



# Energy & Sustainability Statement

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Listen. Consider. Apply. Deliver.

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## 1.0 Introduction

### 1.1 Executive Summary

MES have been commissioned to provide an Energy & Sustainability Statement to address the requirements of Hillingdon Borough Council in relation to the proposed development on Farm Road, Northwood. The purpose of this statement is to provide an overview of how sustainability will be promoted and establish the predicted energy requirements and associated carbon dioxide emissions for the development.

The applicable planning policies this report will address are detailed in the Local Plan Part 2 – Development Management Policies 2014, specifically DMEI1, DMEI2, and DMEI3. These policies do not set any specific targets on new dwellings in the area, rather promote that general sustainable design and low carbon energy be incorporated. Similarly, while the proposed development does fall within catchment of the London Plan 2021, because it is considered ‘Minor’ – consisting of only one new build dwelling – there are no specific carbon reduction targets. Despite this, the proposed development does provide reductions in key metrics covered by the London Plan and has achieved so by completing the following, which includes:

- Calculation of baseline energy consumption and CO<sub>2</sub> emissions using a SAP 10.2 calculation in line with Part L 2021.
- Implementation of the energy hierarchy and calculation of CO<sub>2</sub> emissions at each stage (Be Lean, Be Clean, Be Green).
- Calculation of final energy consumption and CO<sub>2</sub> emissions.
- Calculation of contribution from any renewable energy generation and subsequent reduction in emissions achieved.

In line with the favoured approach of the GLA the total energy requirements and carbon emissions for the development have been calculated using a Part L 2021 SAP calculation for the proposed dwelling. This is in line with the guidance contained in paragraph 9.2.6 of the London Plan 2021 and the June 2022 Energy Assessment Guidance document. For the proposed development this has been achieved by:

- An improved building fabric over the Part L 2021 requirements.
- Reduced air permeability to lower heat loss from uncontrolled ventilation.
- Specification of MVHR to limit heat loss from uncontrolled ventilation.
- The use of an ASHP to provide space heating.

Table 1.1, below, shows the modelled performance based on the SAP calculations for each stage of the energy hierarchy. Further details can be found in Section 3 and the appendices to this report.

Table 1.1: Total reduction in energy use and carbon emissions

	Regulated Energy Consumption (kWh per annum)	Regulated CO <sub>2</sub> Emissions (Tonnes per annum)	Regulated CO <sub>2</sub> savings	
			(Tonnes per annum)	(%)
Baseline	33,325.40	7.9		
Be Lean	26,303.61	5.9	2.0	25%
Be Clean	26,303.61	5.9	0.0	0%
Be Green	23,517.46	3.5	2.4	31%
<b>Cumulative on-site savings</b>	<b>9,807.94</b>		<b>4.4</b>	<b>56%</b>

As required by the June 2022 updated guidance for the production of energy statements, the Energy Use Intensity (EUI), space heating demand and FEES performance have been calculated using the same SAP10.2 and models as the energy and CO<sub>2</sub> consumption. This information can be found in Table 1.2 below.

It should be noted that the targets for these metrics (both EUI and Space Heating Demand) are based on modelling using the PassivHaus Planning Package. This uses a different set of modelling conventions, as well as producing a different set of performance figures even for the same building – particularly when it comes to the unregulated energy. For the proposed development the predicted unregulated energy, as calculated using SAP10.2, gives an EUI of 14.5 which makes the target of 35.0 for all energy consumption seem difficult to achieve when using SAP as the modelling approach.

**Table 1.2: EUI, space heating demand & FEES**

Building Type	Energy Use Intensity (kWh/m <sup>2</sup> /year, excluding renewable energy)	Space Heating Demand (kWh/m <sup>2</sup> /year, excluding renewable energy)	Design Fabric Energy Efficiency (FEES)
Residential	63.4	53.8	83.73
Target	35.0	15.0	83.92

In line with Development Management Policy DME15, potable water use will be reduced. Water efficient fittings will be specified for this development to ensure it achieves the Optional Requirement of the Building Regulations – a mains water consumption of 105 litres per person per day. Section 6 and Appendix 5 will detail this further.

This report has also completed pre-planning overheating calculations using the GHA Overheating tool which can be found in Section 5 and Appendix 4.

## 1.2 Planning Policy

The relevant policies laid out in the Hillingdon Development Management Policies document 2014 and the London Plan 2021 have been reproduced below for clarity.

### Policy DME1: Sustainable Design Standards

All development proposals are required to comply with the following:

- All new residential development shall achieve a minimum Code for Sustainable Homes Level 4 (or equivalent).

- Non-residential developments are required to achieve a minimum of Very Good under the relevant BREEAM assessment criteria (or equivalent).
- Residential developments consisting of the refurbishment of existing buildings, including the conversion of existing buildings to form flats, are required to achieve EcoHomes Excellent (or equivalent).

The design and layout of development proposals should incorporate techniques that enhance biodiversity, such as green roofs and walls. These measures will benefit other sustainability objectives including surface water attenuation and the avoidance of internal and urban overheating.

**Policy DMEI2: Reducing Carbon Emissions**

All developments are required to make the fullest contribution to minimising carbon dioxide emissions in accordance with London Plan targets.

All major development proposals must be accompanied by an energy assessment showing how these reductions will be achieved.

Proposals that fail to take reasonable steps to achieve the required savings will be resisted. However, if the Council is minded to approve the application despite not meeting the carbon reduction targets, then it will seek an offsite contribution to make up for the shortfall. The contribution will be sought at a flat rate at £/tonne in accordance with the current 'allowable solutions cost'.

**POLICY DMEI3: Decentralised Energy**

All major developments are required to be designed to be able to connect to a Decentralised Energy Network (DEN).

Major developments located within 500 metres of an existing DEN, and minor new-build developments located within 100 metres, will be required to connect to that network, including provision of the means to connect to that network and a reasonable financial contribution to the connection charge, unless a feasibility assessment demonstrates that connection is not reasonably possible.

Major developments located within 500 metres of a planned future DEN, which is considered by the council likely to be operational within 3 years of a grant of planning permission, will be required to provide a means to connect to that network and developers shall provide a reasonable financial contribution for the future cost of connection and a commitment to connect via a legal agreement or contract, unless a feasibility assessment demonstrates that connection is not reasonably possible.

The Council will support the development of decentralised energy networks and energy centres in principle, subject to meeting the wider policy requirements of this plan and in particular on design and air quality.

**Policy DMEI15: Water Efficiency in Homes**

New residential development should demonstrate efficient use of natural resources, including water and aim to achieve the highest possible rating in the Code for Sustainable Homes (CSH).

