gas CHPs or boilers, as they offer no benefit to the environmental and sustainable credentials of this proposal.

Gas-fired boilers would only become acceptable if used as a placeholder while connection to a heat network was facilitated, however as this is not the case in this development, they are not deemed feasible or beneficial.

6.5 The Be Clean Reduction

After the feasibility of 'Be Clean' measures in the second step of the energy hierarchy, no means of reducing CO₂ emissions were deemed suitable for this development.

The site is not in close proximity to either an existing or proposed district network, and is not large enough to implement secondary heat on a communal scale, the use of CHP and gas-fired boilers was also not considered suitable in terms of targeting a net zero carbon development and minimizing emissions of NO_x.

Therefore, no reduction in CO₂ emissions is recorded at this stage of the energy hierarchy.

7.0 Be Green – Renewable Energy

The third step of the energy hierarchy, 'Be Green', requires that renewable and LZC technology be incorporated in to the proposal. This requires that the feasibility of various technologies be assessed and, where reasonably practicable, be implemented into the proposal regardless of whether the required reduction in emissions has been achieved in the previous steps.

7.1 Types of Renewable Technology Considered

There is a wide range of renewable technology available for direct use in developments. These can all be scaled to suit single dwelling developments, all the way up to major multi-use residential/commercial developments.

The following renewable and decentralised Low/Zero Carbon (LZC) technologies have been considered:

- Biomass
- Heat pumps (ground, water and air source)
- Wind
- PV Panels
- Solar thermal panels
- Hydro-electric power

Selection of these technologies depends on various factors, typically:

- CO₂/energy savings
- Site constraints
- Payback period
- Visual impact
- Practicality
- Demand profiles

7.2 Demand Profiles

The balance of technologies chosen will depend on the development's energy demand patterns. Space heating patterns will change seasonally, as will cooling patterns depending on system selection due to overheating mitigation strategies. Energy demand from hot water will provide a significant base load throughout the year, however, as this varies less than space conditioning requirements

Electrical demand is also likely to vary through the year, as well as through the day with demand for lighting likely to be higher in the evening.

The implementation of renewable technology should be made with demand profiles in mind. Additional storage technologies can be considered to supplement this, storing up energy in times of low-demand to be deployed in when demand exceeds supply.

7.3 Feasibility Assessment

At this stage, the feasibility of the available 'Be Green' technologies are assessed. As the design is in the early stages, the feasibility scores in Table 7.1 are only intended to provide an outline for the purpose of the energy statement.

Table 7.1: Indicative Feasibility Assessment			
Renewable Technology	Assessment	Indicative Feasibility	Adopted for the site
Biomass	Provided material (such as wood pellets) is source from sustainable suppliers, this is a good option. These fuels, however, do emit high levels of NOx pollutants, so in urban/suburban environments, this would contribute to poor local air quality. There would also be concerns surrounding delivery of the fuel within an urban environment.	Low	No
Photovoltaic (PV) Panels	An array of PV panels would generate significant savings in CO ₂ emissions and energy consumption for the proposal. There would also be a minimal impact on the external appearance, especially if integrated systems are used. Possibility to be installed in the future;	High	No
Solar Thermal	Similar to PV, these would be roof mounted, and can offer savings in energy consumption relating to hot water usage within the property. These do, however, reduce the available roof area for PV, which offer greater savings than this technology.	Med	No
Air Source Heat Pump/Exhaust Air heat pumps	Heat pumps can upgrade low-grade heat from the environment into high-grade heat for space heating and hot water. Heat pumps that take heat from the air, while less efficient than other sources, they still offer significant savings and run at a high COP. They also take up less space, and are more versatile with regards to installation requirements.	High	Yes
Ground Source Heat Pump	As ground temperatures are more stable (especially with deeper boreholes), this source for heat pumps can offer greater efficiency. There are, however, significantly higher initial costs, largely associated with the excavation/drilling required to install ground loops to the correct depth. These make them less suitable for a development of this size in an urban/suburban environment.	Med	No
Water Source Heat Pump	As with ground source, installing loops at a water-source can offer more stable temperatures compared to air-source. There are still high initial costs to consider, however, as well as proximity and access to an appropriate body of water, which is not present on this site.	Low	No

7.4 Detailed Assessment of Renewable Technologies

7.4.1 Air Source Heat Pumps

An Exhaust Air Heat Pump (EAHP), such as the Dimplex Edel 200, is a suitable low-carbon solution for the proposed development of six new-build flats. The system recovers heat from extracted air within the dwellings and uses it to efficiently heat domestic hot water, achieving a typical Coefficient of Performance (COP) of up to 3.3. This significantly reduces energy consumption and regulated carbon emissions compared with conventional electric water heating.

As the unit is installed entirely within each apartment, there are no external condenser units, eliminating external noise and visual impacts. This makes the system particularly suitable for flatted developments where space is limited and avoiding acoustic issues is an important planning consideration.

The EAHP also complements the building's mechanical ventilation strategy by recovering heat that would otherwise be lost through extracted air, improving the overall energy efficiency of the dwellings. Individual units provide simple installation, independent operation and reduced maintenance compared with communal heating systems.

Overall, the system provides an efficient, practical and future-proof heating solution that supports compliance with Building Regulations Part L while delivering a low-carbon heating strategy with minimal impact on the external appearance of the development.

7.4.2 Photovoltaic (PV) Panels

Four types of solar cells are available on the market at present and these are mono-crystalline, polycrystalline, thin film and hybrid panels. Although mono-crystalline and hybrid cells are the most expensive, they are also the most efficient with an efficiency rate of 12-20%. Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but can be produced as thin and flexible sheets.

1.00 kWp of PV panels can produce approximately 850-900kWh/year of electricity in this region, reducing the grid energy requirement and CO₂ emissions.

Photovoltaic (PV) panels have not been included within the current design, as the required carbon reduction targets are already achieved through the incorporation of low-carbon technologies, including the exhaust air heat pump. As such, the proposal complies with the relevant energy and carbon reduction requirements without the need for on-site renewable electricity generation. However, PV panels remain a viable enhancement and could be incorporated during the detailed design stage should the client wish to further reduce operational carbon emissions and energy consumption.

An appropriately sized PV array would provide additional reductions in CO₂ emissions, lower electricity demand from the grid, and have minimal impact on the external appearance of the building, particularly where integrated roof-mounted systems are utilised.

This will be mandatory requirement that renewable technology such as solar be installed should the project fall under Part L 2026 standards.

7.5 Green Reduction

After all green measures were implemented, use of renewable technology on site has been maximised where practicably possible. The effects of these are outlined in Table 7.3. These reductions have been achieved using the following technologies:

- Highly efficient Exhaust Air Source Heat Pump from BRE approved database

Table 7.3: 'Be Green' energy consumption and CO ₂ emissions - Residential				
	Energy Consumption [kWh/year]	Energy Consumption Savings [%]	CO ₂ Emissions [Tonnes CO ₂ /Year]	CO ₂ Emissions Savings [%]
Baseline	20735.03		4.71	
Be Lean	17633.71	14.96%	2.62	44.30%
Be Clean	17633.71	0.00%	2.62	0.00%
Be Green	14112.36	16.98%	2.14	10.24%
Total Reduction		31.94%		54.54%

8.0 Sustainable Design Measures

8.1 Overheating Risk

Under the 2021 building regulations, all new-build residential developments are required to analyse the risk of overheating. This falls under Part O 2021. Compliance with this can be achieved via two methodologies, the simplified version and the more detailed dynamic simulation.

For this development, the analysis utilising either methodology is to be undertaken in the post-planning stage, with all recommendations to be made by following the cooling hierarchy.

This is a step-by-step structure that seeks to ensure all passive measures are explored before mechanical ventilation and cooling systems are required. These steps are summarised below:

- Reduce the amount of heat entering the building
- Minimise internal heat generation through energy efficient design
- Manage the heat within the building through exposed internal thermal mass and high ceilings
- Provide passive ventilation
- Provide mechanical ventilation
- Provide active cooling

8.2 Biodiversity

Reading is characterised by a mix of urban development, suburban neighbourhoods and green infrastructure, including parks, rivers, woodlands and open spaces that support local biodiversity. New developments should seek opportunities to protect and enhance these ecological assets where appropriate.

The incorporation of features such as green roofs, native planting, and bird and bat boxes can enhance biodiversity, improve rainwater management and contribute to a more sustainable built environment. For this development, the ecological impact is considered to be low due to the nature and scale of the proposals. Where appropriate, suitable biodiversity enhancement measures will be incorporated to ensure the development contributes positively to the local environment and complies with relevant planning policy.

8.3 Waste Management

A Site Waste Management Plan will be developed for the site to outline the procedures for waste minimisation, sorting, reuse and recycling.

Sustainable waste management should follow the hierarchy described in BS 5906: *Waste management in buildings. Code of practice*. This outlines the following principles in decreasing order of desirability:

- Reuse land and buildings wherever feasible and consistent with maintaining and enhancing local character and distinctiveness.
- Reuse and recycle materials that arise through demolition and refurbishment, including the reuse of excavated soil and hardcore within the site.
- Prioritise the use of materials and construction techniques that have smaller ecological and carbon footprints, help to sustain or create good air quality, and improve resilience to a changing climate where appropriate.
- Incorporate green roofs and/or walls into the structure of buildings where technically feasible to improve water management in the built environment, provide space for biodiversity and aid resilience and adaptation to climate change.
- Consider the lifecycle of the building and public spaces, including how they can be easily adapted and modified to meet changing social and economic needs and how materials can be recycled at the end of their lifetime.

8.4 Materials

Material efficiency will be a priority for the design team and will be one of the key considerations during the detailed design. Potential measures for reducing the material demand and for designing out waste will be explored by all key design team disciplines at each design stage, according to the first stages of the Waste Hierarchy.

Specifically, the following notes have been made on the potential project materials:

- Timber Frame structure
- Off-site construction and Prefabrication
- Recycled Glass
- Recycled Tiles
- Locally sourced materials

Where there are suitable opportunities to recycle a proportion of the material recovered from the existing site it should always be done.

8.5 Flood Risk

The Environment Agency has developed a flood risk map for planning to identify the relative risk of flooding for proposed development planning locations. Flood zones assume that no defences are present and so where these do exist, they are only indicative of the potential for flooding.

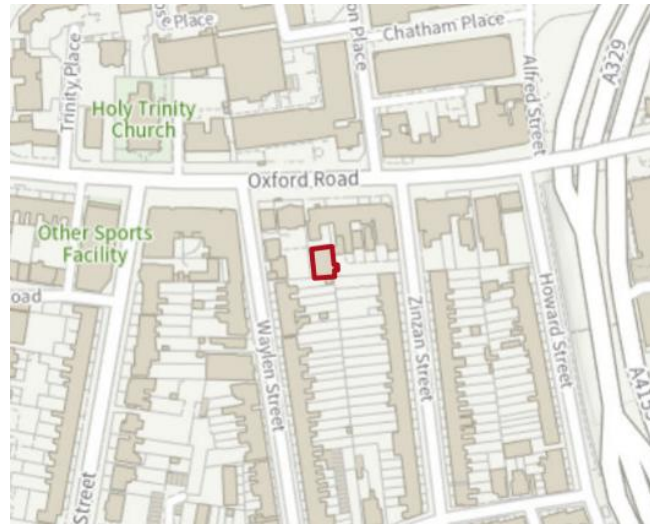


Figure 8.1. Environment Agency Flood Zone Interactive Map

The whole of the development lies within flood zone 1 of the Environment Agency's flood risk map as seen in figure 8.1. Land located within flood zone 1 is at low risk of flooding having an associated annual probability of flooding of less than 1 in 1000 (0.1%).

8.5.1 Study Approach

In accordance with Planning Practice Guidance for Flood Risk document, land within flood zone 1 is suitable for all uses. Assessment of this site has been based upon the Environment Agency's flood interactive map, the topographical site survey and the architect's proposed development layout.

8.5.2 Flood Vulnerability

Based on the Environment Agencies flood map, the development site is located within Flood Zone 1 and in accordance with Planning Practice Guidance for Flood Risk neither a sequential or exception test is required.

8.5.3 Sustainable Urban Drainage Systems (SuDS)

Sustainable Urban Drainage Systems are a method to manage excess water within urban environments. They are designed to work by allowing the water to be drained by infiltration allowing the excess water to positively impact the environment around. SuDS limit the volume and rate of surface water entering the public sewer system. They therefore have the potential to play an important role in helping to ensure the sewerage network has the capacity to cater for population growth and is resilient to the effects of climate change.

SuDS can offer multiple benefits such as;

- Managing Flood Risks
- Improving Biodiversity by creating new habitats
- Recharging groundwater supplies
- Possibilities for rainwater re-using
- Providing communities with open public spaces

The design of SuDS should explore fully the potential to deliver these benefits.

8.6 Water Efficiency

The local policy requires water efficiency in new development to meet the highest national standard. For residential development, this is defined in the supporting text as the 'optional Building Regulation' for water efficiency in new dwellings, which is 110 litres per day per person, or a tighter standard if one becomes available nationally. If a new, tighter national standard is introduced, this will be adopted automatically by virtue of Local planning policy.

For all developments, the submitted information should set out an approach to water management that reduces water usage and waste and priorities demand reduction measures over supply measures.

8.6.1 Reducing Water Use

In order to reduce the proposals environmental impact, it is important to use efficient sanitaryware to lower water consumption.

The following methodology has enabled the following measures to be considered within this proposal;

- Low flow and flush volume sanitaryware
- Aerated washbasin/kitchen taps and shower heads,
- Tapered and low-capacity baths,
- Rainwater harvesting
- Greywater harvesting
- Choosing the best location for the main heating & hot water system

The methodology adopted will aim to keep the mains water consumption below 105 litres/person/day as required by the local policy. If a new, tighter national standard is introduced, this will be adopted automatically by virtue of this policy.

For all developments, the submitted information should set out an approach to water management that reduces water usage and waste and priorities demand reduction measures over supply measures.

Recycling systems should be backed up by mains supply or a sufficiently large reserve storage system to meet higher demands during dry spells. Storage tanks will need an overflow to allow excess water to be released which should be able to flow into a soakaway.

9.0 Conclusion

This report provides a detailed analysis of the proposed development at **117-119 Oxford Road, Reading, RG1 7UH**, showing alignment with the required local and national planning policies. The proposal has achieved a significant reduction in CO₂ emissions from the Part L 2021 baseline, which demonstrates the client and the design team's commitment to sustainability in the built environment.

This reduction in consumption and CO₂ emissions has been achieved by following the energy hierarchy. The measures taken at each stage are summarised in Table 9.1.

Table 9.1: Strategies implemented in the energy hierarchy	
Be Lean	Improved Fabric Low energy lighting
Be Clean	The provision of a communal heat network. There are no existing or proposed heat networks in the proximity of the site which could be connected to. However, the communal heat network will include a single point of connection which will help facilitate a future connection to an external network.
Be Green	Use of high efficiency exhaust air source heat pumps
Be Seen	Suitable metering provided and management procedures put in place.

The energy consumption and CO₂ emissions savings made by implementing these measures across the site is summarised in Table 9.2:

Table 9.2: Summary of energy consumption and CO ₂ emissions - Residential				
	Energy Consumption [kWh/year]	Energy Consumption Savings [%]	CO ₂ Emissions [Tonnes CO ₂ /Year]	CO ₂ Emissions Savings [%]
Baseline	20735.03		4.71	
Be Lean	17633.71	14.96%	2.62	44.30%
Be Clean	17633.71	0.00%	2.62	0.00%
Be Green	14112.36	16.98%	2.14	10.24%
Total Reduction		31.94%		54.54%

To ensure that the figures in this document are maintained post-occupancy, suitable measures will be taken to record and report operational energy use by the use of smart metering.