## The London Plan 2021

### Policy SI 2 Minimising greenhouse gas emissions

- A. Major development should be net-zero carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:
  1. Be Lean: use less energy and manage demand during operation
  2. Be Clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly
  3. Be Green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site
  4. Be Seen: monitor, verify, and report on energy performance.
- B. Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.
- C. A minimum on-site reduction of at least 35% beyond Building Regulations is required for major development. Residential development should achieve 10%, and non-residential development should achieve 15% through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:
  1. through a cash in lieu contribution to the borough's carbon offset fund, or
  2. off-site provided that an alternative proposal is identified and delivery is certain.
- D. Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually.
- E. Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.
- F. Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

### Policy SI 3 Energy infrastructure

- A. Boroughs and developers should engage at an early stage with relevant energy companies and bodies to establish the future energy and infrastructure requirements arising from large-scale development proposals such as Opportunity Areas, Town Centres, other growth areas or clusters of significant new development.
- B. Energy masterplans should be developed for large-scale development locations (such as those outlined in Part A and other opportunities) which establish the most effective energy supply options. Energy masterplans should identify:
  1. major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)
  2. heat loads from existing buildings that can be connected to future phases of a heat network
  3. major heat supply plant including opportunities to utilise heat from energy from waste plants
  4. secondary heat sources, including both environmental and waste heat
  5. opportunities for low and ambient temperature heat networks
  6. possible land for energy centres and/or energy storage
  7. possible heating and cooling network routes
  8. opportunities for futureproofing utility infrastructure networks to minimise the impact from road works
  9. infrastructure and land requirements for electricity and gas supplies

10. implementation options for delivering feasible projects, considering issues of procurement, funding and risk, and the role of the public sector
11. opportunities to maximise renewable electricity generation and incorporate demand-side response measures.

C. Development Plans should:

1. identify the need for, and suitable sites for, any necessary energy infrastructure requirements including energy centres, energy storage and upgrades to existing infrastructure
2. identify existing heating and cooling networks, identify proposed locations for future heating and cooling networks, and identify opportunities for expanding and inter-connecting existing networks, as well as establishing new networks.

D. Major development proposals within Heat Network Priority Areas should have a communal low-temperature heating system:

1. the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:
  - a) connect to local existing or planned heat networks
  - b) use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
  - c) use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
  - d) use ultra-low NOx gas boilers
2. CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements in Part B of Policy SI1 Improving Air Quality
3. where a heat network is planned but not yet in existence the development should be designed to allow for the cost-effective connection at a later date.

E. Heat networks should achieve good practice design and specification standards for primary, secondary and tertiary systems comparable to those set out in the CIBSE/ADE Code of Practice CP1 or equivalent.

**Policy SI 4 Managing heat risk**

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

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

1. reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure
2. minimise internal heat generation through energy efficient design
3. manage the heat within the building through exposed internal thermal mass and high ceilings
4. provide passive ventilation
5. provide mechanical ventilation
6. provide active cooling systems.

**Policy SI 5 Water Infrastructure**

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

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

C. Development proposals should:

1. through the use of Planning Conditions, minimise the use of mains water in line with the Optional Requirement of the Building Regulations (residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption)
2. achieve at least the BREEAM excellent standard for the 'Wat 01' water category or equivalent (commercial development)
3. incorporate measures such as smart metering, water saving and recycling measures, including retrofitting, to help achieve lower water consumption rates and maximise future proofing.

D. In terms of water quality, Development Plans should:

1. promote the protection and improvement of the water environment in line with the Thames River Basin Management Plan, and should take account of Catchment Plans
2. support wastewater treatment infrastructure investment to accommodate London's growth and climate change impacts. Such infrastructure should be constructed in a timely and sustainable manner taking account of new, smart technologies, intensification opportunities on existing sites, and energy implications. Boroughs should work with Thames Water in relation to local wastewater infrastructure requirements.

E. Development proposals should:

1. seek to improve the water environment and ensure that adequate wastewater infrastructure capacity is provided.
2. take action to minimise the potential for misconnections between foul and surface water networks.

F. Development Plans and proposals for strategically or locally defined growth locations with particular flood risk constraints or where there is insufficient water infrastructure capacity should be informed by Integrated Water Management Strategies at an early stage.

### 1.3 Part L 2021

A new version of Part L of the Building Regulations was introduced on 15<sup>th</sup> June 2022. Following this the GLA have updated their guidance for the production of energy statements provided via their document 'Energy Assessment Guidance'<sup>1</sup>.

This clarifies that the same carbon reductions due to energy efficiency measures and overall carbon reductions continue to apply, with these now being required over the 2021 Part L.

It also requires that residential developments report the Fabric Energy Efficiency Standard (FEES) for the development as a whole. It should also be shown how much improvement the proposed specification has made over the Target FEES.

It also requires that the Energy Use Intensity and the space heating demand of the development be provided. Paragraph 7.13 (page 20) states that applications should aim to achieve the values in Table 4 of the Energy Assessment Guidance document – this is reproduced below.

Building Type	Energy Use Intensity (kWh/m <sup>2</sup> /year)	Space Heating (kWh/m <sup>2</sup> /year)
Residential	35	15
School	65	15
Office	55	15
Hotel	55	15
All other non-residential	55	15

<sup>1</sup> [https://www.london.gov.uk/sites/default/files/gla\\_energy\\_assessment\\_guidance\\_june\\_2022\\_0.pdf](https://www.london.gov.uk/sites/default/files/gla_energy_assessment_guidance_june_2022_0.pdf)

Finally, it requires that an assessment is made of the cost to occupants and show what is proposed to protect the consumer from high energy prices.



Farm Road Energy & Sustainability Statement v1.1

## 2.0 Description of the Development

### 2.1 Location

The proposed development is located on Farm Road in Northwood, a residential street comprising large, detached houses with spacious plots and mature gardens. Local amenities include independent schools and hospitals nearby. Public transport access is moderate; Northwood and Moor Park Underground stations are about 0.8-0.9 miles away, and there are several bus stops on Rickmansworth Road. The site location can be found in Figure 2.1 below.

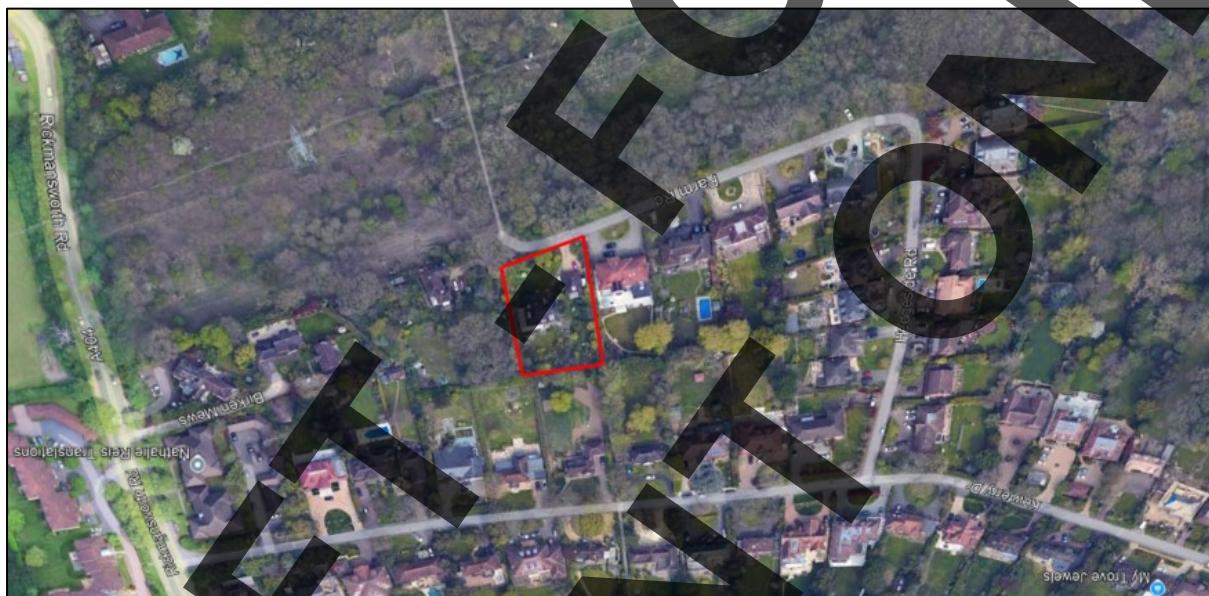


Figure 2.1 - Aerial photograph showing site location

### 2.2 Details of the Development

The application is for the demolition of an existing dwelling, that is of mid-20<sup>th</sup> century construction, and the construction of a new dwelling.

The proposed dwelling will be constructed to achieve higher than statutorily required standards of insulation and air permeability. This, combined with the use of renewable and energy-efficient heating systems, will ensure a highly sustainable and energy-efficient home. The restrictions that the existing construction places on retrofit (external walls with a narrow cavity and solid ground floor) mean that much greater thermal efficiency can be achieved in the proposed new dwelling than by retrofitting the existing. LZC heating and ventilation systems are also only economically viable for buildings with good thermal performance as they are significantly more efficient in highly efficient buildings and provide much better occupant comfort.

Floor plans and elevations showing the proposed development can be found in Figures 2.2-2.7, below.