Appendices

The following Appendices are provided to support this energy statement:

Appendix A SAP output documents

Appendix B Low & zero carbon technology review

Appendix C Sample Water Calculations

Appendix A - SAP output documents

Full SAP Calculation Printout



Plot Reference	PR13235-Flat 1			Issued on Date	27/07/2026
Assessment Reference	001-Be Lean/Clean	Plot Type Ref	Ground Floor Flat		
Plot Address	Flat 1, 117-119 Oxford Road, Reading, Berkshire, RG1 7UH			SAP Version	10.2
SAP Rating	71 C	DER	7.53	TER	13.15
Environmental	94 A	% DER < TER			42.74
CO ₂ Emissions (t/year)	0.48	DFEE	34.78	TFEE	38.08
Compliance Check	See BREL	% DFEE < TFEE			8.66
% DPER < TPER	-12.92	DPER	78.22	TPER	69.27
Assessor Details	Mr. Rajohn Ali			Assessor ID	R582-0001
Client	Oxford Homes Residential Limit, Oxford Homes Residential Limited				

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Main dwelling			
Ground floor	74.9200 (1b)	2.4500 (2b)	183.5540 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	74.9200		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	183.5540 (5)

2. Ventilation rate

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

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1634 (8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50		5.0000 (17)
Infiltration rate		0.4134 (18)
Number of sides sheltered	4	(19)

Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2894 (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	0.3690	0.3618	0.3545	0.3183	0.3111	0.2749	0.2749	0.2677	0.2894	0.3111	0.3256	0.3401 (22b)
Effective ac	0.5681	0.5654	0.5628	0.5507	0.5484	0.5378	0.5378	0.5358	0.5419	0.5484	0.5530	0.5578 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Main dwelling							
Door to Corridor			1.9100	1.4000	2.6740		(26)
Window and Glazed Door			11.9500	1.1450	13.6832		(27)
Heatloss Floor			74.9200	0.1200	8.9904	110.0000	8241.2000 (28a)
External Wall	64.6000	11.9500	52.6500	0.1800	9.4770	140.0000	7371.0000 (29a)
Wall to Corridor	23.1900	1.9100	21.2800	0.1600	3.4048	110.0000	2340.8000 (29a)
Total net area of external elements Aum(A, m ²)			162.7100				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	38.2294		(33)
Main dwelling							
Party Wall			9.5500	0.0000	0.0000	20.0000	191.0000 (32)
Party Ceiling			74.9200			20.0000	1498.4000 (32b)
Internal Wall			139.4300			9.0000	1254.8700 (32c)

Heat capacity Cm = Sum (A x k)	(28)...(30) + (32) + (32a)...(32e) =	20897.2700 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K		278.9278 (35)

List of Thermal Bridges	Length	Psi-value	Total
K1 Element	8.1500	0.2680	2.1842
E2 Other lintels (including other steel lintels)	5.4300	0.0220	0.1195
E3 Sill	17.4000	0.0170	0.2958
E4 Jamb	35.8300	0.0620	2.2215
E5 Ground floor (normal)			

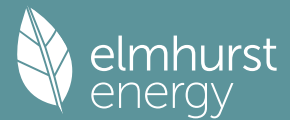
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	34.4101	34.2500	34.0930	33.3558	33.2179	32.5758	32.5758	32.4569	32.8231	33.2179	33.4969	33.7886 (38)
Heat transfer coeff	79.4453	79.2852	79.1282	78.3910	78.2531	77.6110	77.6110	77.4921	77.8583	78.2531	78.5321	78.8238 (39)
Average = Sum(39)m / 12 =												78.3903
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1.0604	1.0583	1.0562	1.0463	1.0445	1.0359	1.0359	1.0343	1.0392	1.0445	1.0482	1.0521 (40)
HLP (average)												1.0463
Days in month	31	28	31	30	31	30	31	31	30	31	30	31

Assumed occupancy													2.3594 (42)
Hot water usage for mixer showers	63.7794	62.8209	61.4242	58.7519	56.7798	54.5805	53.3305	54.7166	56.2360	58.5974	61.3271	63.5350 (42a)	
Hot water usage for baths	27.5505	27.1413	26.5651	25.5027	24.7072	23.8251	23.3487	23.9208	24.5438	25.4877	26.5719	27.4573 (42b)	
Hot water usage for other uses	38.7928	37.3822	35.9715	34.5609	33.1502	31.7396	31.7396	33.1502	34.5609	35.9715	37.3822	38.7928 (42c)	
Average daily hot water use (litres/day)												119.6123 (43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	130.1227	127.3444	123.9609	118.8155	114.6373	110.1453	108.4187	111.7877	115.3407	120.0566	125.2812	129.7852 (44)	
Energy content (annual)	206.0825	181.3367	190.5232	162.6525	154.3238	135.4364	131.1231	138.4165	142.2267	162.9157	178.4861	203.2122 (45)	
Distribution loss (46)m = 0.15 x (45)m	30.9124	27.2005	28.5785	24.3979	23.1486	20.3155	19.6685	20.7625	21.3340	24.4373	26.7729	30.4818 (46)	
Water storage loss (or HIU loss):													
Store volume												201.0000 (47)	
a) If manufacturer declared loss factor is known (kWh/day):												1.6100 (48)	
Temperature factor from Table 2b												0.5400 (49)	
Enter (49) or (54) in (55)												0.8694 (55)	
Total storage loss	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514 (56)	
If cylinder contains dedicated solar storage	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514 (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	256.2963	226.6911	240.7370	211.2465	204.5376	184.0304	181.3369	188.6303	190.8207	213.1295	227.0801	253.4260 (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	256.2963	226.6911	240.7370	211.2465	204.5376	184.0304	181.3369	188.6303	190.8207	213.1295	227.0801	253.4260 (64)	
12Total per year (kWh/year)												2577.9624 (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	108.6935	96.5780	103.5200	92.9572	91.4837	83.9078	83.7695	86.1945	86.1656	94.3405	98.2218	107.7391 (65)	

Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	109.7820	121.5444	109.7820	113.4414	109.7820	113.4414	109.7820	109.7820	113.4414	109.7820	113.4414	109.7820 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	208.4977	210.6613	205.2092	193.6024	178.9508	165.1804	155.9809	153.8174	159.2695	170.8763	185.5279	199.2983 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971 (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)	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768 (71)
Water heating gains (Table 5)	146.0934	143.7172	139.1398	129.1072	122.9620	116.5386	112.5934	115.8528	119.6744	126.8017	136.4192	144.8106 (72)
Total internal gains	522.7645	534.3142	512.5224	494.5423	470.0861	453.5518	436.7476	437.8436	450.7766	465.8514	493.7798	512.2822 (73)

[Jan]				Area m ²	Solar flux Table 6a W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		Gains W
East				5.4300	19.6403		0.6300		0.7000		0.7700		32.5926 (76)
West				6.5200	19.6403		0.6300		0.7000		0.7700		39.1351 (80)
Solar gains	71.7277	140.3146	231.0782	337.0138	413.0231	422.8026	402.5253	345.7633	268.7535	166.4951	89.4360		58.9854 (83)
Total gains	594.4922	674.6289	743.6006	831.5561	883.1092	876.3544	839.2730	783.6069	719.5301	632.3465	583.2158		571.2676 (84)

Full SAP Calculation Printout



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	73.0666	73.2142	73.3594	74.0493	74.1798	74.7935	74.7935	74.9083	74.5559	74.1798	73.9162	73.6427	
alpha	5.8711	5.8809	5.8906	5.9366	5.9453	5.9862	5.9862	5.9939	5.9704	5.9453	5.9277	5.9095	
util living area	0.9950	0.9888	0.9712	0.9057	0.7620	0.5584	0.4058	0.4527	0.7086	0.9398	0.9885	0.9960 (86)	
MIT	20.0216	20.1887	20.4338	20.7394	20.9268	20.9902	20.9988	20.9977	20.9635	20.7070	20.3131	19.9935 (87)	
Th 2	20.0333	20.0351	20.0368	20.0449	20.0464	20.0535	20.0535	20.0548	20.0508	20.0464	20.0433	20.0401 (88)	
util rest of house	0.9933	0.9849	0.9612	0.8761	0.7030	0.4797	0.3191	0.3609	0.6266	0.9137	0.9838	0.9946 (89)	
MIT 2	18.9072	19.1202	19.4278	19.7965	19.9912	20.0487	20.0532	20.0541	20.0294	19.7700	19.2858	18.8766 (90)	
Living area fraction	19.3238	19.5197	19.8039	20.1490	20.3410	20.4007	20.4067	20.4069	fLA = Living area / (4) =				0.3739 (91)
MIT	19.3238	19.5197	19.8039	20.1490	20.3410	20.4007	20.4067	20.4069	20.3786	20.1203	19.6699	19.2942 (92)	
Temperature adjustment												0.0000	
adjusted MIT	19.3238	19.5197	19.8039	20.1490	20.3410	20.4007	20.4067	20.4069	20.3786	20.1203	19.6699	19.2942 (93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9915	0.9822	0.9583	0.8797	0.7222	0.5090	0.3516	0.3953	0.6562	0.9161	0.9814	0.9932 (94)
Useful gains	589.4663	662.6496	712.6022	731.5201	637.7728	446.0963	295.0713	309.7711	472.1214	579.2713	572.3902	567.3545 (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	1193.5728	1159.1231	1052.7143	881.8183	676.1836	450.1961	295.4411	310.5020	488.8405	744.9939	987.1400	1189.7826 (97)
Space heating kWh	449.4552	333.6302	253.0434	108.2147	28.5777	0.0000	0.0000	0.0000	0.0000	123.2976	298.6199	463.0865 (98a)
Space heating requirement - total per year (kWh/year)												2057.9251
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	449.4552	333.6302	253.0434	108.2147	28.5777	0.0000	0.0000	0.0000	0.0000	123.2976	298.6199	463.0865 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2057.9251
Space heating per m2										(98c) / (4) =		27.4683 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11)													0.0000 (201)
Fraction of space heat from main system(s)													1.0000 (202)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of main space heating system 2 (in %)													0.0000 (207)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	449.4552	333.6302	253.0434	108.2147	28.5777	0.0000	0.0000	0.0000	0.0000	123.2976	298.6199	463.0865 (98)	
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000 (210)	
Space heating fuel (main heating system)	449.4552	333.6302	253.0434	108.2147	28.5777	0.0000	0.0000	0.0000	0.0000	123.2976	298.6199	463.0865 (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	256.2963	226.6911	240.7370	211.2465	204.5376	184.0304	181.3369	188.6303	190.8207	213.1295	227.0801	253.4260 (64)	
Efficiency of water heater	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000 (216)	
Fuel for water heating, kWh/month	150.7626	133.3477	141.6100	124.2627	120.3162	108.2532	106.6687	110.9590	112.2474	125.3703	133.5765	149.0741 (219)	
Space cooling fuel requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (221)	
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (231)	
Lighting	24.5250	19.6749	17.7150	12.9788	10.0252	8.1907	9.1453	11.8874	15.4406	20.2589	22.8824	25.2066 (232)	
Electricity generated by PVs (Appendix M) (negative quantity)	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)	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)	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)	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)	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)	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)	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)	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													2057.9251 (211)
Space heating fuel - main system 2													0.0000 (213)
Space heating fuel - secondary													0.0000 (215)
Efficiency of water heater													170.0000
Water heating fuel used													1516.4485 (219)
Space cooling fuel													0.0000 (221)
Electricity for pumps and fans:													
Total electricity for the above, kWh/year													0.0000 (231)
Electricity for lighting (calculated in Appendix L)													197.9310 (232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation													0.0000 (233)
Wind generation													0.0000 (234)

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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	3772.3045 (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	2057.9251	0.1564	321.9478 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1516.4485	0.1409	213.6993 (264)
Space and water heating			535.6471 (265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (267)
Energy for lighting	197.9310	0.1443	28.5676 (268)
Total CO2, kg/year			564.2146 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			7.5300 (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	2057.9251	1.5792	3249.8157 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1516.4485	1.5211	2306.6326 (278)
Space and water heating			5556.4482 (279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (281)
Energy for lighting	197.9310	1.5338	303.5931 (282)
Total Primary energy kWh/year			5860.0414 (286)
Dwelling Primary energy Rate (DPER)			78.2200 (287)

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

1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Main dwelling	74.9200 (1b)	2.4500 (2b)	183.5540 (1b) - (3b)
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	74.9200		183.5540 (4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 183.5540 (5)

2. Ventilation rate

	m3 per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	3 * 10 = 30.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) = 0.1634 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4134 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.2894 (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	0.3690	0.3618	0.3545	0.3183	0.3111	0.2749	0.2749	0.2677	0.2894	0.3111	0.3256	0.3401 (22b)
Effective ac	0.5681	0.5654	0.5628	0.5507	0.5484	0.5378	0.5378	0.5358	0.5419	0.5484	0.5530	0.5578 (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
Main dwelling							
TER Opaque door			1.9100	1.0000	1.9100		(26)
TER Opening Type			11.9500	1.1450	13.6832		(27)
Heatloss Floor			74.9200	0.1300	9.7396		(28a)
External Wall	64.6000	11.9500	52.6500	0.1800	9.4770		(29a)
Wall to Corridor	23.1900	1.9100	21.2800	0.1800	3.8304		(29a)

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Total net area of external elements Aum(A, m2)	162.7100			(31)
Fabric heat loss, W/K = Sum (A x U)	(26) ... (30) + (32) =	38.6402		(33)
Main dwelling				
Party Wall	9.5500	0.0000	0.0000	(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 278.9278 (35)

List of Thermal Bridges				
K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	8.1500	0.0500	0.4075	
E3 Sill	5.4300	0.0500	0.2715	
E4 Jamb	17.4000	0.0500	0.8700	
E5 Ground floor (normal)	35.8300	0.1600	5.7328	
E16 Corner (normal)	7.3500	0.0900	0.6615	
E18 Party wall between dwellings	2.4500	0.0600	0.1470	
E7 Party floor between dwellings (in blocks of flats)	35.8300	0.0700	2.5081	
P1 Party wall - Ground floor	3.9000	0.0800	0.3120	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	3.9000	0.0000	0.0000	
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0900	-0.2205	
E25 Staggered party wall between dwellings	2.4500	0.0600	0.1470	

Thermal bridges (Sum(L x Psi) calculated using Appendix K)			10.8369	(36)
Point Thermal bridges			0.0000	
Total fabric heat loss	(33) + (36) + (36a) =		49.4771	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer coeff	34.4101	34.2500	34.0930	33.3558	33.2179	32.5758	32.5758	32.4569	32.8231	33.2179	33.4969	33.7886	(38)
Average = Sum(39)m / 12 =	83.8872	83.7271	83.5701	82.8329	82.6950	82.0529	82.0529	81.9340	82.3002	82.6950	82.9740	83.2657	(39)
												82.8323	
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.1197	1.1176	1.1155	1.1056	1.1038	1.0952	1.0952	1.0936	1.0985	1.1038	1.1075	1.1114	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

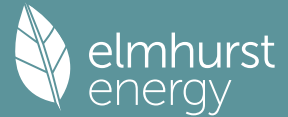
Assumed occupancy													2.3594	(42)
Hot water usage for mixer showers														
63.7794	62.8209	61.4242	58.7519	56.7798	54.5805	53.3305	54.7166	56.2360	58.5974	61.3271	63.5350	(42a)		
Hot water usage for baths														
27.5505	27.1413	26.5651	25.5027	24.7072	23.8251	23.3487	23.9208	24.5438	25.4877	26.5719	27.4573	(42b)		
Hot water usage for other uses														
38.7928	37.3822	35.9715	34.5609	33.1502	31.7396	31.7396	33.1502	34.5609	35.9715	37.3822	38.7928	(42c)		
Average daily hot water use (litres/day)													119.6123	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Daily hot water use	130.1227	127.3444	123.9609	118.8155	114.6373	110.1453	108.4187	111.7877	115.3407	120.0566	125.2812	129.7852	(44)	
Energy content (annual)	206.0825	181.3367	190.5232	162.6525	154.3238	135.4364	131.1231	138.4165	142.2267	162.9157	178.4861	203.2122	(45)	
Distribution loss (46)m = 0.15 x (45)m										Total = Sum(45)m =		1986.7354		
30.9124	27.2005	28.5785	24.3979	23.1486	20.3155	19.6685	20.7625	21.3340	24.4373	26.7729	30.4818	(46)		
Water storage loss (or HIU loss):														
Store volume													201.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):													1.6575	(48)
Temperature factor from Table 2b													0.5400	(49)
Enter (49) or (54) in (55)													0.8950	(55)
Total storage loss														
27.7463	25.0612	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	27.7463	26.8513	27.7463	26.8513	27.7463	(56)	
If cylinder contains dedicated solar storage														
27.7463	25.0612	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	27.7463	26.8513	27.7463	26.8513	27.7463	(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														
257.0913	227.4091	241.5320	212.0158	205.3325	184.7997	182.1318	189.4252	191.5899	213.9244	227.8494	254.2210	(62)		
WWHRS	-29.1573	-25.7869	-27.0026	-22.3592	-20.8380	-17.8312	-16.7139	-17.7736	-18.4489	-21.7492	-24.6392	-28.6173	(63a)	
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)	
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)	
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)	
Output from w/h														
227.9340	201.6222	214.5294	189.6566	184.4945	166.9685	165.4179	171.6516	173.1411	192.1752	203.2102	225.6036	(64)		
12Total per year (kWh/year)										Total per year (kWh/year) = Sum(64)m =		2316.4048	(64)	
Electric shower(s)												2316	(64)	
0.0000	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														
109.3294	97.1524	104.1560	93.5726	92.1196	84.5232	84.4054	86.8305	86.7810	94.9764	98.8372	108.3751	(65)		

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

Metabolic gains (Table 5), Watts													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	109.7820	121.5444	109.7820	113.4414	109.7820	113.4414	109.7820	109.7820	113.4414	109.7820	113.4414	109.7820	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	208.4977	210.6613	205.2092	193.6024	178.9508	165.1804	155.9809	153.8174	159.2695	170.8763	185.5279	199.2983	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	(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)	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	(71)
Water heating gains (Table 5)	146.9482	144.5720	139.9946	129.9619	123.8167	117.3934	113.4481	116.7076	120.5292	127.6565	137.2740	145.6654	(72)
Total internal gains	526.6192	538.1690	516.3771	498.3970	473.9409	454.4065	437.6024	438.6983	451.6314	469.7062	497.6346	516.1370	(73)

6. Solar gains

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[Jan]	Area m2				Solar flux Table 6a W/m2	Specific data or Table 6b	g or Table 6b	Specific data or Table 6c	FF or Table 6c	Access factor Table 6d	Gains W	
East	5.4300				19.6403	0.6300		0.7000		0.7700	32.5926	(76)
West	6.5200				19.6403	0.6300		0.7000		0.7700	39.1351	(80)

Solar gains	71.7277	140.3146	231.0782	337.0138	413.0231	422.8026	402.5253	345.7633	268.7535	166.4951	89.4360	58.9854 (83)
Total gains	598.3470	678.4836	747.4554	835.4109	886.9640	877.2092	840.1277	784.4616	720.3849	636.2013	587.0706	575.1224 (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	69.1976	69.3300	69.4602	70.0784	70.1953	70.7446	70.7446	70.8473	70.5320	70.1953	69.9592	69.7141
alpha	5.6132	5.6220	5.6307	5.6719	5.6797	5.7163	5.7163	5.7232	5.7021	5.6797	5.6639	5.6476
util living area	0.9951	0.9894	0.9737	0.9157	0.7836	0.5854	0.4278	0.4767	0.7344	0.9458	0.9892	0.9961 (86)
MIT	19.9387	20.1081	20.3619	20.6866	20.9022	20.9847	20.9978	20.9961	20.9486	20.6587	20.2440	19.9102 (87)
Th 2	19.9848	19.9865	19.9882	19.9962	19.9977	20.0047	20.0047	20.0060	20.0021	19.9977	19.9947	19.9915 (88)
util rest of house	0.9934	0.9857	0.9643	0.8875	0.7239	0.5004	0.3321	0.3758	0.6493	0.9211	0.9846	0.9947 (89)
MIT 2	18.7652	18.9813	19.3006	19.6952	19.9230	19.9971	20.0042	20.0049	19.9715	19.6737	19.1614	18.7339 (90)
Living area fraction	FLA = Living area / (4) =											
MIT	19.2040	19.4025	19.6974	20.0658	20.2891	20.3663	20.3757	20.3754	20.3368	20.0420	19.5661	19.1737 (92)
Temperature adjustment	0.0000											
adjusted MIT	19.2040	19.4025	19.6974	20.0658	20.2891	20.3663	20.3757	20.3754	20.3368	20.0420	19.5661	19.1737 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9916	0.9829	0.9610	0.8898	0.7424	0.5320	0.3680	0.4136	0.6795	0.9224	0.9821	0.9931 (94)
Useful gains	593.3234	666.8843	718.2985	743.3243	658.4621	466.6480	309.1500	324.4758	489.4743	586.8102	576.5642	571.1790 (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	1250.2517	1214.2564	1102.9072	924.8992	710.2749	473.1444	309.8034	325.7243	513.2912	780.8028	1034.3663	1246.7950 (97)
Space heating kWh	488.7546	367.8341	286.1489	130.7339	38.5487	0.0000	0.0000	0.0000	0.0000	144.3305	329.6175	502.6583 (98a)
Space heating requirement - total per year (kWh/year)	2288.6266											
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	488.7546	367.8341	286.1489	130.7339	38.5487	0.0000	0.0000	0.0000	0.0000	144.3305	329.6175	502.6583 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)	2288.6266											
Space heating per m2	(98c) / (4) = 30.5476 (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	488.7546	367.8341	286.1489	130.7339	38.5487	0.0000	0.0000	0.0000	0.0000	144.3305	329.6175	502.6583 (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)	529.5283	398.5201	310.0205	141.6402	41.7646	0.0000	0.0000	0.0000	0.0000	156.3711	357.1154	544.5919 (211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (215)
Water heating												
Water heating requirement	227.9340	201.6222	214.5294	189.6566	184.4945	166.9685	165.4179	171.6516	173.1411	192.1752	203.2102	225.6036 (64)
Efficiency of water heater (217)m	85.7251	85.3902	84.7066	83.2426	81.2227	79.8000	79.8000	79.8000	79.8000	83.4266	85.1380	79.8000 (216)
Fuel for water heating, kWh/month	265.8893	236.1186	253.2617	227.8360	227.1464	209.2337	207.2906	215.1023	216.9688	230.3524	238.6834	262.9344 (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	22.8105	18.2995	16.4766	12.0715	9.3244	7.6181	8.5060	11.0564	14.3612	18.8427	21.2827	23.4445 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-25.4179	-36.9522	-54.7517	-63.5187	-70.1841	-66.1230	-65.3150	-60.8312	-53.1956	-43.1310	-28.3397	-21.8468 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)												
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)												
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (235c)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233b)m	-11.1480	-23.7591	-47.7986	-72.6366	-96.8711	-97.6354	-96.4845	-81.3115	-59.0991	-34.2532	-14.9729	-8.7925 (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	2479.5521 (211)											
Space heating fuel - main system 2	0.0000 (213)											

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Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	79.8000
Water heating fuel used	2790.8177 (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)	184.0941 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-1234.3696 (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	4306.0943 (238)

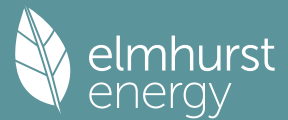
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2479.5521	0.2100	520.7059 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2790.8177	0.2100	586.0717 (264)
Space and water heating			1106.7776 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	184.0941	0.1443	26.5705 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-589.6070	0.1339	-78.9738
PV Unit electricity exported	-644.7626	0.1256	-80.9521
Total			-159.9258 (269)
Total CO2, kg/year			985.3515 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			13.1500 (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	2479.5521	1.1300	2801.8938 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2790.8177	1.1300	3153.6240 (278)
Space and water heating			5955.5178 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	184.0941	1.5338	282.3697 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-589.6070	1.4950	-881.4593
PV Unit electricity exported	-644.7626	0.4609	-297.1393
Total			-1178.5986 (283)
Total Primary energy kWh/year			5189.3897 (286)
Target Primary Energy Rate (TPER)			69.2700 (287)

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Plot Reference	PR13235-Flat 1				Issued on Date	27/07/2026	
Assessment Reference	003-Be Green			Plot Type Ref	Ground Floor Flat		
Plot Address	Flat 1, 117-119 Oxford Road, Reading, Berkshire, RG1 7UH				SAP Version	10.2	
SAP Rating	76 C	DER	6.37	TER	13.03		
Environmental	95 A	% DER < TER				51.11	
CO ₂ Emissions (t/year)	0.39	DFEE	34.78	TFEE	38.08		
Compliance Check	See BREL	% DFEE < TFEE				8.66	
% DPER < TPER	4.65	DPER	65.40	TPER	68.59		
Assessor Details	Mr. Rajohn Ali				Assessor ID	R582-0001	
Client	Oxford Homes Residential Limit, Oxford Homes Residential Limited						

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Main dwelling			
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	74.9200		
Dwelling volume			

2. Ventilation rate

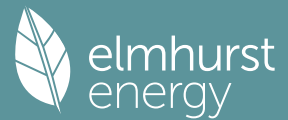
	m ³ per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	3 * 10 = 30.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) = 0.1634 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4134 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.2894 (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	0.3690	0.3618	0.3545	0.3183	0.3111	0.2749	0.2749	0.2677	0.2894	0.3111	0.3256	0.3401 (22b)
Effective ac	0.5681	0.5654	0.5628	0.5507	0.5484	0.5378	0.5378	0.5358	0.5419	0.5484	0.5530	0.5578 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Main dwelling							
Door to Corridor			1.9100	1.4000	2.6740		(26)
Window and Glazed Door			11.9500	1.1450	13.6832		(27)
Heatloss Floor			74.9200	0.1200	8.9904	110.0000	8241.2000 (28a)
External Wall	64.6000	11.9500	52.6500	0.1800	9.4770	140.0000	7371.0000 (29a)
Wall to Corridor	23.1900	1.9100	21.2800	0.1600	3.4048	110.0000	2340.8000 (29a)
Total net area of external elements Aum(A, m ²)			162.7100				(31)
Fabric heat loss, W/K = Sum (A x U)					(26)...(30) + (32) =	38.2294	(33)
Main dwelling							
Party Wall			9.5500	0.0000	0.0000	20.0000	191.0000 (32)
Party Ceiling			74.9200			20.0000	1498.4000 (32b)
Internal Wall			139.4300			9.0000	1254.8700 (32c)
Heat capacity Cm = Sum(A x k)							(28)...(30) + (32) + (32a)...(32e) = 20897.2700 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							278.9278 (35)
List of Thermal Bridges							
K1 Element				Length	Psi-value		Total
E2 Other lintels (including other steel lintels)				8.1500	0.2680		2.1842
E3 Sill				5.4300	0.0220		0.1195
E4 Jamb				17.4000	0.0170		0.2958
E5 Ground floor (normal)				35.8300	0.0620		2.2215

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E16 Corner (normal)	7.3500	0.0460	0.3381	
E18 Party wall between dwellings	2.4500	0.0400	0.0980	
E7 Party floor between dwellings (in blocks of flats)	35.8300	0.0370	1.3257	
P1 Party wall - Ground floor	3.9000	0.0930	0.3627	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	3.9000	0.0000	0.0000	
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0880	-0.2156	
E25 Staggered party wall between dwellings	2.4500	0.0310	0.0760	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				6.8058 (36)
Point Thermal Bridges				0.0000
Total fabric heat loss		(33) + (36) + (36a) =		45.0352 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer coeff	34.4101	34.2500	34.0930	33.3558	33.2179	32.5758	32.5758	32.4569	32.8231	33.2179	33.4969	33.7886	(38)
Average = Sum(39)m / 12 =	79.4453	79.2852	79.1282	78.3910	78.2531	77.6110	77.6110	77.4921	77.8583	78.2531	78.5321	78.8238	(39)
												78.3903	
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.0604	1.0583	1.0562	1.0463	1.0445	1.0359	1.0359	1.0343	1.0392	1.0445	1.0482	1.0521	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	
												1.0463	
												31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.3594 (42)
Hot water usage for mixer showers	63.7794	62.8209	61.4242	58.7519	56.7798	54.5805	53.3305	54.7166	56.2360	58.5974	61.3271	63.5350	(42a)
Hot water usage for baths	27.5505	27.1413	26.5651	25.5027	24.7072	23.8251	23.3487	23.9208	24.5438	25.4877	26.5719	27.4573	(42b)
Hot water usage for other uses	38.7928	37.3822	35.9715	34.5609	33.1502	31.7396	31.7396	33.1502	34.5609	35.9715	37.3822	38.7928	(42c)
Average daily hot water use (litres/day)												119.6123	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	130.1227	127.3444	123.9609	118.8155	114.6373	110.1453	108.4187	111.7877	115.3407	120.0566	125.2812	129.7852	(44)
Energy content (annual)	206.0825	181.3367	190.5232	162.6525	154.3238	135.4364	131.1231	138.4165	142.2267	162.9157	178.4861	203.2122	(45)
Distribution loss (46)m = 0.15 x (45)m	30.9124	27.2005	28.5785	24.3979	23.1486	20.3155	19.6685	20.7625	21.3340	24.4373	26.7729	30.4818	(46)
Water storage loss (or HIU loss):													
Store volume													201.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.6100 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.8694 (55)
Total storage loss	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514	(56)
If cylinder contains dedicated solar storage	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514	(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	0.0000	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	233.0339	205.6799	217.4746	188.7345	181.2752	161.5184	158.0745	165.3679	168.3087	189.8671	204.5681	230.1636	(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	233.0339	205.6799	217.4746	188.7345	181.2752	161.5184	158.0745	165.3679	168.3087	189.8671	204.5681	230.1636	(64)
												2304.0664	(64)
												2304	(64)
12Total per year (kWh/year)													
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)
												0.0000	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =													
Heat gains from water heating, kWh/month	68.5224	60.2945	63.3490	54.0820	51.3127	45.0326	43.5984	46.0235	47.2904	54.1695	59.3466	67.5681	(65)

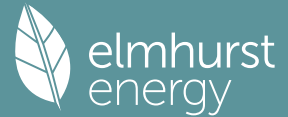
5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts													
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	(66)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	109.7820	121.5444	109.7820	113.4414	109.7820	113.4414	109.7820	109.7820	113.4414	109.7820	113.4414	109.7820	(67)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	208.4977	210.6613	205.2092	193.6024	178.9508	165.1804	155.9809	153.8174	159.2695	170.8763	185.5279	199.2983	(68)
Pumps, fans	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	(69)
Losses e.g. evaporation (negative values) (Table 5)	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)
	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	(71)
Water heating gains (Table 5)	92.1001	89.7239	85.1465	75.1138	68.9686	62.5453	58.6000	61.8595	65.6811	72.8084	82.4259	90.8173	(72)
Total internal gains	468.7711	480.3209	458.5290	440.5489	416.0928	399.5584	382.7543	383.8502	396.7833	411.8581	439.7865	458.2889	(73)