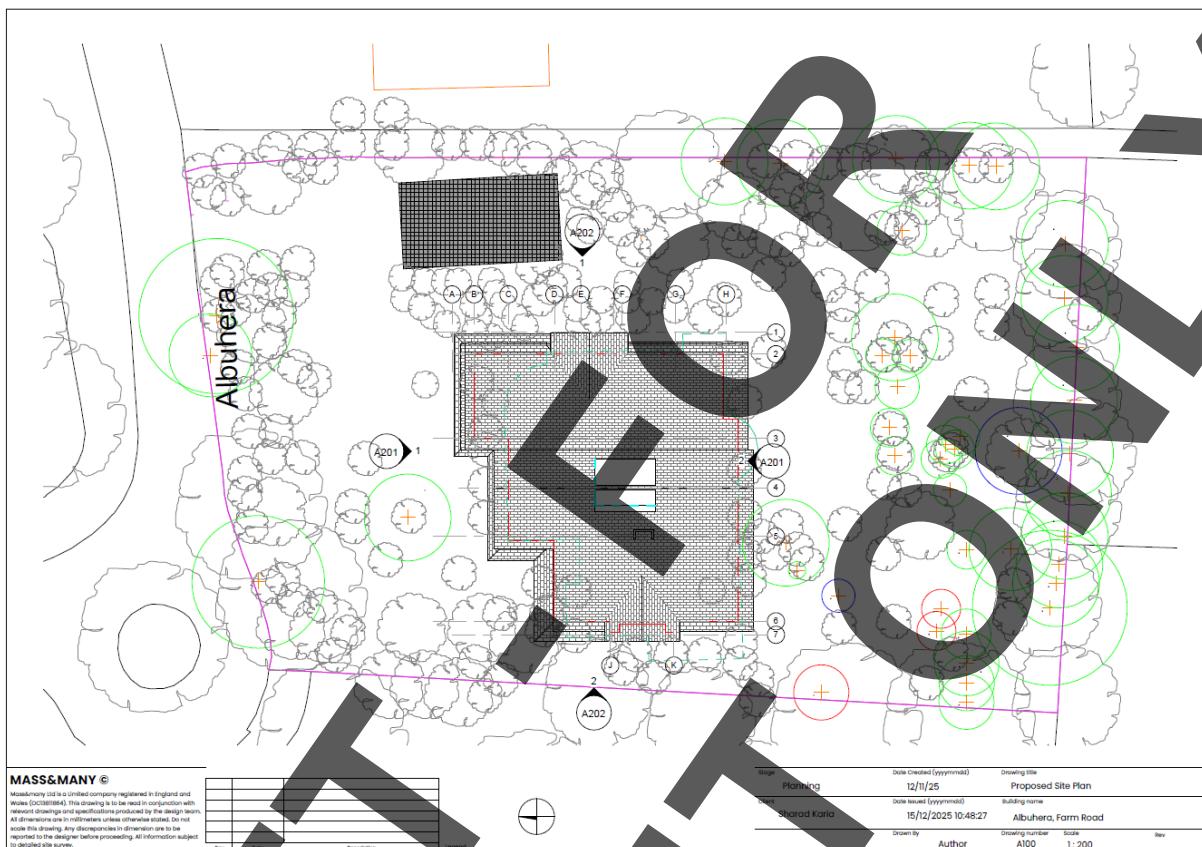


Figure 2.2 – Master Site Layout

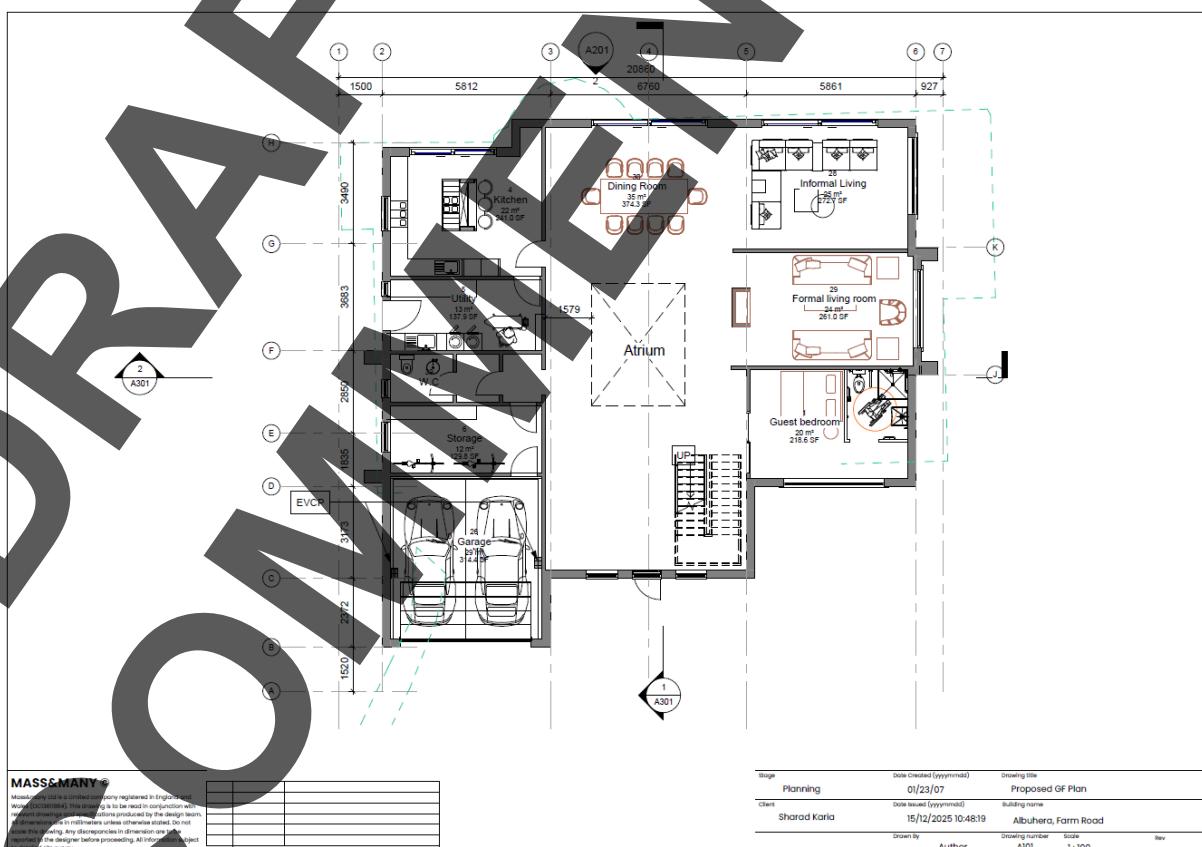


Figure 2.3 – Ground Floor Plan

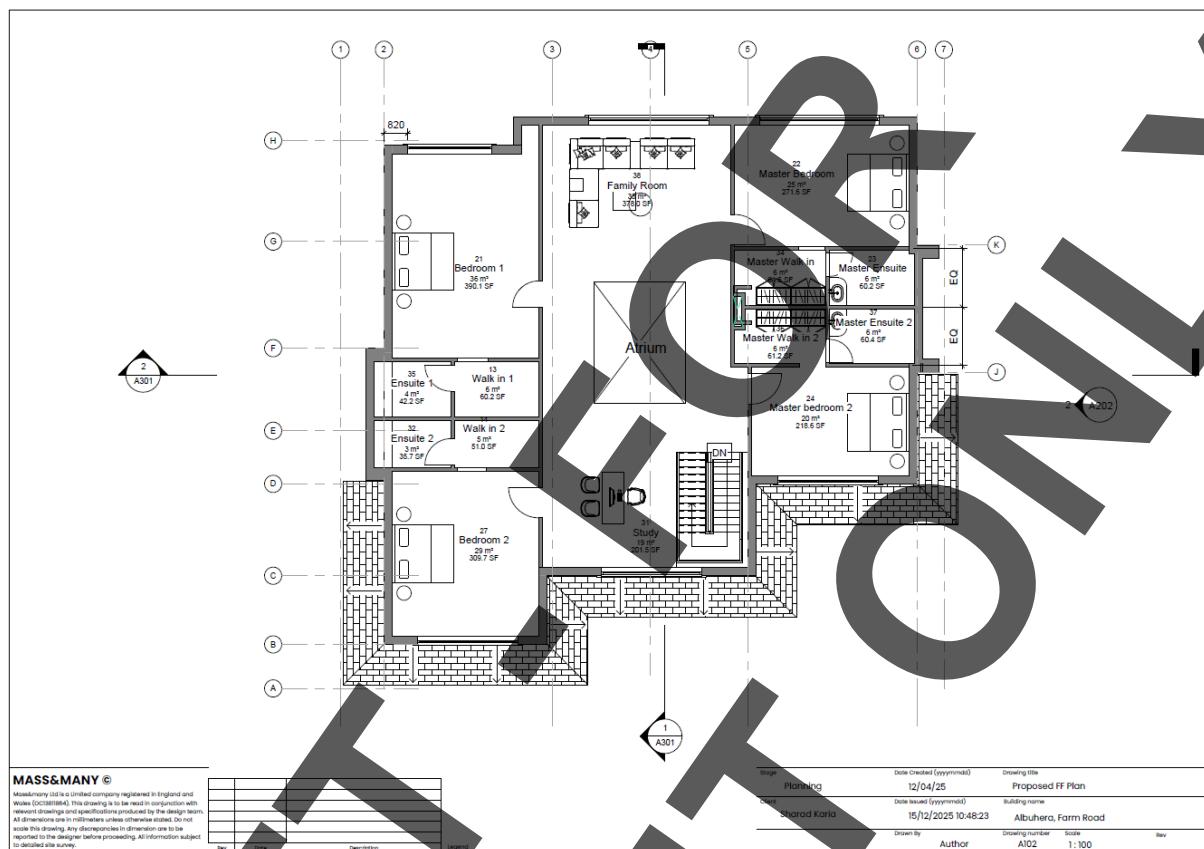


Figure 2.4 – First Floor Plan

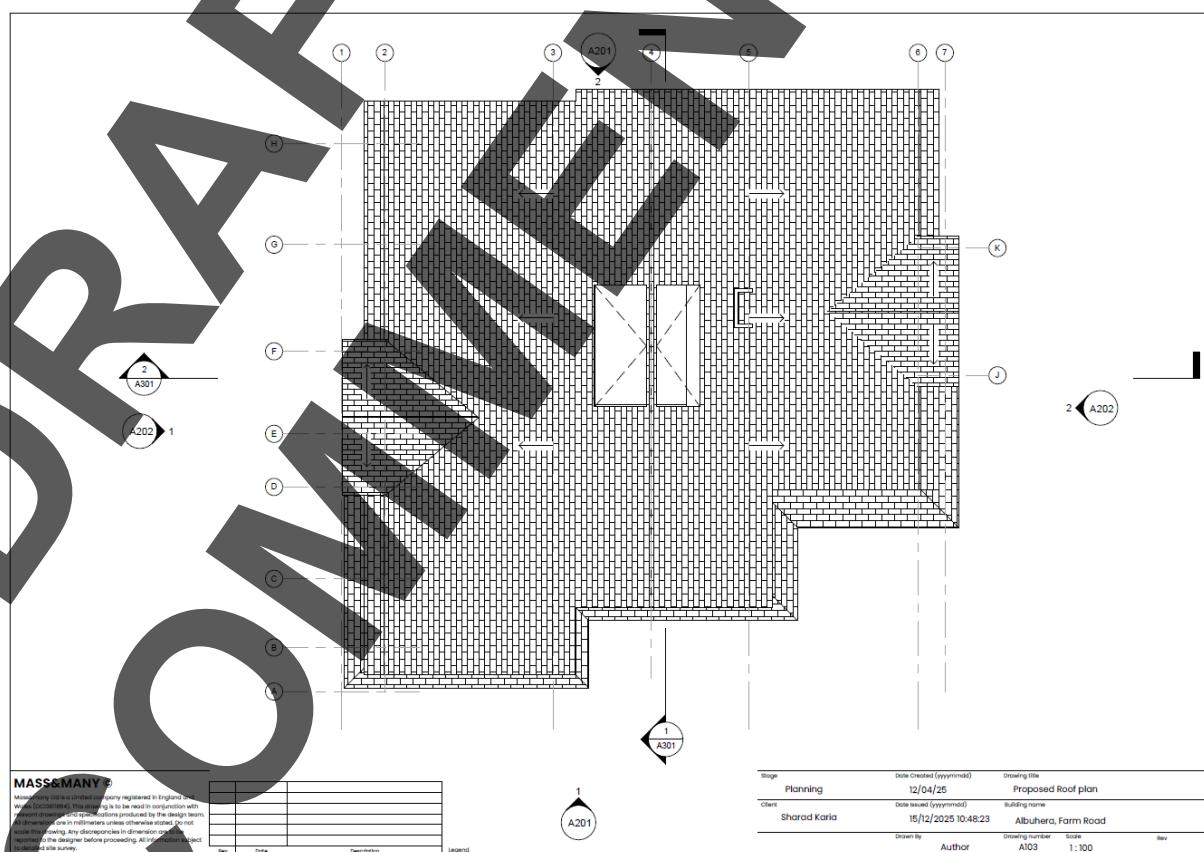


Figure 2.5 – Roof Plan

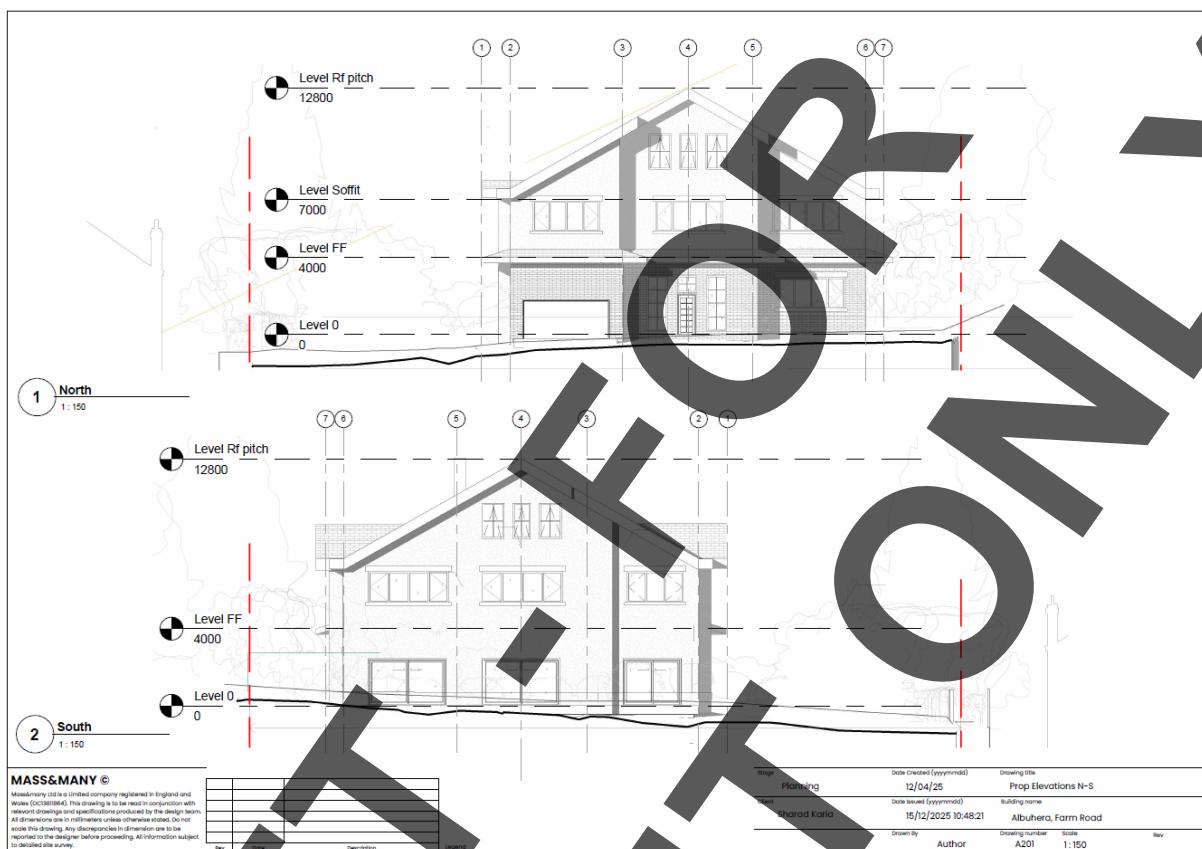


Figure 2.6 – Front and Rear Elevations

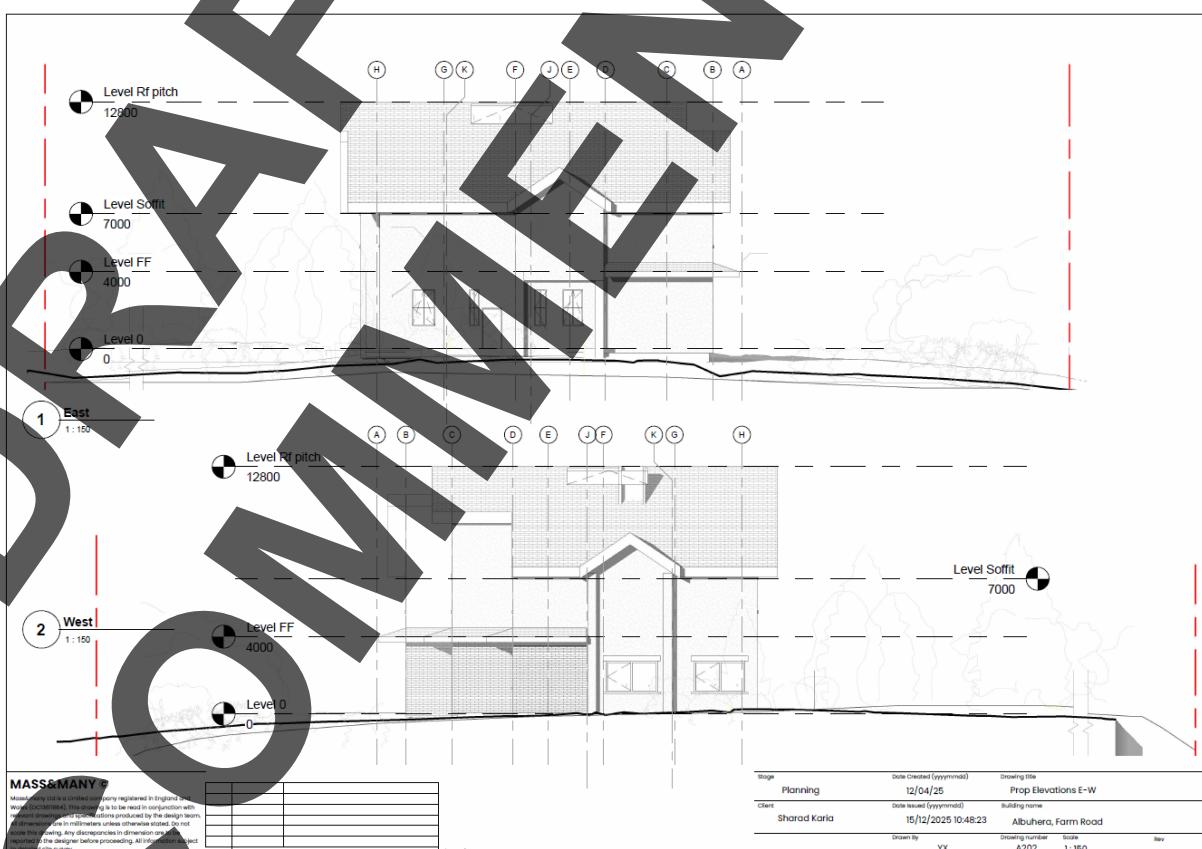


Figure 2.7 – Right and Left Side Elevations

### 3.0 Energy Statement

#### 3.1 The Energy Hierarchy

To address energy efficiency the design team have adopted the energy hierarchy. The energy hierarchy is generally accepted as the most effective way of reducing a buildings' carbon emissions.

1. Be Lean: use less energy
2. Be Clean: supply energy efficiently
3. Be Green: use renewable energy
4. Be Seen: monitor, verify and report on energy performance

Development proposals should:

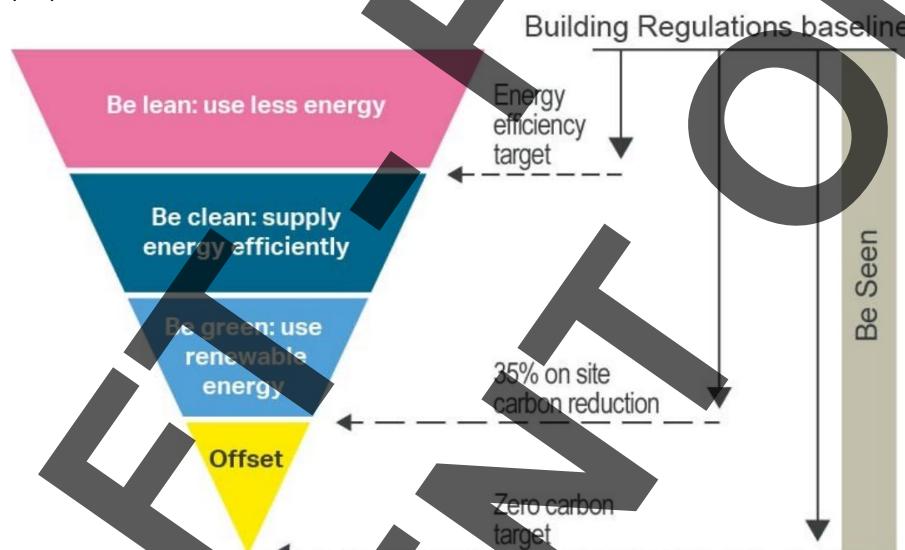


Figure 3.1: The Energy Hierarchy

- ***Reducing energy demand***

The first step in the process of reducing the overall energy used and CO<sub>2</sub> produced by the building is to minimise the energy required to heat it. A well-insulated building envelope and passive design will reduce the energy requirement for heating and ventilating the building.

- ***Energy efficient systems***

The second step is to specify services and controls, lighting and appliances that are energy efficient and which result in further reduction in energy requirements.

- ***Making use of Low or zero-carbon (LZC) technologies***

When the energy demand has been reduced by implementing the processes of improving the fabric and energy efficiency, then LZC technologies can be employed to reduce the environmental impact of the remaining energy consumption.

- ***Monitoring and reporting***