6. Solar gains

[Jan]													
	Area												
	m2												
	Solar flux												
	Table 6a												
	W/m2												
	Specific data												
	or Table 6b												
	Specific data												
	or Table 6c												
	Access												
	factor												
	Table 6d												
East	5.4300												32.5926 (76)
West	6.5200												39.1351 (80)
Solar gains	71.7277	140.3146	231.0782	337.0138	413.0231	422.8026	402.5253	345.7633	268.7535	166.4951	89.4360	58.9854	(83)
Total gains	540.4989	620.6355	689.6073	777.5628	829.1159	822.3611	785.2796	729.6135	665.5368	578.3532	529.2225	517.2743	(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, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	73.0666	73.2142	73.3594	74.0493	74.1798	74.7935	74.7935	74.9083	74.5559	74.1798	73.9162	73.6427
alpha	5.8711	5.8809	5.8906	5.9366	5.9453	5.9862	5.9862	5.9939	5.9704	5.9453	5.9277	5.9095
util living area	0.9970	0.9926	0.9795	0.9260	0.7948	0.5920	0.4332	0.4851	0.7513	0.9581	0.9929	0.9976 (86)
MIT	19.9515	20.1207	20.3716	20.6951	20.9082	20.9868	20.9982	20.9966	20.9503	20.6535	20.2450	19.9229 (87)
Th 2	20.0333	20.0351	20.0368	20.0449	20.0464	20.0535	20.0535	20.0548	20.0508	20.0464	20.0433	20.0401 (88)
util rest of house	0.9959	0.9899	0.9720	0.9007	0.7377	0.5099	0.3410	0.3874	0.6697	0.9382	0.9899	0.9968 (89)
MIT 2	18.8180	19.0347	19.3518	19.7482	19.9754	20.0468	20.0530	20.0538	20.0206	19.7098	19.2004	18.7867 (90)
Living area fraction										FLA = Living area / (4) =		0.3739 (91)
MIT	19.2418	19.4407	19.7331	20.1022	20.3242	20.3982	20.4064	20.4063	20.3682	20.0626	19.5910	19.2115 (92)
Temperature adjustment												0.0000
adjusted MIT	19.2418	19.4407	19.7331	20.1022	20.3242	20.3982	20.4064	20.4063	20.3682	20.0626	19.5910	19.2115 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9946	0.9877	0.9691	0.9024	0.7554	0.5404	0.3755	0.4240	0.6986	0.9386	0.9880	0.9958 (94)
Useful gains	537.5823	613.0200	668.3000	701.6675	626.3189	444.4077	294.8886	309.3894	464.9522	542.8279	522.8504	515.0770 (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	1187.0529	1152.8615	1047.1097	878.1530	674.8665	450.0071	295.4187	310.4562	488.0310	740.4752	980.9412	1183.2645 (97)
Space heating kWh	483.2061	362.7735	281.8344	127.0695	36.1195	0.0000	0.0000	0.0000	0.0000	147.0496	329.8254	497.1315 (98a)
Space heating requirement - total per year (kWh/year)												2265.0095
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	483.2061	362.7735	281.8344	127.0695	36.1195	0.0000	0.0000	0.0000	0.0000	147.0496	329.8254	497.1315 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2265.0095
Space heating per m2										(98c) / (4) =		30.2324 (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)
Fraction of main heating from main system 2													0.0000 (203)
Fraction of total heating from main system 1													1.0000 (204)
Fraction of total heating from main system 2													0.0000 (205)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of main space heating system 2 (in %)													0.0000 (207)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	483.2061	362.7735	281.8344	127.0695	36.1195	0.0000	0.0000	0.0000	0.0000	147.0496	329.8254	497.1315	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	483.2061	362.7735	281.8344	127.0695	36.1195	0.0000	0.0000	0.0000	0.0000	147.0496	329.8254	497.1315	(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)
Space heating fuel used, main system 2													(213)
Water heating													
Water heating requirement	233.0339	205.6799	217.4746	188.7345	181.2752	161.5184	158.0745	165.3679	168.3087	189.8671	204.5681	230.1636	(64)
Efficiency of water heater	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	(216)
(217)m	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	343.2628	(217)
Fuel for water heating, kWh/month	67.8879	59.9191	63.3552	54.9825	52.8095	47.0539	46.0506	48.1753	49.0320	55.3125	59.5952	67.0517	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	24.5250	19.6749	17.7150	12.9788	10.0252	8.1907	9.1453	11.8874	15.4406	20.2589	22.8824	25.2066	(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													2265.0095 (211)
Space heating fuel - main system 2													0.0000 (213)
Space heating fuel - secondary													0.0000 (215)
Efficiency of water heater													343.2628
Water heating fuel used													671.2253 (219)
Space cooling fuel													0.0000 (221)
Electricity for pumps and fans:													
Total electricity for the above, kWh/year													0.0000 (231)
Electricity for lighting (calculated in Appendix L)													197.9310 (232)

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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	3134.1657 (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	2265.0095	0.1562	353.7005 (261)
Space heating - main system 2	0.0000	0.0000	0.0000 (262)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	671.2253	0.1412	94.7659 (264)
Space and water heating			448.4664 (265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (267)
Energy for lighting	197.9310	0.1443	28.5676 (268)
Total CO2, kg/year			477.0340 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			6.3700 (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	2265.0095	1.5781	3574.4662 (275)
Space heating - main system 2	0.0000	0.0000	0.0000 (276)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	671.2253	1.5221	1021.6446 (278)
Space and water heating			4596.1107 (279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (281)
Energy for lighting	197.9310	1.5338	303.5931 (282)
Total Primary energy kWh/year			4899.7038 (286)
Dwelling Primary energy Rate (DPER)			65.4000 (287)

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

1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Main dwelling	74.9200	2.4500	183.5540
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	74.9200		
Dwelling volume			

2. Ventilation rate

	m3 per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	3 * 10 = 30.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) = 0.1634 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4134 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.2894 (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	0.3690	0.3618	0.3545	0.3183	0.3111	0.2749	0.2749	0.2677	0.2894	0.3111	0.3256	0.3401 (22b)
Effective ac	0.5681	0.5654	0.5628	0.5507	0.5484	0.5378	0.5378	0.5358	0.5419	0.5484	0.5530	0.5578 (25)

3. Heat losses and heat loss parameter

Element	Gross	Openings	NetArea	U-value	A x U	K-value	A x K
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Main dwelling	m2	m2	m2	W/m2K	W/K	kJ/m2K	kJ/K
TER Opaque door			1.9100	1.0000	1.9100		(26)
TER Opening Type			11.9500	1.1450	13.6832		(27)
Heatloss Floor			74.9200	0.1300	9.7396		(28a)
External Wall	64.6000	11.9500	52.6500	0.1800	9.4770		(29a)
Wall to Corridor	23.1900	1.9100	21.2800	0.1800	3.8304		(29a)
Total net area of external elements Aum(A, m2)			162.7100				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	38.6402		(33)
Main dwelling							
Party Wall			9.5500	0.0000	0.0000		(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 278.9278 (35)

List of Thermal Bridges	Length	Psi-value	Total
K1 Element	8.1500	0.0500	0.4075
E2 Other lintels (including other steel lintels)	5.4300	0.0500	0.2715
E3 Sill	17.4000	0.0500	0.8700
E4 Jamb	35.8300	0.1600	5.7328
E5 Ground floor (normal)	7.3500	0.0900	0.6615
E16 Corner (normal)	2.4500	0.0600	0.1470
E7 Party wall between dwellings	35.8300	0.0700	2.5081
P1 Party wall - Ground floor	3.9000	0.0800	0.3120
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	3.9000	0.0000	0.0000
E17 Corner (inverted - internal area greater than external area)	2.4500	-0.0900	-0.2205
E25 Staggered party wall between dwellings	2.4500	0.0600	0.1470
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			10.8369 (36)
Point Thermal bridges			0.0000
Total fabric heat loss		(33) + (36) + (36a) =	49.4771 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat transfer coeff	34.4101	34.2500	34.0930	33.3558	33.2179	32.5758	32.5758	32.4569	32.8231	33.2179	33.4969	33.7886 (38)
Average = Sum(39)m / 12 =												82.8323
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP (average)	1.1197	1.1176	1.1155	1.1056	1.1038	1.0952	1.0952	1.0936	1.0985	1.1038	1.1075	1.1114 (40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

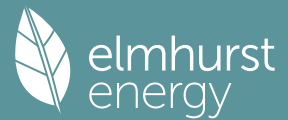
4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.3594 (42)
Hot water usage for mixer showers	63.7794	62.8209	61.4242	58.7519	56.7798	54.5805	53.3305	54.7166	56.2360	58.5974	61.3271	63.5350 (42a)	
Hot water usage for baths	27.5505	27.1413	26.5651	25.5027	24.7072	23.8251	23.3487	23.9208	24.5438	25.4877	26.5719	27.4573 (42b)	
Hot water usage for other uses	38.7928	37.3822	35.9715	34.5609	33.1502	31.7396	31.7396	33.1502	34.5609	35.9715	37.3822	38.7928 (42c)	
Average daily hot water use (litres/day)													119.6123 (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	130.1227	127.3444	123.9609	118.8155	114.6373	110.1453	108.4187	111.7877	115.3407	120.0566	125.2812	129.7852 (44)	
Energy content (annual)	206.0825	181.3367	190.5232	162.6525	154.3238	135.4364	131.1231	138.4165	142.2267	162.9157	178.4861	203.2122 (45)	
Distribution loss (46)m = 0.15 x (45)m	30.9124	27.2005	28.5785	24.3979	23.1486	20.3155	19.6685	20.7625	21.3340	24.4373	26.7729	30.4818 (46)	
Water storage loss (or HIU loss):													
Store volume													150.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.3938 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.7527 (55)
Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325 (56)	
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325 (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	252.6774	223.4225	237.1182	207.7443	200.9187	180.5283	177.7180	185.0114	187.3185	209.5106	223.5779	249.8072 (62)	
WWHRS	-29.1573	-25.7869	-27.0026	-22.3592	-20.8380	-17.8312	-16.7139	-17.7736	-18.4489	-21.7492	-24.6392	-28.6173 (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	223.5202	197.6355	210.1156	185.3851	180.0807	162.6971	161.0040	167.2378	168.8696	187.7614	198.9387	221.1898 (64)	
12Total per year (kWh/year)													2264.4355 (64)
Electric shower(s)													2264 (64)
	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)	
													0.0000 (64a)
Heat gains from water heating, kWh/month	105.7984	93.9630	100.6249	90.1554	88.5886	81.1061	80.8743	83.2994	83.3638	91.4454	95.4201	104.8440 (65)	

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

Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710	117.9710 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	109.7820	121.5444	109.7820	113.4414	109.7820	113.4414	109.7820	109.7820	113.4414	109.7820	113.4414	109.7820 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	208.4977	210.6613	205.2092	193.6024	178.9508	165.1804	155.9809	153.8174	159.2695	170.8763	185.5279	199.2983 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971	34.7971 (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)	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768	-94.3768 (71)
Water heating gains (Table 5)	142.2021	139.8260	135.2485	125.2159	119.0707	112.6473	108.7021	111.9616	115.7831	122.9105	132.5279	140.9193 (72)
Total internal gains	521.8732	533.4229	511.6311	493.6510	469.1948	449.6605	432.8563	433.9523	446.8853	464.9601	492.8885	511.3910 (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			
East				5.4300	19.6403	0.6300	0.7000	0.7700	32.5926 (76)			
West				6.5200	19.6403	0.6300	0.7000	0.7700	39.1351 (80)			
Solar gains	71.7277	140.3146	231.0782	337.0138	413.0231	422.8026	402.5253	345.7633	268.7535	166.4951	89.4360	58.9854 (83)
Total gains	593.6009	673.7376	742.7093	830.6648	882.2179	872.4631	835.3817	779.7156	715.6389	631.4552	582.3246	570.3763 (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	69.1976	69.3300	69.4602	70.0784	70.1953	70.7446	70.7446	70.8473	70.5320	70.1953	69.9592	69.7141	
alpha	5.6132	5.6220	5.6307	5.6719	5.6797	5.7163	5.7163	5.7232	5.7021	5.6797	5.6639	5.6476	
util living area	0.9953	0.9898	0.9744	0.9174	0.7863	0.5883	0.4301	0.4795	0.7379	0.9473	0.9896	0.9963 (86)	
MIT	19.9327	20.1022	20.3565	20.6827	20.9004	20.9843	20.9977	20.9959	20.9474	20.6541	20.2381	19.9041 (87)	
Th 2	19.9848	19.9865	19.9882	19.9962	19.9977	20.0047	20.0047	20.0060	20.0021	19.9977	19.9947	19.9915 (88)	
util rest of house	0.9937	0.9862	0.9653	0.8896	0.7268	0.5030	0.3340	0.3780	0.6529	0.9231	0.9852	0.9949 (89)	
MIT 2	18.7575	18.9739	19.2940	19.6909	19.9215	19.9969	20.0041	20.0048	19.9707	19.6685	19.1541	18.7261 (90)	
Living area fraction									fLA = Living area / (4) =				0.3739 (91)
MIT	19.1968	19.3957	19.6912	20.0617	20.2875	20.3661	20.3756	20.3754	20.3358	20.0370	19.5593	19.1665 (92)	
Temperature adjustment												0.0000	
adjusted MIT	19.1968	19.3957	19.6912	20.0617	20.2875	20.3661	20.3756	20.3754	20.3358	20.0370	19.5593	19.1665 (93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9919	0.9834	0.9619	0.8916	0.7451	0.5346	0.3700	0.4161	0.6830	0.9243	0.9827	0.9934 (94)
Useful gains	588.7914	662.5542	714.4271	740.6541	657.3615	466.4621	309.1279	324.4318	488.7757	583.6368	572.2533	566.6104 (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	1249.6554	1213.6844	1102.3944	924.5554	710.1422	473.1227	309.8006	325.7188	513.2087	780.3909	1033.8011	1246.1984 (97)
Space heating kWh	491.6828	370.3595	288.6477	132.4090	39.2688	0.0000	0.0000	0.0000	0.0000	146.3850	332.3144	505.6135 (98a)
Space heating requirement - total per year (kWh/year)												2306.6807
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	491.6828	370.3595	288.6477	132.4090	39.2688	0.0000	0.0000	0.0000	0.0000	146.3850	332.3144	505.6135 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2306.6807
Space heating per m2										(98c) / (4) =		30.7886 (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	491.6828	370.3595	288.6477	132.4090	39.2688	0.0000	0.0000	0.0000	0.0000	146.3850	332.3144	505.6135 (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)	532.7008	401.2562	312.7278	143.4550	42.5447	0.0000	0.0000	0.0000	0.0000	158.5970	360.0372	547.7936 (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	223.5202	197.6355	210.1156	185.3851	180.0807	162.6971	161.0040	167.2378	168.8696	187.7614	198.9387	221.1898 (64)
Efficiency of water heater	85.7766	85.4468	84.7723	83.3184	81.2747	79.8000	79.8000	79.8000	79.8000	83.5078	85.2016	79.8000 (216)
Fuel for water heating, kWh/month	260.5841	231.2965	247.8587	222.5021	221.5705	203.8810	201.7594	209.5712	211.6161	224.8429	233.4917	257.6371 (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	22.8105	18.2995	16.4766	12.0715	9.3244	7.6181	8.5060	11.0564	14.3612	18.8427	21.2827	23.4445 (232)
Electricity generated by PVs (Appendix M) (negative quantity)	-25.4179	-36.9522	-54.7517	-63.5187	-70.1841	-66.1230	-65.3150	-60.8312	-53.1956	-43.1310	-28.3397	-21.8468 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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)	-11.1480	-23.7591	-47.7986	-72.6366	-96.8711	-97.6354	-96.4845	-81.3115	-59.0991	-34.2532	-14.9729	-8.7925 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)												

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(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												2499.1124	(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												2726.6114	(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)												184.0941	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-1234.3696	(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												4261.4483	(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	2499.1124	0.2100	524.8136	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2726.6114	0.2100	572.5884	(264)
Space and water heating			1097.4020	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	184.0941	0.1443	26.5705	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-589.6070	0.1339	-78.9738	
PV Unit electricity exported	-644.7626	0.1256	-80.9521	
Total			-159.9258	(269)
Total CO2, kg/year			975.9759	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			13.0300	(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	2499.1124	1.1300	2823.9970	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2726.6114	1.1300	3081.0709	(278)
Space and water heating			5905.0679	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	184.0941	1.5338	282.3697	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-589.6070	1.4950	-881.4593	
PV Unit electricity exported	-644.7626	0.4609	-297.1393	
Total			-1178.5986	(283)
Total Primary energy kWh/year			5138.9398	(286)
Target Primary Energy Rate (TPER)			68.5900	(287)

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Plot Reference	PR13235-Flat 4			Issued on Date	27/07/2026
Assessment Reference	001-Be Lean/Clean	Plot Type Ref	Mid Floor Flat		
Plot Address	Flat 4, 117-119 Oxford Road, Reading, Berkshire, RG1 7UH			SAP Version	10.2
SAP Rating	75 C	DER	8.31	TER	15.87
Environmental	95 A	% DER < TER		47.64	
CO ₂ Emissions (t/year)	0.3	DFEE	33.40	TFEE	33.50
Compliance Check	See BREL	% DFEE < TFEE		0.32	
% DPER < TPER	-3.37	DPER	87.14	TPER	84.30
Assessor Details	Mr. Rajohn Ali			Assessor ID	R582-0001
Client	Oxford Homes Residential Limit, Oxford Homes Residential Limited				

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Main dwelling	40.8200 (1b)	2.4500 (2b)	100.0090 (1b) - (3b)
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	40.8200		100.0090 (4)
Dwelling volume			100.0090 (5)

2. Ventilation rate

	m ³ per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	2 * 10 = 20.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) = 0.2000 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4500 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3150 (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	0.4016	0.3937	0.3859	0.3465	0.3386	0.2992	0.2992	0.2914	0.3150	0.3386	0.3544	0.3701 (22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Main dwelling							
Door to Corridor			1.9100	1.4000	2.6740		(26)
Window and Glazed Door			2.7200	1.1450	3.1145		(27)
Oriel Window			5.4300	1.1450	6.2176		(27)
External Wall	22.1700	8.1500	14.0200	0.1800	2.5236	140.0000	1962.8000 (29a)
Wall to Corridor	11.8000	1.9100	9.8900	0.1600	1.5824	110.0000	1087.9000 (29a)
External Roof Plane	40.8200		40.8200	0.1200	4.8984	9.0000	367.3800 (30)
Total net area of external elements Aum(A, m ²)			74.7900				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	21.0105		(33)
Main dwelling							
Party Wall			33.6400	0.0000	0.0000	20.0000	672.8000 (32)
Party Floor			40.8200			30.0000	1224.6000 (32d)
Internal Wall			51.2100			9.0000	460.8900 (32c)
Heat capacity Cm = Sum(A x k)					(28)...(30) + (32) + (32a)...(32e) =		5776.3700 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							141.5083 (35)
List of Thermal Bridges							
K1 Element				Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)				2.7200	0.2680	0.7290	
E3 Sill				1.8100	0.0220	0.0398	
E4 Jamb				10.2000	0.0170	0.1734	

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E25 Staggered party wall between dwellings	4.9000	0.0310	0.1519
E18 Party wall between dwellings	4.9000	0.0400	0.1960
E7 Party floor between dwellings (in blocks of flats)	13.8700	0.0370	0.5132
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	13.7300	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	13.7300	0.1010	1.3867
E10 Eaves (insulation at ceiling level)	9.0500	0.0560	0.5068
E12 Gable (insulation at ceiling level)	4.8200	0.0560	0.2699
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			3.9667 (36)
Point Thermal bridges		(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =		24.9772 (37)

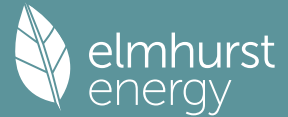
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat transfer coeff	19.1630	19.0597	18.9584	18.4825	18.3935	17.9791	17.9791	17.9023	18.1387	18.3935	18.5736	18.7619
Average = Sum(39)m / 12 =	44.1402	44.0368	43.9355	43.4597	43.3707	42.9563	42.9563	42.8795	43.1159	43.3707	43.5508	43.7391
												43.4593
HLP	1.0813	1.0788	1.0763	1.0647	1.0625	1.0523	1.0523	1.0505	1.0562	1.0625	1.0669	1.0715
HLP (average)												1.0647
Days in month	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)												
Assumed occupancy												1.4283 (42)
Hot water usage for mixer showers												
	48.1673	47.4434	46.3886	44.3704	42.8810	41.2201	40.2760	41.3229	42.4704	44.2537	46.3152	47.9827
Hot water usage for baths												
	20.8367	20.5273	20.0915	19.2880	18.6864	18.0192	17.6589	18.0916	18.5628	19.2766	20.0967	20.7663
Hot water usage for other uses												
	29.2572	28.1933	27.1294	26.0655	25.0016	23.9377	23.9377	25.0016	26.0655	27.1294	28.1933	29.2572
Average daily hot water use (litres/day)												90.3250
												(43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	98.2612	96.1640	93.6095	89.7239	86.5690	83.1770	81.8726	84.4161	87.0986	90.6597	94.6052	98.0062
Energy conte	155.6217	136.9362	143.8743	122.8275	116.5385	102.2759	99.0178	104.5247	107.4013	123.0244	134.7824	153.4540
Energy content (annual)												
												1500.2788
Distribution loss (46)m = 0.15 x (45)m												
	23.3433	20.5404	21.5811	18.4241	17.4808	15.3414	14.8527	15.6787	16.1102	18.4537	20.2174	23.0181
Water storage loss (or HIU loss):												
Store volume												201.0000
a) If manufacturer declared loss factor is known (kWh/day):												1.6100
Temperature factor from Table 2b												0.5400
Enter (49) or (54) in (55)												0.8694
Total storage loss												
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514
If cylinder contains dedicated solar storage												
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514
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
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
Total heat required for water heating calculated for each month												
	205.8355	182.2906	194.0881	171.4215	166.7523	150.8699	149.2316	154.7385	155.9953	173.2382	183.3764	203.6678
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
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
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
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
Output from w/h												
	205.8355	182.2906	194.0881	171.4215	166.7523	150.8699	149.2316	154.7385	155.9953	173.2382	183.3764	203.6678
12Total per year (kWh/year)												2091.5058
Electric shower(s)												2092
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =												0.0000
Heat gains from water heating, kWh/month												
	91.9153	81.8148	88.0092	79.7154	78.9201	72.8819	73.0945	74.9255	74.5861	81.0766	83.6904	91.1945

5. Internal gains (see Table 5 and 5a)												
Metabolic gains (Table 5), Watts												
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149
	62.3772	69.0605	62.3772	64.4564	62.3772	64.4564	62.3772	62.3772	64.4564	62.3772	64.4564	62.3772
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	123.6011	124.8837	121.6516	114.7709	106.0852	97.9219	92.4682	91.1857	94.4177	101.2985	109.9842	118.1475
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415
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
Losses e.g. evaporation (negative values) (Table 5)	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319
Water heating gains (Table 5)	123.5420	121.7482	118.2920	110.7158	106.0754	101.2249	98.2453	100.7063	103.5919	108.9740	116.2366	122.5732
Total internal gains	353.9448	360.1169	346.7453	334.3676	318.9622	308.0277	297.5152	298.6936	306.8905	317.0741	335.1017	347.5224

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
West				2.7200	19.6403		0.6300		0.7000		0.7700	16.3263 (80)
East				5.4300	19.6403		0.6300		0.8000		0.7700	37.2487 (76)
Solar gains	53.5750	104.8041	172.5973	251.7229	308.4959	315.8005	300.6549	258.2581	200.7379	124.3588	66.8017	44.0575 (83)
Total gains	407.5198	464.9209	519.3426	586.0905	627.4582	623.8281	598.1701	556.9518	507.6284	441.4330	401.9034	391.5799 (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, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	36.3512	36.4365	36.5205	36.9203	36.9961	37.3530	37.3530	37.4199	37.2147	36.9961	36.8431	36.6845	
alpha	3.4234	3.4291	3.4347	3.4614	3.4664	3.4902	3.4902	3.4947	3.4810	3.4664	3.4562	3.4456	
util living area	0.9366	0.9042	0.8463	0.7321	0.5852	0.4262	0.3121	0.3480	0.5445	0.7844	0.9027	0.9431 (86)	
MIT	19.5515	19.8231	20.1938	20.6037	20.8518	20.9629	20.9904	20.9859	20.9134	20.5707	20.0076	19.5064 (87)	
Th 2	20.0161	20.0182	20.0202	20.0298	20.0316	20.0400	20.0400	20.0415	20.0367	20.0316	20.0280	20.0242 (88)	
util rest of house	0.9262	0.8894	0.8235	0.6964	0.5365	0.3669	0.2456	0.2780	0.4801	0.7457	0.8852	0.9337 (89)	
MIT 2	18.3624	18.6981	19.1491	19.6328	19.9016	20.0146	20.0355	20.0345	19.9721	19.6116	18.9397	18.3121 (90)	
Living area fraction									fLA = Living area / (4) =				0.6117 (91)
MIT	19.0898	19.3863	19.7881	20.2267	20.4829	20.5947	20.6196	20.6165	20.5479	20.1983	19.5929	19.0427 (92)	
Temperature adjustment												0.0000	
adjusted MIT	19.0898	19.3863	19.7881	20.2267	20.4829	20.5947	20.6196	20.6165	20.5479	20.1983	19.5929	19.0427 (93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9145	0.8784	0.8175	0.7040	0.5597	0.4015	0.2860	0.3203	0.5150	0.7528	0.8761	0.9223 (94)
Useful gains	372.6738	408.3829	424.5687	412.5982	351.1860	250.4839	171.0554	178.3924	261.4284	332.3187	352.1269	361.1432 (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	652.8227	637.9301	583.8208	492.2550	380.9185	257.5089	172.6682	180.8022	278.0073	416.2834	544.0769	649.2039 (97)
Space heating kWh	208.4308	154.2557	118.4836	57.3529	22.1210	0.0000	0.0000	0.0000	0.0000	62.4698	138.2040	214.3171 (98a)
Space heating requirement - total per year (kWh/year)												975.6349
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	208.4308	154.2557	118.4836	57.3529	22.1210	0.0000	0.0000	0.0000	0.0000	62.4698	138.2040	214.3171 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												975.6349
Space heating per m2										(98c) / (4) =		23.9009 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11)													0.0000 (201)
Fraction of space heat from main system(s)													1.0000 (202)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of main space heating system 2 (in %)													0.0000 (207)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	208.4308	154.2557	118.4836	57.3529	22.1210	0.0000	0.0000	0.0000	0.0000	62.4698	138.2040	214.3171 (98)	
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000 (210)	
Space heating fuel (main heating system)	208.4308	154.2557	118.4836	57.3529	22.1210	0.0000	0.0000	0.0000	0.0000	62.4698	138.2040	214.3171 (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	205.8355	182.2906	194.0881	171.4215	166.7523	150.8699	149.2316	154.7385	155.9953	173.2382	183.3764	203.6678 (64)	
Efficiency of water heater	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000	170.0000 (216)	
Fuel for water heating, kWh/month	121.0797	107.2298	114.1695	100.8362	98.0896	88.7470	87.7833	91.0227	91.7620	101.9048	107.8685	119.8046 (219)	
Space cooling fuel requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (221)	
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (231)	
Lighting	11.8885	9.5374	8.5874	6.2915	4.8597	3.9704	4.4332	5.7624	7.4848	9.8205	11.0922	12.2189 (232)	
Electricity generated by PVs (Appendix M) (negative quantity)	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)	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)	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)	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)	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)	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)	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)	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													975.6349 (211)
Space heating fuel - main system 2													0.0000 (213)
Space heating fuel - secondary													0.0000 (215)
Efficiency of water heater													170.0000
Water heating fuel used													1230.2975 (219)
Space cooling fuel													0.0000 (221)
Electricity for pumps and fans:													
Total electricity for the above, kWh/year													0.0000 (231)
Electricity for lighting (calculated in Appendix L)													95.9469 (232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation													0.0000 (233)
Wind generation													0.0000 (234)

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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	2301.8794 (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	975.6349	0.1560	152.2030 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1230.2975	0.1408	173.1865 (264)
Space and water heating			325.3895 (265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (267)
Energy for lighting	95.9469	0.1443	13.8481 (268)
Total CO2, kg/year			339.2376 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			8.3100 (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	975.6349	1.5775	1539.1027 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1230.2975	1.5205	1870.6705 (278)
Space and water heating			3409.7733 (279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (281)
Energy for lighting	95.9469	1.5338	147.1666 (282)
Total Primary energy kWh/year			3556.9399 (286)
Dwelling Primary energy Rate (DPER)			87.1400 (287)

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

1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Main dwelling	40.8200 (1b)	2.4500 (2b)	100.0090 (1b) - (3b)
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	40.8200		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	100.0090 (5)

2. Ventilation rate

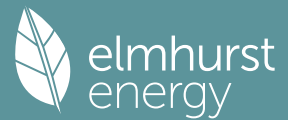
	m3 per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	2 * 10 = 20.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) = 0.2000 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4500 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3150 (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	0.4016	0.3937	0.3859	0.3465	0.3386	0.2992	0.2992	0.2914	0.3150	0.3386	0.3544	0.3701 (22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685 (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
Main dwelling							
TER Opaque door			1.9100	1.0000	1.9100		(26)
TER Opening Type			8.1500	1.1450	9.3321		(27)
External Wall	22.1700	8.1500	14.0200	0.1800	2.5236		(29a)
Wall to Corridor	11.8000	1.9100	9.8900	0.1800	1.7802		(29a)
External Roof Plane	40.8200		40.8200	0.1100	4.4902		(30)

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Total net area of external elements Aum(A, m2)	74.7900												(31)
Fabric heat loss, W/K = Sum (A x U)	(26)...(30) + (32) =	20.0361											(33)
Main dwelling													
Party Wall	33.6400	0.0000	0.0000										(32)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K												141.5083	(35)
List of Thermal Bridges													
K1 Element		Length	Psi-value	Total									
E2 Other lintels (including other steel lintels)		2.7200	0.0500	0.1360									
E3 Sill		1.8100	0.0500	0.0905									
E4 Jamb		10.2000	0.0500	0.5100									
E25 Staggered party wall between dwellings		4.9000	0.0600	0.2940									
E18 Party wall between dwellings		4.9000	0.0600	0.2940									
E7 Party floor between dwellings (in blocks of flats)		13.8700	0.0700	0.9709									
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)		13.7300	0.0000	0.0000									
P4 Party wall - Roof (insulation at ceiling level)		13.7300	0.1200	1.6476									
E10 Eaves (insulation at ceiling level)		9.0500	0.0600	0.5430									
E12 Gable (insulation at ceiling level)		4.8200	0.0600	0.2892									
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				4.7752	(36)								
Point Thermal bridges				(36a) =	0.0000								
Total fabric heat loss				(33) + (36) + (36a) =	24.8113	(37)							
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(38)
Heat transfer coeff	19.1630	19.0597	18.9584	18.4825	18.3935	17.9791	17.9791	17.9023	18.1387	18.3935	18.5736	18.7619	(38)
Average = Sum(39)m / 12 =	43.9743	43.8709	43.7696	43.2938	43.2048	42.7903	42.7903	42.7136	42.9500	43.2048	43.3849	43.5731	(39)
												43.2934	(39)
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(40)
HLP (average)	1.0773	1.0747	1.0723	1.0606	1.0584	1.0483	1.0483	1.0464	1.0522	1.0584	1.0628	1.0674	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	(40)