Ensure comprehensive monitoring and reporting of energy demand and carbon emissions. Major developments are required to undertake this process for at least five years.

## 3.2 Calculating Baseline Energy Demand

The first step is to calculate a Building Regulations Part L1 2021 compliant specification to establish baseline emissions for the development. Calculated energy data using the government's approved methodology, SAP10.2, has been used to establish baseline energy requirements which comply with the 2021 edition of Part L standards.

The baseline emissions and energy consumption figures have been taken from the Part L1 TER 'Be Green' calculation. The result of this can be found in Table 3.1 below and full details (SAP Worksheets) can be found in Appendix 2.

**Table 3.1: 'Baseline' energy use and carbon emissions**

	Regulated Energy Consumption (kWh per annum)	Regulated CO <sub>2</sub> Emissions (Tonnes per annum)	Regulated CO <sub>2</sub> savings	
	(Tonnes per annum)	(%)		
Baseline	33,325.40	7.9		

## 3.3 'Be Lean' – Building Fabric Improvements

The first step of the energy hierarchy looks at reducing energy consumption in the building through improvements to its fabric. This reduces the energy required to run the building and thus the emissions associated with that energy use.

The new 2021 Part L is already very stringent in terms of fabric performance targets; thus, it can be difficult to achieve further improvements over the fabric specification used for the 'Notional Building'. As such, further opportunities for improvement to the building fabric and services beyond those which meet the current 2021 Building Regulations requirements can be very limited. However, some further improvements are possible by considering the following steps:

- An improved building fabric over the Part L requirements.