4. Water heating energy requirements (kWh/year)

Assumed occupancy													1.4283	(42)
Hot water usage for mixer showers														
48.1673	47.4434	46.3886	44.3704	42.8810	41.2201	40.2760	41.3229	42.4704	44.2537	46.3152	47.9827	47.9827	(42a)	
Hot water usage for baths														
20.8367	20.5273	20.0915	19.2880	18.6864	18.0192	17.6589	18.0916	18.5628	19.2766	20.0967	20.7663	20.7663	(42b)	
Hot water usage for other uses														
29.2572	28.1933	27.1294	26.0655	25.0016	23.9377	23.9377	25.0016	26.0655	27.1294	28.1933	29.2572	29.2572	(42c)	
Average daily hot water use (litres/day)													90.3250	(43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
98.2612	96.1640	93.6095	89.7239	86.5690	83.1770	81.8726	84.4161	87.0986	90.6597	94.6052	98.0062	98.0062	(44)	
Energy content (annual)	155.6217	136.9362	143.8743	122.8275	116.5385	102.2759	99.0178	104.5247	107.4013	123.0244	134.7824	153.4540	(45)	
Distribution loss (46)m = 0.15 x (45)m														
23.3433	20.5404	21.5811	18.4241	17.4808	15.3414	14.8527	15.6787	16.1102	18.4537	20.2174	23.0181	23.0181	(46)	
Water storage loss (or HIU loss):														
Store volume													201.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):													1.6575	(48)
Temperature factor from Table 2b													0.5400	(49)
Enter (49) or (54) in (55)													0.8950	(55)
Total storage loss														
27.7463	25.0612	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	(56)	
If cylinder contains dedicated solar storage														
27.7463	25.0612	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	26.8513	27.7463	26.8513	27.7463	27.7463	(57)	
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	22.5120	23.2624	22.5120	23.2624	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														
206.6304	183.0086	194.8830	172.1908	167.5472	151.6392	150.0266	155.5335	156.7646	174.0331	184.1457	204.4627	204.4627	(62)	
WWHRS	-22.0201	-19.4747	-20.3928	-16.8860	-15.7372	-13.4664	-12.6226	-13.4229	-13.9329	-16.4253	-18.6079	-21.6123	(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	184.6104	163.5339	174.4902	155.3048	151.8100	138.1727	137.4039	142.1106	142.8317	157.6078	165.5378	182.8505	(64)	
12Total per year (kWh/year)													1896.2643	(64)
Electric shower(s)													1896	(64)
0.0000	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)	
													0.0000	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =														
Heat gains from water heating, kWh/month	92.5512	82.3892	88.6452	80.3308	79.5560	73.4974	73.7304	75.5615	75.2016	81.7126	84.3058	91.8304	(65)	

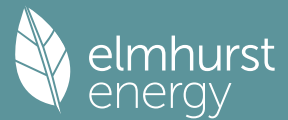
5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	62.7930	69.5209	62.7930	64.8861	62.7930	64.8861	62.7930	62.7930	64.8861	62.7930	64.8861	62.7930	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	123.6011	124.8837	121.6516	114.7709	106.0852	97.9219	92.4682	91.1857	94.4177	101.2985	109.9842	118.1475	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	(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)	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	(71)
Water heating gains (Table 5)	124.3968	122.6030	119.1468	111.5705	106.9302	102.0797	99.1000	101.5611	104.4466	109.8288	117.0914	123.4280	(72)
Total internal gains	358.2154	364.4320	351.0159	338.6520	323.2328	309.3121	298.7858	299.9642	308.1750	321.3447	339.3862	351.7930	(73)

6. Solar gains

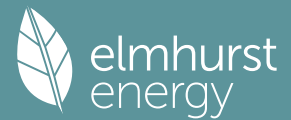
[Jan]	Area	Solar flux	g	FF	Access	Gains
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				m2	Table 6a W/m2	Specific data or Table 6b		Specific data or Table 6c		factor Table 6d		W
East	5.4300				19.6403	0.6300		0.7000		0.7700		32.5926 (76)
West	2.7200				19.6403	0.6300		0.7000		0.7700		16.3263 (80)
Solar gains	48.9189	95.6958	157.5973	229.8462	281.6852	288.3549	274.5257	235.8135	183.2922	113.5511	60.9961	40.2285 (83)
Total gains	407.1343	460.1278	508.6132	568.4983	604.9180	597.6670	573.3114	535.7777	491.4671	434.8958	400.3823	392.0216 (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	36.4883	36.5743	36.6589	37.0618	37.1382	37.4979	37.4979	37.5653	37.3585	37.1382	36.9840	36.8242
alpha	3.4326	3.4383	3.4439	3.4708	3.4759	3.4999	3.4999	3.5044	3.4906	3.4759	3.4656	3.4549
util living area	0.9365	0.9061	0.8520	0.7436	0.6002	0.4415	0.3239	0.3597	0.5573	0.7891	0.9032	0.9428 (86)
MIT	19.5595	19.8185	20.1776	20.5854	20.8411	20.9590	20.9894	20.9846	20.9078	20.5646	20.0110	19.5172 (87)
Th 2	20.0194	20.0215	20.0236	20.0331	20.0349	20.0433	20.0433	20.0449	20.0401	20.0349	20.0313	20.0275 (88)
util rest of house	0.9261	0.8915	0.8298	0.7085	0.5513	0.3808	0.2554	0.2879	0.4924	0.7508	0.8857	0.9333 (89)
MIT 2	18.3746	18.6951	19.1329	19.6163	19.8948	20.0152	20.0383	20.0372	19.9708	19.6080	18.9463	18.3278 (90)
Living area fraction	fLA = Living area / (4) =											0.6117 (91)
MIT	19.0994	19.3823	19.7719	20.2092	20.4736	20.5925	20.6201	20.6167	20.5440	20.1932	19.5976	19.0554 (92)
Temperature adjustment												0.0000
adjusted MIT	19.0994	19.3823	19.7719	20.2092	20.4736	20.5925	20.6201	20.6167	20.5440	20.1932	19.5976	19.0554 (93)
8. Space heating requirement												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9145	0.8805	0.8234	0.7152	0.5741	0.4161	0.2969	0.3312	0.5273	0.7575	0.8767	0.9219 (94)
Useful gains	372.3118	405.1571	418.8175	406.5826	347.2561	248.6762	170.2310	177.4706	259.1384	329.4524	351.0218	361.4058 (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	650.7944	635.3529	580.9074	489.6162	379.0620	256.4227	172.0209	180.1112	276.7686	414.4698	542.2059	647.2944 (97)
Space heating kWh	207.1910	154.6916	120.5949	59.7841	23.6636	0.0000	0.0000	0.0000	0.0000	63.2530	137.6525	212.7011 (98a)
Space heating requirement - total per year (kWh/year)												979.5319
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	207.1910	154.6916	120.5949	59.7841	23.6636	0.0000	0.0000	0.0000	0.0000	63.2530	137.6525	212.7011 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												979.5319
Space heating per m2	(98c) / (4) =											23.9964 (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	207.1910	154.6916	120.5949	59.7841	23.6636	0.0000	0.0000	0.0000	0.0000	63.2530	137.6525	212.7011 (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)	224.4756	167.5965	130.6554	64.7716	25.6377	0.0000	0.0000	0.0000	0.0000	68.5298	149.1360	230.4454 (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	184.6104	163.5339	174.4902	155.3048	151.8100	138.1727	137.4039	142.1106	142.8317	157.6078	165.5378	182.8505 (64)
Water heating requirement	84.3192	83.9353	83.2481	82.1132	80.9058	79.8000	79.8000	79.8000	79.8000	82.1855	83.6491	84.3998 (216)
Efficiency of water heater (217)m	84.3192	83.9353	83.2481	82.1132	80.9058	79.8000	79.8000	79.8000	79.8000	82.1855	83.6491	84.3998 (217)
Fuel for water heating, kWh/month	218.9423	194.8333	209.6025	189.1350	187.6380	173.1488	172.1854	178.0834	178.9871	191.7707	197.8955	216.6480 (219)
Space cooling fuel requirement	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)
(221)m	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)
Pumps and Fa	13.0472	10.4669	9.4243	6.9046	5.3333	4.3574	4.8653	6.3240	8.2143	10.7776	12.1733	13.4098 (232)
Lighting	-14.1710	-20.7770	-31.0608	-36.3954	-40.5684	-38.3953	-37.9678	-35.2079	-30.5316	-24.4451	-15.8751	-12.1633 (233a)
Electricity generated by PVs (Appendix M) (negative quantity)	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)
(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 (235a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)
(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 (235c)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)	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)
(235a)m	-5.7518	-12.3014	-24.8135	-37.7886	-50.4512	-50.8282	-50.1882	-42.2383	-30.6519	-17.7176	-7.7237	-4.5305 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)
(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 (235b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)	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)
(235d)m	Annual totals kWh/year											
Space heating fuel - main system 1												1061.2480 (211)
Space heating fuel - main system 2												0.0000 (213)
Space heating fuel - secondary												0.0000 (215)

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Efficiency of water heater	79.8000	
Water heating fuel used	2308.8700	(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)	105.2980	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-672.5436	(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	2888.8725	(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	1061.2480	0.2100	222.8621 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2308.8700	0.2100	484.8627 (264)
Space and water heating			707.7248 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	105.2980	0.1443	15.1978 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-337.5588	0.1337	-45.1404
PV Unit electricity exported	-334.9848	0.1255	-42.0447
Total			-87.1850 (269)
Total CO2, kg/year			647.6668 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			15.8700 (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	1061.2480	1.1300	1199.2103 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2308.8700	1.1300	2609.0231 (278)
Space and water heating			3808.2334 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	105.2980	1.5338	161.5096 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-337.5588	1.4942	-504.3733
PV Unit electricity exported	-334.9848	0.4607	-154.3274
Total			-658.7007 (283)
Total Primary energy kWh/year			3441.1431 (286)
Target Primary Energy Rate (TPER)			84.3000 (287)

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Plot Reference	PR13235-Flat 4			Issued on Date	27/07/2026
Assessment Reference	003-Be Green	Plot Type Ref	Mid Floor Flat		
Plot Address	Flat 4, 117-119 Oxford Road, Reading, Berkshire, RG1 7UH			SAP Version	10.2
SAP Rating	82 B	DER	6.38	TER	15.60
Environmental	96 A	% DER < TER			59.10
CO ₂ Emissions (t/year)	0.22	DFEE	33.40	TFEE	33.50
Compliance Check	See BREL	% DFEE < TFEE			0.32
% DPER < TPER	20.45	DPER	65.91	TPER	82.85
Assessor Details	Mr. Rajohn Ali			Assessor ID	R582-0001
Client	Oxford Homes Residential Limit, Oxford Homes Residential Limited				

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Main dwelling	40.8200 (1b)	x 2.4500 (2b)	= 100.0090 (1b) - (3b)
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	40.8200		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 100.0090 (5)

2. Ventilation rate

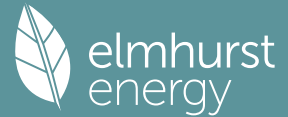
	m ³ per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	2 * 10 = 20.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c)	20.0000 / (5) = 0.2000 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4500 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3150 (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	0.4016	0.3937	0.3859	0.3465	0.3386	0.2992	0.2992	0.2914	0.3150	0.3386	0.3544	0.3701 (22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Main dwelling							
Door to Corridor			1.9100	1.4000	2.6740		(26)
Window and Glazed Door			2.7200	1.1450	3.1145		(27)
Oriel Window			5.4300	1.1450	6.2176		(27)
External Wall	22.1700	8.1500	14.0200	0.1800	2.5236	140.0000	1962.8000 (29a)
Wall to Corridor	11.8000	1.9100	9.8900	0.1600	1.5824	110.0000	1087.9000 (29a)
External Roof Plane	40.8200		40.8200	0.1200	4.8984	9.0000	367.3800 (30)
Total net area of external elements Aum(A, m ²)			74.7900				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	21.0105		(33)
Main dwelling							
Party Wall			33.6400	0.0000	0.0000	20.0000	672.8000 (32)
Party Floor			40.8200			30.0000	1224.6000 (32d)
Internal Wall			51.2100			9.0000	460.8900 (32c)
Heat capacity Cm = Sum(A x k)					(28)...(30) + (32) + (32a)...(32e) =		5776.3700 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							141.5083 (35)
List of Thermal Bridges							
K1 Element				Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)				2.7200	0.2680	0.7290	
E3 Sill				1.8100	0.0220	0.0398	
E4 Jamb				10.2000	0.0170	0.1734	

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E25 Staggered party wall between dwellings	4.9000	0.0310	0.1519
E18 Party wall between dwellings	4.9000	0.0400	0.1960
E7 Party floor between dwellings (in blocks of flats)	13.8700	0.0370	0.5132
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	13.7300	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	13.7300	0.1010	1.3867
E10 Eaves (insulation at ceiling level)	9.0500	0.0560	0.5068
E12 Gable (insulation at ceiling level)	4.8200	0.0560	0.2699
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			3.9667 (36)
Point Thermal bridges		(36a) =	0.0000
Total fabric heat loss		(33) + (36) + (36a) =	24.9772 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat transfer coeff	19.1630	19.0597	18.9584	18.4825	18.3935	17.9791	17.9791	17.9023	18.1387	18.3935	18.5736	18.7619 (38)
Average = Sum(39)m / 12 =	44.1402	44.0368	43.9355	43.4597	43.3707	42.9563	42.9563	42.8795	43.1159	43.3707	43.5508	43.7391 (39)
												43.4593
HLP	1.0813	1.0788	1.0763	1.0647	1.0625	1.0523	1.0523	1.0505	1.0562	1.0625	1.0669	1.0715 (40)
HLP (average)												1.0647
Days in month	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)

Assumed occupancy												1.4283 (42)
Hot water usage for mixer showers												
	48.1673	47.4434	46.3886	44.3704	42.8810	41.2201	40.2760	41.3229	42.4704	44.2537	46.3152	47.9827 (42a)
Hot water usage for baths												
	20.8367	20.5273	20.0915	19.2880	18.6864	18.0192	17.6589	18.0916	18.5628	19.2766	20.0967	20.7663 (42b)
Hot water usage for other uses												
	29.2572	28.1933	27.1294	26.0655	25.0016	23.9377	23.9377	25.0016	26.0655	27.1294	28.1933	29.2572 (42c)
Average daily hot water use (litres/day)												90.3250 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	98.2612	96.1640	93.6095	89.7239	86.5690	83.1770	81.8726	84.4161	87.0986	90.6597	94.6052	98.0062 (44)
Energy content	155.6217	136.9362	143.8743	122.8275	116.5385	102.2759	99.0178	104.5247	107.4013	123.0244	134.7824	153.4540 (45)
Energy content (annual)										Total = Sum(45)m =		1500.2788
Distribution loss (46)m = 0.15 x (45)m												
	23.3433	20.5404	21.5811	18.4241	17.4808	15.3414	14.8527	15.6787	16.1102	18.4537	20.2174	23.0181 (46)
Water storage loss (or HIU loss):												
Store volume												201.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.6100 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.8694 (55)
Total storage loss												
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514 (56)
If cylinder contains dedicated solar storage												
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514 (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	0.0000	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												
	182.5731	161.2794	170.8257	148.9095	143.4899	128.3579	125.9692	131.4761	133.4833	149.9758	160.8644	180.4054 (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												
	182.5731	161.2794	170.8257	148.9095	143.4899	128.3579	125.9692	131.4761	133.4833	149.9758	160.8644	180.4054 (64)
12Total per year (kWh/year)										Total per year (kWh/year) = Sum(64)m =		1817.6098 (64)
Electric shower(s)												1818 (64)
	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												
	51.7442	45.5313	47.8382	40.8402	38.7491	34.0067	32.9234	34.7545	35.7109	40.9056	44.8152	51.0235 (65)

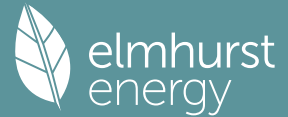
5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts												
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149 (66)
	62.3772	69.0605	62.3772	64.4564	62.3772	64.4564	62.3772	62.3772	64.4564	62.3772	64.4564	62.3772 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	123.6011	124.8837	121.6516	114.7709	106.0852	97.9219	92.4682	91.1857	94.4177	101.2985	109.9842	118.1475 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415 (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)												
	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319 (71)
Water heating gains (Table 5)												
	69.5487	67.7549	64.2987	56.7224	52.0821	47.2316	44.2519	46.7130	49.5985	54.9807	62.2433	68.5799 (72)
Total internal gains												
	299.9515	306.1236	292.7520	280.3742	264.9689	254.0343	243.5218	244.7003	252.8972	263.0808	281.1084	293.5291 (73)