- Reduced air permeability to lower heat loss from uncontrolled ventilation.
- Specification of MVHR to limit heat loss from uncontrolled ventilation.

The full specification used for modelling at this stage of the energy hierarchy can be found in Table 3.2, below.

**Table 3.2: 'Be Lean' Specification**

Element	Specification
External Walls	0.18W/m <sup>2</sup> K
Sloped Roof	0.12W/m <sup>2</sup> K
Plane Roof	0.12W/m <sup>2</sup> K
Ground Floor	0.10W/m <sup>2</sup> K
Exposed Floor	0.15W/m <sup>2</sup> K
Windows & Solid Door	1.00W/m <sup>2</sup> K
Roof Windows	1.20W/m <sup>2</sup> K
Thermal Bridging	Representative details for masonry cavity wall construction
Air Permeability	2.50m <sup>3</sup> /m <sup>2</sup> /hr@50pa
Ventilation	MVHR
Lighting	LED lamps throughout
Space Heating	Mains gas combi boiler
DHW	From main heating system with wastewater heat recovery system
LZC Technology	PV as per 'notional building'

The 'Be Lean' carbon dioxide emissions and energy consumption figures as taken from the SAP10.2 model for the above specification are shown in Table 3.3, below, and the SAP worksheets can be found in Appendix 1.

Table 3.3: 'Be Lean' energy use and carbon emissions

	Regulated Energy Consumption (kWh per annum)	Regulated CO <sub>2</sub> Emissions (Tonnes per annum)	Regulated CO <sub>2</sub> savings	
			(Tonnes per annum)	(%)
Baseline	33,325.40	7.9		
Be Lean	26,303.61	5.9	2.0	25%

### 3.4 'Be Clean' – Communal Heating & CHP

Policy DMEI3 of the Hillingdon Development Management Policies and Policy SI3 of the London Plan require that new developments should seek to connect to an existing or proposed district heating network. As Figure 3.2 demonstrates, there are currently no confirmed existing or proposed heat networks directly around the proposed development. In fact, the closest district heat network is just over 8km away from the proposed development.