6. Solar gains

[Jan]												Gains
				Area	Solar flux	g		FF	Access			
				m2	Table 6a	Specific data		Specific data	factor		W	
					W/m2	or Table 6b		or Table 6c	Table 6d			
West				2.7200	19.6403	0.6300		0.7000	0.7700		16.3263 (80)	
East				5.4300	19.6403	0.6300		0.8000	0.7700		37.2487 (76)	
Solar gains	53.5750	104.8041	172.5973	251.7229	308.4959	315.8005	300.6549	258.2581	200.7379	124.3588	66.8017	44.0575 (83)
Total gains	353.5265	410.9276	465.3493	532.0972	573.4648	569.8348	544.1767	502.9584	453.6350	387.4396	347.9101	337.5866 (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, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	36.3512	36.4365	36.5205	36.9203	36.9961	37.3530	37.3530	37.4199	37.2147	36.9961	36.8431	36.6845
alpha	3.4234	3.4291	3.4347	3.4614	3.4664	3.4902	3.4902	3.4947	3.4810	3.4664	3.4562	3.4456
util living area	0.9562	0.9289	0.8781	0.7713	0.6256	0.4621	0.3416	0.3830	0.5946	0.8311	0.9315	0.9617 (86)
MIT	19.3737	19.6653	20.0677	20.5272	20.8173	20.9523	20.9872	20.9810	20.8860	20.4712	19.8491	19.3240 (87)
Th 2	20.0161	20.0182	20.0202	20.0298	20.0316	20.0400	20.0400	20.0415	20.0367	20.0316	20.0280	20.0242 (88)
util rest of house	0.9486	0.9170	0.8584	0.7375	0.5763	0.3991	0.2694	0.3068	0.5279	0.7967	0.9180	0.9550 (89)
MIT 2	18.1422	18.5063	19.0013	19.5503	19.8692	20.0070	20.0339	20.0319	19.9499	19.5038	18.7488	18.0854 (90)
Living area fraction										fLA = Living area / (4) =		0.6117 (91)
MIT	18.8955	19.2153	19.6536	20.1479	20.4492	20.5852	20.6171	20.6125	20.5225	20.0956	19.4218	18.8430 (92)
Temperature adjustment												0.0000
adjusted MIT	18.8955	19.2153	19.6536	20.1479	20.4492	20.5852	20.6171	20.6125	20.5225	20.0956	19.4218	18.8430 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9378	0.9056	0.8501	0.7419	0.5982	0.4353	0.3131	0.3526	0.5625	0.7992	0.9080	0.9447 (94)
Useful gains	331.5344	372.1176	395.5878	394.7517	343.0206	248.0759	170.4067	177.3658	255.1812	309.6337	315.9096	318.9296 (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	644.2498	630.3993	577.9123	488.8290	379.4579	257.1025	172.5589	180.6294	276.9135	411.8307	536.6252	640.4720 (97)
Space heating kWh	232.6602	173.5653	135.6494	67.7357	27.1093	0.0000	0.0000	0.0000	0.0000	76.0346	158.9152	239.2275 (98a)
Space heating requirement - total per year (kWh/year)												1110.8973
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	232.6602	173.5653	135.6494	67.7357	27.1093	0.0000	0.0000	0.0000	0.0000	76.0346	158.9152	239.2275 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1110.8973
Space heating per m2										(98c) / (4) =		27.2145 (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)
Fraction of main heating from main system 2													0.0000 (203)
Fraction of total heating from main system 1													1.0000 (204)
Fraction of total heating from main system 2													0.0000 (205)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of main space heating system 2 (in %)													0.0000 (207)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	232.6602	173.5653	135.6494	67.7357	27.1093	0.0000	0.0000	0.0000	0.0000	76.0346	158.9152	239.2275 (98)	
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000 (210)	
Space heating fuel (main heating system)	232.6602	173.5653	135.6494	67.7357	27.1093	0.0000	0.0000	0.0000	0.0000	76.0346	158.9152	239.2275 (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)	
Space heating fuel used, main system 2												0.0000 (213)	
Water heating													
Water heating requirement	182.5731	161.2794	170.8257	148.9095	143.4899	128.3579	125.9692	131.4761	133.4833	149.9758	160.8644	180.4054 (64)	
Efficiency of water heater	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100 (216)	
Fuel for water heating, kWh/month	52.2518	46.1576	48.8898	42.6174	41.0663	36.7356	36.0520	37.6280	38.2025	42.9226	46.0389	51.6314 (219)	
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (221)	
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (231)	
Lighting	11.8885	9.5374	8.5874	6.2915	4.8597	3.9704	4.4332	5.7624	7.4848	9.8205	11.0922	12.2189 (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												1110.8973 (211)	
Space heating fuel - main system 2												0.0000 (213)	
Space heating fuel - secondary												0.0000 (215)	
Efficiency of water heater												349.4100	
Water heating fuel used												520.1940 (219)	
Space cooling fuel												0.0000 (221)	
Electricity for pumps and fans:													
Total electricity for the above, kWh/year												0.0000 (231)	
Electricity for lighting (calculated in Appendix L)												95.9469 (232)	

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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	1727.0382 (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	1110.8973	0.1558	173.0440 (261)
Space heating - main system 2	0.0000	0.0000	0.0000 (262)
Total CO2 associated with community systems			0.0000 (273)
Water heating (other fuel)	520.1940	0.1411	73.3878 (264)
Space and water heating			246.4318 (265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (267)
Energy for lighting	95.9469	0.1443	13.8481 (268)
Total CO2, kg/year			260.2800 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			6.3800 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	1110.8973	1.5767	1751.5235 (275)
Space heating - main system 2	0.0000	0.0000	0.0000 (276)
Total CO2 associated with community systems			0.0000 (273)
Water heating (other fuel)	520.1940	1.5217	791.5601 (278)
Space and water heating			2543.0836 (279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000 (281)
Energy for lighting	95.9469	1.5338	147.1666 (282)
Total Primary energy kWh/year			2690.2502 (286)
Dwelling Primary energy Rate (DPER)			65.9100 (287)

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Main dwelling			
Ground floor	40.8200 (1b)	x 2.4500 (2b)	= 100.0090 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	40.8200		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 100.0090 (5)

2. Ventilation rate

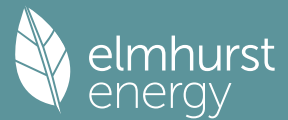
	m ³ per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	2 * 10 = 20.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c)	20.0000 / (5) = 0.2000 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	5.0000 (17)
Infiltration rate	0.4500 (18)
Number of sides sheltered	4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3150 (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	0.4016	0.3937	0.3859	0.3465	0.3386	0.2992	0.2992	0.2914	0.3150	0.3386	0.3544	0.3701 (22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685 (25)

3. Heat losses and heat loss parameter

Element	Gross	Openings	NetArea	U-value	A x U	K-value	A x K
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Main dwelling	m2	m2	m2	W/m2K	W/K	kJ/m2K	kJ/K
TER Opaque door			1.9100	1.0000	1.9100		(26)
TER Opening Type			8.1500	1.1450	9.3321		(27)
External Wall	22.1700	8.1500	14.0200	0.1800	2.5236		(29a)
Wall to Corridor	11.8000	1.9100	9.8900	0.1800	1.7802		(29a)
External Roof Plane	40.8200		40.8200	0.1100	4.4902		(30)
Total net area of external elements Aum(A, m2)			74.7900				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		20.0361		(33)
Main dwelling							
Party Wall			33.6400	0.0000	0.0000		(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							141.5083 (35)
List of Thermal Bridges							
K1 Element				Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)				2.7200	0.0500	0.1360	
E3 Sill				1.8100	0.0500	0.0905	
E4 Jamb				10.2000	0.0500	0.5100	
E25 Staggered party wall between dwellings				4.9000	0.0600	0.2940	
E18 Party wall between dwellings				4.9000	0.0600	0.2940	
E7 Party floor between dwellings (in blocks of flats)				13.8700	0.0700	0.9709	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)				13.7300	0.0000	0.0000	
P4 Party wall - Roof (insulation at ceiling level)				13.7300	0.1200	1.6476	
E10 Eaves (insulation at ceiling level)				9.0500	0.0600	0.5430	
E12 Gable (insulation at ceiling level)				4.8200	0.0600	0.2892	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)						4.7752	(36)
Point Thermal bridges						(36a) =	0.0000
Total fabric heat loss						(33) + (36) + (36a) =	24.8113 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer coeff	19.1630	19.0597	18.9584	18.4825	18.3935	17.9791	17.9791	17.9023	18.1387	18.3935	18.5736	18.7619	(38)
Average = Sum(39)m / 12 =	43.9743	43.8709	43.7696	43.2938	43.2048	42.7903	42.7903	42.7136	42.9500	43.2048	43.3849	43.5731	(39)
												43.2934	
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.0773	1.0747	1.0723	1.0606	1.0584	1.0483	1.0483	1.0464	1.0522	1.0584	1.0628	1.0674	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

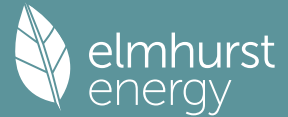
4. Water heating energy requirements (kWh/year)

Assumed occupancy													1.4283 (42)
Hot water usage for mixer showers													
	48.1673	47.4434	46.3886	44.3704	42.8810	41.2201	40.2760	41.3229	42.4704	44.2537	46.3152	47.9827	(42a)
Hot water usage for baths													
	20.8367	20.5273	20.0915	19.2880	18.6864	18.0192	17.6589	18.0916	18.5628	19.2766	20.0967	20.7663	(42b)
Hot water usage for other uses													
	29.2572	28.1933	27.1294	26.0655	25.0016	23.9377	23.9377	25.0016	26.0655	27.1294	28.1933	29.2572	(42c)
Average daily hot water use (litres/day)													90.3250 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	98.2612	96.1640	93.6095	89.7239	86.5690	83.1770	81.8726	84.4161	87.0986	90.6597	94.6052	98.0062	(44)
Energy conte	155.6217	136.9362	143.8743	122.8275	116.5385	102.2759	99.0178	104.5247	107.4013	123.0244	134.7824	153.4540	(45)
Energy content (annual)													
Distribution loss (46)m = 0.15 x (45)m													
	23.3433	20.5404	21.5811	18.4241	17.4808	15.3414	14.8527	15.6787	16.1102	18.4537	20.2174	23.0181	(46)
Water storage loss (or HIU loss):													
Store volume													150.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.3938 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.7527 (55)
Total storage loss													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(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													
	202.2166	179.0219	190.4692	167.9194	163.1334	147.3677	145.6127	151.1196	152.4932	169.6193	179.8743	200.0489	(62)
WWHRS	-22.0201	-19.4747	-20.3928	-16.8860	-15.7372	-13.4664	-12.6226	-13.4229	-13.9329	-16.4253	-18.6079	-21.6123	(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	180.1965	159.5472	170.0764	151.0333	147.3962	133.9013	132.9901	137.6967	138.5603	153.1940	161.2664	178.4366	(64)
												1844.2951	(64)
12Total per year (kWh/year)													
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)
													0.0000 (64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =													
Heat gains from water heating, kWh/month	89.0201	79.1999	85.1141	76.9136	76.0250	70.0802	70.1994	72.0304	71.7844	78.1815	80.8886	88.2994	(65)

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

Metabolic gains (Table 5), Watts													
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	71.4149	(66)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	62.7930	69.5209	62.7930	64.8861	62.7930	64.8861	62.7930	62.7930	64.8861	62.7930	64.8861	62.7930	(67)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	123.6011	124.8837	121.6516	114.7709	106.0852	97.9219	92.4682	91.1857	94.4177	101.2985	109.9842	118.1475	(68)
Pumps, fans	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	30.1415	(69)
Losses e.g. evaporation (negative values) (Table 5)	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	-57.1319	(71)
Water heating gains (Table 5)	119.6507	117.8569	114.4007	106.8245	102.1841	97.3336	94.3540	96.8150	99.7006	105.0827	112.3453	118.6820	(72)
Total internal gains	353.4693	359.6860	346.2698	333.9060	318.4868	304.5661	294.0397	295.2182	303.4289	316.5987	334.6401	347.0470	(73)

Full SAP Calculation Printout



6. Solar gains

[Jan]	Area m2				Solar flux Table 6a W/m2	Specific data or Table 6b	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W
East	5.4300				19.6403		0.6300	0.7000	0.7700	32.5926 (76)
West	2.7200				19.6403		0.6300	0.7000	0.7700	16.3263 (80)
Solar gains	48.9189	95.6958	157.5973	229.8462	281.6852	288.3549	274.5257	235.8135	183.2922	40.2285 (83)
Total gains	402.3882	455.3817	503.8671	563.7522	600.1720	592.9210	568.5654	531.0317	430.1498	387.2755 (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)												
tau	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
alpha	36.4883	36.5743	36.6589	37.0618	37.1382	37.4979	37.4979	37.5653	37.3585	37.1382	36.9840	36.8242
util living area	3.4326	3.4383	3.4439	3.4708	3.4759	3.4999	3.4999	3.5044	3.4906	3.4759	3.4656	3.4549
util living area	0.9384	0.9084	0.8549	0.7470	0.6037	0.4447	0.3265	0.3628	0.5616	0.7932	0.9059	0.9445 (86)
MIT	19.5444	19.8052	20.1669	20.5789	20.8381	20.9581	20.9891	20.9842	20.9055	20.5565	19.9977	19.5017 (87)
Th 2	20.0194	20.0215	20.0236	20.0331	20.0349	20.0433	20.0433	20.0449	20.0401	20.0349	20.0313	20.0275 (88)
util rest of house	0.9283	0.8940	0.8329	0.7121	0.5548	0.3836	0.2574	0.2904	0.4965	0.7553	0.8887	0.9353 (89)
MIT 2	18.3561	18.6790	19.1205	19.6093	19.8920	20.0145	20.0382	20.0369	19.9690	19.5994	18.9306	18.3087 (90)
Living area fraction	19.0830	19.3679	19.7606	20.2025	20.4707	20.5917	20.6199	20.6164	20.5419	20.1848	19.5834	19.0385 (92)
Temperature adjustment	19.0830	19.3679	19.7606	20.2025	20.4707	20.5917	20.6199	20.6164	20.5419	20.1848	19.5834	0.0000
adjusted MIT	19.0830	19.3679	19.7606	20.2025	20.4707	20.5917	20.6199	20.6164	20.5419	20.1848	19.5834	19.0385 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Useful gains	0.9166	0.8830	0.8263	0.7185	0.5774	0.4191	0.2993	0.3340	0.5314	0.7616	0.8796	0.9240 (94)
Ext temp.	368.8381	402.0938	416.3636	405.0623	346.5549	248.4674	170.1755	177.3850	258.6257	327.6021	348.0069	357.8410 (95)
Heat loss rate W	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)
Space heating kWh	650.0721	634.7197	580.4103	489.3261	378.9372	256.3875	172.0116	180.0968	276.6793	414.1106	541.5890	646.5582 (97)
Space heating requirement - total per year (kWh/year)	209.2381	156.3246	122.0507	60.6699	24.0924	0.0000	0.0000	0.0000	0.0000	64.3624	139.3791	214.8056 (98a)
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (98b)
Solar heating contribution - total per year (kWh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Space heating kWh	209.2381	156.3246	122.0507	60.6699	24.0924	0.0000	0.0000	0.0000	0.0000	64.3624	139.3791	214.8056 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)	209.2381	156.3246	122.0507	60.6699	24.0924	0.0000	0.0000	0.0000	0.0000	64.3624	139.3791	214.8056 (98c)
Space heating per m2	(98c) / (4) =											24.2754 (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)											
Space heating requirement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating efficiency (main heating system 1)	209.2381	156.3246	122.0507	60.6699	24.0924	0.0000	0.0000	0.0000	0.0000	64.3624	139.3791	214.8056 (98)
Space heating fuel (main heating system)	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 efficiency (main heating system 2)	226.6935	169.3658	132.2326	65.7312	26.1023	0.0000	0.0000	0.0000	0.0000	69.7317	151.0066	232.7255 (211)
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 (212)
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 (213)
Water heating	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 requirement	180.1965	159.5472	170.0764	151.0333	147.3962	133.9013	132.9901	137.6967	138.5603	153.1940	161.2664	178.4366 (64)
Efficiency of water heater	84.3957	84.0140	83.3285	82.1871	80.9527	79.8000	79.8000	79.8000	79.8000	82.2667	83.7344	79.8000 (216)
Fuel for water heating, kWh/month	213.5138	189.9054	204.1035	183.7676	182.0770	167.7961	166.6543	172.5523	173.6344	186.2163	192.5928	211.2255 (219)
Space cooling fuel requirement	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	13.0472	10.4669	9.4243	6.9046	5.3333	4.3574	4.8653	6.3240	8.2143	10.7776	12.1733	13.4098 (232)
Electricity generated by PVs (Appendix M) (negative quantity)	-14.1710	-20.7770	-31.0608	-36.3954	-40.5684	-38.3953	-37.9678	-35.2079	-30.5316	-24.4451	-15.8751	-12.1633 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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)	-5.7518	-12.3014	-24.8135	-37.7886	-50.4512	-50.8282	-50.1882	-42.2383	-30.6519	-17.7176	-7.7237	-4.5305 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)

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	1073.5891	1.1300	1213.1557 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2244.0389	1.1300	2535.7640 (278)
Space and water heating			3748.9197 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	105.2980	1.5338	161.5096 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-337.5588	1.4942	-504.3733
PV Unit electricity exported	-334.9848	0.4607	-154.3274
Total			-658.7007 (283)
Total Primary energy kWh/year			3381.8294 (286)
Target Primary Energy Rate (TPER)			82.8500 (287)

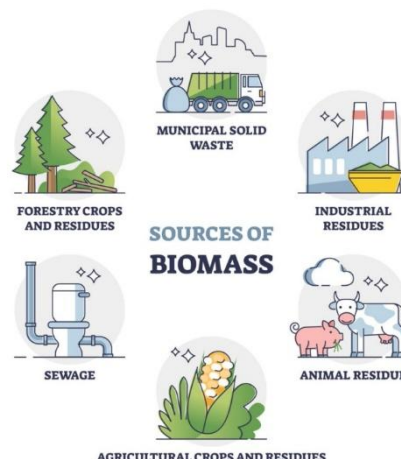
Appendix B - Low & zero carbon technology review

This appendix provides details of the renewable energy technologies discussed within the 'Be Green' section of this report.

B.1 - Biomass

Biomass is a energy source in which organic materials such as wood, plants, manure and household waste are burned as heating fuel. This is considered renewable as, providing sustainable sources are used (e.g., FSC certified forests) that can replenish the raw material.

While being a renewable, sustainable source of heating, when burned as fuel harmful CO₂ and NO_x emissions are emitted. There is also no centralized grid as there is with mains gas or electricity to deliver fuel to site. These factors mean that implementation in urban environments can be problematic. Emissions can contribute to already poor air quality in the cities around the UK, and delivery of large quantities of fuel raises issues regarding on-site storage and access for vehicles.



This being said, if the site sits in a more rural area, where the sources (such as farms with waste such as manure, etc) are more local and easier to deliver, then this renewable technology becomes feasible. Concerns surround emissions can also be addressed as the natural local environment can absorb and sequester some of the harmful pollutants.

B.2 - Geothermal Energy

Geothermal energy technologies use the heat energy stored beneath the surface of the ground. This can be through direct applications where the energy is used to defrost driveways, or, more typically, indirectly when the low-grade heat is upgraded via a heat pump for use as a space heating and hot water system.

The utilisation of this can be more efficient than air-source equivalents as there are less extremes in temperature underground, than in the atmosphere. For example, the ground can have constant, stable temperatures from 11-13 °C at a depth of 50m.

The right choice of appropriate heat exchanger depends on several factors, including:

- Size of space heating/hot water system
- Available site area for the heat exchangers
- Local ground conditions

The different heat exchanger options are discussed below:

B.2.1 Closed Loop System

A frequently used and simple ground source heat exchanger, for a small to medium size project, is a closed loop system. The system comprises of a sealed network of pipes buried within the ground (Vertically or Horizontally), in which water is continuously pumped through the pipes to achieve the required heat exchange.

Vertically Closed Loop System

Vertically Closed Loop Systems, consists of multiple sets of two polyethylene pipes with a U-shape connector at the base of the hole – effectively providing a flow down to the bottom of the hole and return back up to the surface. These pipes usually are up to 100m deep into the ground and are connected to complete the heat exchange loop but should have enough distancing to prevent heat transfer between boreholes.

Horizontally Closed Loop System

Horizontal closed loop heat systems consist of horizontal trenches 1.5-2m deep, with either straight pipes or 'slinky' coiled pipes, these require significant excavation work and significant site area to achieve appreciable outputs as such are not normally suited to medium to large projects.

B.2.2 Open Loop Systems

A further Ground Source option is an open loop system. The system compromises of the abstraction of ground water as a direct energy source passing through the heat exchanged and injecting it back to the borehole (Two Well System) or into a nearby water source (Direct System). These systems are capable of providing very high rates of heat exchange for a relatively small number of boreholes, which makes it very efficient in terms of site area required. However, this depends greatly on the availability of ground water, which in turn varies according to location. A major downside of this system is that the extraction of water from deep boreholes via pumps consumes a lot of energy, as the water has to be physically lifted to the surface by the pump – this in effect reduces the carbon emissions saved by this system as a whole.

Open Loop Two Well System

Open Loop Two Well Systems, consists of using boreholes in which pumps are inserted. Each borehole pump abstracts ground water, circulates it around the heat pump and then discharges the water back to the ground via an absorbing well, some distance from the original abstraction borehole.

Open Loop Direct System

Open Loop Two Well Systems, consists of using boreholes in which pumps are inserted. Each borehole pump abstracts ground water, circulates it around the heat pump and then discharges the water back to a nearby watercourse or sewer.

B.3 Air Source Heat Pumps

Air Source Heat Pumps take heat from outside air and increases it to a higher temperature with a compressor. This heat then is transferred to the heating system. Effectively they work on the same principle as a refrigeration unit, just in reverse.

A heat pump consumes electrical power to drive the compressor and other ancillary elements. The ratio between total energy input and heat energy output of the heat pump is a measure of its efficiency – usually referred to as ‘Coefficient of Performance’ - COP. Air Source Heat Pumps run over 100% efficiently, meaning they produce more heat energy than they use to run. There are 2 common types of air source heat pumps; Air-to-Air and Air-to-Water.

B.3.1 Air-to-Air Heat Pump

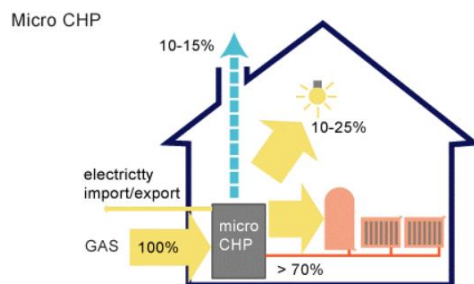
Air-to-Air heat pumps take air from outside and heat or cool it to then feed into the building through fans. These heat pumps can be used for heating and cooling but not heating hot water.

B.3.2 Air-to-Water Heat Pump

Air-to-Water heat pumps take air from outside and feeds it into a water based central heating system. These heat pumps produce a low heat which may require larger radiators or underfloor heating to work at its optimum. These heat pumps can be used for heating and heating hot water.

B.4 Combined Heat and Power (CHP)

Combined heat and power (CHP) is a process involving simultaneous generation of heat and electricity, where the heat generated in the process is harnessed via heat recovery equipment. CHP is fairly common at the large commercial size premises which have a simultaneous demand for heating and electricity for long periods, such as hospitals, recreational centres and hotels.

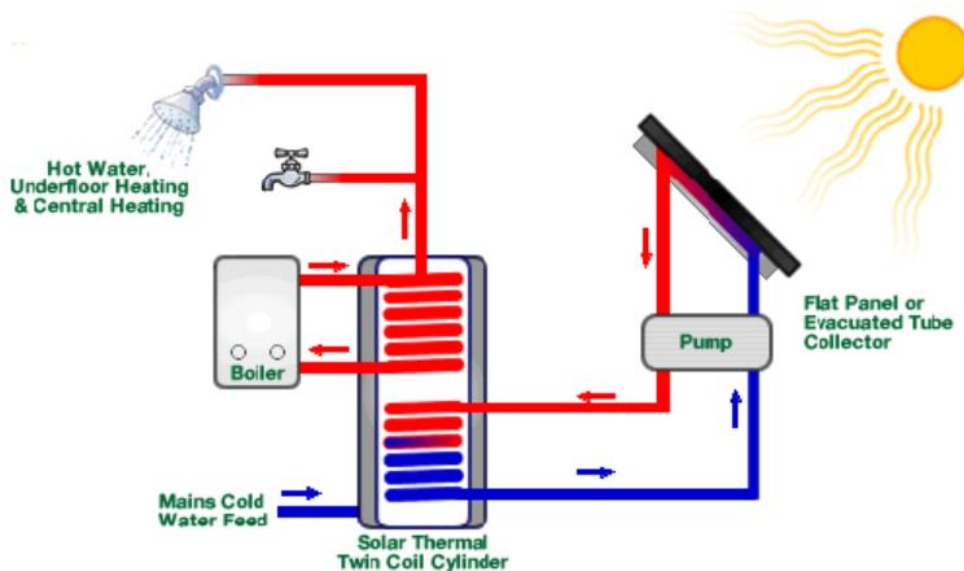


In addition, small CHP systems are available for individual houses, group residential units and small non-residential premises. Compared with using centrally generated electricity supplied via the grid, CHP can offer a more efficient and economic method of supplying energy demand, if installed and operated appropriately. This is due to the utilisation of heat which is normally rejected to the atmosphere from central generating stations, and by reducing network distribution losses due to local generation and use.

Heat generated can be used for space and water heating, and additional heat storage may be used to lengthen use periods, to assist in warm-up and to improve overall energy efficiency. For overall good energy efficiency, as with all CHP, usage must be heat-demand led. Thus, a sophisticated control system is required and users should be made aware of efficient operating practices.

B.5 Solar thermal collectors

Solar thermal collectors (flat plate or evacuated tubes) convert solar thermal energy into heat for hot water generation. These are usually located on a roof oriented at the south direction with an ideal slope of 45 degree. Solar collectors properly sized and designed provide can approximately 50% of annual hot water demand.



B.6 - Photovoltaic Arrays

Photovoltaic modules convert sunlight directly into DC electricity and can be integrated into buildings. Photovoltaics (PVs) are distinct from other renewable energy technologies since they have no moving parts to be maintained and are silent. PV systems can be incorporated into buildings in various ways: on sloped roofs and flat roofs, in façades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles.



Currently, a PV system will cost between £1,500 and £2,500 per kWp, and frequently part of this cost can be offset owing to the displacement of a conventional cladding material.

While single crystal silicon remains the most efficient flat plate technology (15–16% conversion efficiency); it also has the least potential for cost reduction. PV cells made from poly-crystalline silicon have become popular as they are less expensive to produce, although they have a slightly lower efficiency.

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials on a low-cost backing such as glass, stainless steel or plastic. A material with much less semiconductor qualities is required as for crystalline silicon cells, material

costs are potentially much lower. Efficiencies are much lower, around 4–5%, although this can be boosted to 8–10% by depositing two or three layers of thin film material. Thin film production also requires less handling as the films are produced as large, complete modules and not as individual cells that have to be mounted in frames and wired together. Hence, there is the potential for significant cost reductions with volume production.

Since PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form. The cost of the inverter and these 'Balance of System' (BOS) components can approach 30% of the total cost of a PV system. Hence, simplification and cost reductions in these components over the coming years will also be necessary to make PV systems affordable.

B.7 Wind Energy

Wind power is the most successful and fastest spreading renewable energy technology in the UK with a number of individual and group installations of varying size, capacity and location.

All wind turbines depend and work from a central axis which turns from the impact of the wind, this motion produces electricity which can be fed into the grid or used individually. The output largely depends on the wind speed and the correlation between the two is a cube function. This means that in short periods of above-average wind speeds the generation increases exponentially. As a result, it is difficult to make precise calculations of the annual output of a turbine, but average figures can provide useful guidance to designers and architects. In reasonably windy areas (average wind speed of 6m/s) the expected output from 1kW installed is about 2500kWh annually.



The cost per kW installed varies considerably by manufacturer and size of machine with an indicative bracket of £2,500–£5,000. With a lifespan of more than 20 years, wind turbines can save money if design and planning are carried out in a robust way.

B.7.1 Vertical Axis Wind Turbines

Vertical Axis Wind Turbines are becoming increasingly popular as a renewable energy source. The benefit of the vertical axis means that the array does not need to be positioned directly in the wind's direction, and therefore can be installed closer to the ground or on roof tops. These turbines are often lighter and more accessible for domestic or urban environments.

B.7.2 Horizontal Axis Wind Turbines

Horizontal Axis Wind Turbines are the most common and usually used for offshore or rural wind farms. These turbines should be placed where the wind factor is high as they

are built to withstand large forces, the disadvantage of this is that they require heavy construction process. A Horizontal axis Wind Turbine has a similar design to a traditional windmill with all the blades facing one direction on top of a high column.

B.7.3 Roof Mounted Wind Turbines

Roof Mounted Wind Turbines are often used to generate electricity directly to the building they are mounted onto. Whilst these turbines are drastically smaller than free standing wind turbines, therefore they may not provide enough power for your electricity. They are a lot cheaper to manufacture, install and maintain.

B.7.4 Free Standing Wind Turbines

Free Standing Wind Turbines are usually located on top of a hill or in a large array of water. The height of these turbines allows for little turbulence or obstructions. Free Standing Turbines can produce a great amount of electricity however require a large amount of space.

Appendix C – Sample water calculations



Job no:	PR13235
Date:	28/07/2026
Assessor name:	Iraj Maghounaki
Registration no:	BRE400012
Development name:	Flat 1-6, 117-119 Oxford Road, Reading, Berkshire, RG1 7UH

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WATER EFFICIENCY CALCULATOR FOR NEW DWELLINGS - (BASIC CALCULATOR)

		House Type:		Type 1		Type 2		Type 3		Type 4		Type 5		Type 6		Type 7		Type 8		Type 9		Type 10	
		Description:		Flat 1 (Sample Unit)		Flat 4 (Sample Unit)																	
Installation Type	Unit of measure	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day
Is a dual or single flush WC specified?		Dual		Dual																			
WC	Full flush volume	6	8.76	6	8.76		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
	Part flush volume	3	8.88	3	8.88		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Taps (excluding kitchen and external taps)		Flow rate (litres / minute)	5	9.48	5	9.48		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
Are both a Bath & Shower Present?		Bath & Shower		Bath & Shower																			
Bath	Capacity to overflow	170	18.70	170	18.70		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Shower	Flow rate (litres / minute)	8	34.96	8	34.96		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Kitchen sink taps	Flow rate (litres / minute)	6	13.00	6	13.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a washing machine been specified?		Yes		Yes																			
Washing Machine	Litres / kg	8.17	17.16	8.17	17.16		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a dishwasher been specified?		Yes		Yes																			
Dishwasher	Litres / place setting	1.25	4.50	1.25	4.50		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a waste disposal unit been specified?		No		No																			
Water Softener	Litres / person / day		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Calculated Use		115.4		115.4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Normalisation factor		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91	
Code for Sustainable Homes	Total Consumption	105.0		105.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
	Mandatory level	Level 1/2		Level 1/2		-		-		-		-		-		-		-		-		-	
Building Regulations 17.K	External use	5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0	
	Total Consumption	110.0		110.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	
	17.K Compliance?	Yes		Yes		-		-		-		-		-		-		-		-		-	