It would also not be viable to introduce a communal heating system into this development since its small scale would result in significant inefficiencies in the utilisation of CHP and provision of an energy centre for surrounding buildings. As such, a standalone heating system will be required.

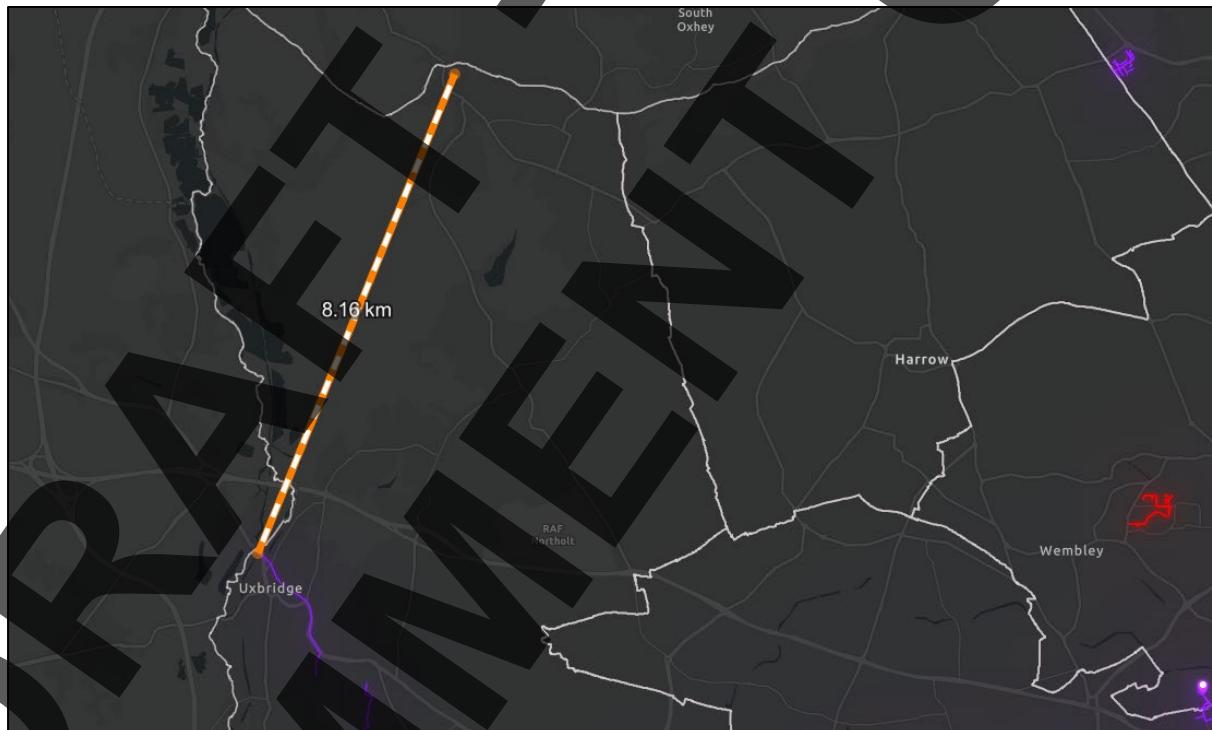


Figure 3.2: London Heat Map – Farm Road

Table 3.4, below, shows the performance following the 'Be Clean' stage of the energy hierarchy.

Table 3.4: 'Be Clean' energy use and carbon emissions

	Regulated Energy Consumption (kWh per annum)	Regulated CO <sub>2</sub> Emissions (Tonnes per annum)	Regulated CO <sub>2</sub> savings	
			(Tonnes per annum)	(%)
Baseline	33,325.40	7.9		
Be Lean	26,303.61	5.9	2.0	25%
Be Clean	26,303.61	5.9	0.0	0%

### 3.5 'Be Green' – CO<sub>2</sub> Reduction Through the Use of LZC Technologies

This section will examine the available renewable energy generation technologies and determine which is most appropriate for the proposed development.

#### Available Renewable Generation Technologies

Energy resources accepted as renewable or low carbon technologies are defined by the Department of Energy and Climate Change Low Carbon Buildings Program as:

- Solar photovoltaics
- Wind turbines
- Small hydro
- Solar thermal hot water
- Ground source heat pumps
- Air source heat pumps
- Bioenergy
- Renewable CHP
- Micro CHP (Combined heat and power)

#### Solar Photovoltaics

Solar panel electricity systems, also known as solar photovoltaics (PV), capture the sun's energy using photovoltaic cells. These cells do not need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run household appliances and lighting. When excess power is generated, this can be sold back to the grid or stored on-site.



PV panels would be highly suitable for the sloped roof of this development, particularly the south-east and south-west facades. At this moment in time, they have not been specified for the proposed development, and the development achieves a 56% reduction in carbon emissions without them which suffices the 35% target in the London Plan 2021; future installation of PV panels would provide further reductions, however.

#### Wind Turbines

Wind turbines harness the power of the wind and use it to generate electricity. 40% of all the wind energy in Europe blows over the UK, making it an ideal country for domestic turbines.



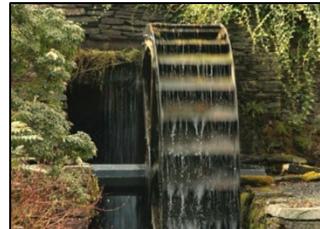
The suburban nature of the site means that a wind turbine cannot be recommended as a viable option for this development. There are also general issues surrounding the use of building mounted turbines with the potential of excessive noise and vibration within the building, as well as the effect of flicker on surrounding buildings and amenity spaces.

**Table 3.5: Average Wind Speeds**

45m above ground level	6.4m/s
25m above ground level	5.8m/s
10m above ground level	5.2m/s

#### Small Hydro Generation

Hydroelectricity generation uses running water to generate electricity, whether from a small stream or larger river. All streams and rivers flow downhill, gaining potential energy because of their height. Hydropower systems convert this potential energy into kinetic energy in a turbine, which drives a generator to produce electricity. Small, or 'micro' hydro generation requires a reliable source of flowing water with a reasonably constant flow velocity. Systems of this nature are normally installed in locations with a natural moving water source such as a



river, stream or spring where part of the flow can be diverted through a generator.

There is no such source of flowing water in this case therefore small hydro generation is not an option for this development.

### Solar Water Heating

Solar water heating systems use free heat from the Sun to warm domestic hot water. They can potentially generate large proportions of a building's annual DHW requirement. However, this technology needs sufficient roof space for the panels as well as complex pipework along the side of the property. Space within the buildings is also required for a DHW cylinder as this is required to store the heated water, and the associated pumps and control units.



For this development, the available roof space would be more effectively utilised by installing PV panels rather than solar thermal system. As technology progresses, it has become increasingly viable to use electricity generated from solar PV to power water heating systems which offer greater flexibility and less maintenance-intensive infrastructure than solar hot water systems. As such, solar water heating is not considered to be a suitable technology for use on this development.

### Heat Pumps

Heat pumps operate on the same principle as refrigerators in reverse, using a refrigerant to extract heat from a source and convert it into useful energy. Common sources include the ground, air, or water.

- *Ground source heat pumps* (GSHPs) use a long circuitous pipe through which a refrigerant is pumped, this is buried in a series of horizontal trenches or in deep vertical boreholes (up to 200m) to gather heat.
- *Water source heat pumps* (WSHPs) use a similar system, either floated or submerged in bodies of water.
- *Air source heat pumps* (ASHPs) have a refrigerant coil mounted outside the building through which air is passed so that heat can be extracted.



All three types generally use the collected heat to heat water which can then be used for space heating and domestic hot water (DHW). While they require electricity to run, their efficiency is high – typically producing 2.5 times the energy they consume, equating to 250% or greater efficiency.

The installation of an air source heat pump (ASHP) on the proposed development has been concluded as a viable LZC energy solution. ASHPs are compact and straightforward to install, making them particularly well-suited to properties with limited internal or external space. Their ability to efficiently extract heat from the ambient air – even in colder conditions – ensures reliable year-round heating and hot water. This technology also supports improved energy performance and contributes to the overall sustainability of the development.

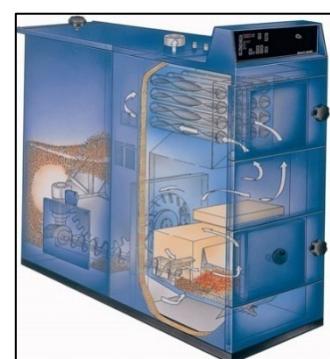
### Bioenergy

Biomass, also known as bioenergy or biofuels, is derived from organic materials such as plants, animal waste, and industrial by-products. It falls into two categories:

- *Woody biomass* – forest products, untreated wood, and energy crops (e.g. willow).
- *Non-woody biomass* – animal waste, food processing by-products, high energy crops (e.g. maize and sugar cane).

For domestic or small commercial use, biomass typically comes in the form of wood pellets, chips, or logs. It is used in:

- *Stoves* – to heat a single room and fuelled by logs or pellets. Generally, they are 5-11kW in output, and some include a back boiler for water heating.
- *Boilers* – to be integrated into the central heating and hot water systems. These are fuelled by pellets, logs, or chips, and are generally larger than 15kW in output.



This technology is dismissed as viable due to the space requirements needed for the boiler and pellet store which make it impractical for the properties on this site.

### **'Be Green' Modelled Performance**

As identified above, an ASHP has been identified as the most suitable technology for this development. Use of ASHPs for space heating will provide a large improvement in the overall energy consumption and, therefore, carbon emissions associated with the development.

The full specification used for modelling at this stage of the energy hierarchy can, therefore, be found in Table 3.6, below.

**Table 3.6: 'Be Green' Specification**

Element	Specification
External Walls	0.18W/m <sup>2</sup> K
Sloped Roof	0.12W/m <sup>2</sup> K
Plane Roof	0.12W/m <sup>2</sup> K
Ground Floor	0.10W/m <sup>2</sup> K
Exposed Floor	0.15W/m <sup>2</sup> K
Windows & Solid Door	1.00W/m <sup>2</sup> K
Roof Windows	1.20W/m <sup>2</sup> K
Thermal Bridging	Representative details for masonry cavity wall construction
Air Permeability	2.50m <sup>3</sup> /m <sup>2</sup> /hr@50pa
Ventilation	MVHR
Lighting	LED lamps throughout
Space Heating	ASHP
DHW	From main heating system
LZC Technology	N/A

The improved 'Be Green' carbon dioxide emissions and energy consumption figures as taken from the SAP10.2 model for the above specification are shown in Table 3.7, below, and the SAP worksheets can be found in Appendix 2.

**Table 3.7: 'Be Green' energy use and carbon emissions**

	Regulated Energy Consumption (kWh per annum)	Regulated CO <sub>2</sub> Emissions (Tonnes per annum)	Regulated CO <sub>2</sub> savings	
			(Tonnes per annum)	(%)
Baseline	33,325.40	7.9		
Be Lean	26,303.61	5.9	2.0	25%
Be Clean	26,303.61	5.9	0.0	0%
Be Green	23,517.46	3.5	2.4	31%
<b>Cumulative on-site savings</b>	<b>9,807.94</b>		<b>4.4</b>	<b>56%</b>

## 3.6 M & E Specification Information

### **Heat Pump Details**

Paragraph 10.9 of the GLA Energy Assessment Guidance (June 2022) document requires that specific information is provided when Heat Pumps are proposed for a development.

### SCOP/SEER

For the purposes of this report the 'Be Green' modelling has used the SAP 'Default' efficiency for an ASHP of 170%, as there is no detailed design yet undertaken.

Although no detailed design work has been undertaken – and this will need to be done subsequent to this report by a suitably qualified designer – a suitable unit, such as the Mitsubishi Ecodan, should be able to deliver the modelled performance for this scale of development. Information relating to these units (including SCOP & MCS accreditation) can be found in Appendix 3 to this report.

### Integration with other heating/cooling technologies

No other heating technologies are proposed for this development – it is proposed that 100% of the space heating demand for the entire development will be provided by the ASHP.

The DHW will also be provided by the ASHP through the heating of a dedicated cylinder in the properties. This will be provided with an immersion backup and the impact of this has been modelled through the SAP calculations.

### Installation & minimum efficiencies

The proposed location of the external condenser would be to the front of the building in the patio space. Although no specific heat pump has been specified at this stage, the dimensions of the condenser would be expected to be no larger than those of a Mitsubishi Ecodan. Full details of this, in terms of the manufacturer's data sheet and confirmation of the MCS certification can also be found in Appendix 3 to this report.

### Information Provision

Full details of the installation, controls, instructions for operation and details of the required maintenance regime will be provided to the occupants via the Home User Guide.

## 3.7 EUI, space heating demand & FEES

As required by the June 2022 updated guidance for the production of energy statements, the Energy Use Intensity (EUI), space heating demand and FEES performance should all be calculated and documented as part of the Energy Statement.

For this report all of these have been calculated using the same SAP models as the energy and CO<sub>2</sub> consumption. This information can be found in Table 3.8, below.

Table 3.8: EUI, space heating demand & FEES

Building Type	Energy Use Intensity (kWh/m <sup>2</sup> /year, excluding renewable energy)	Space Heating Demand (kWh/m <sup>2</sup> /year, excluding renewable energy)	Design Fabric Energy Efficiency (FEES)
Residential	63.4	53.8	83.73
Target	35.0	15.0	83.92

### FEES

The figures in the above table are taken directly from the compliance figures from the 'Be Green' SAP worksheets provided as Appendix 2 to this report. This is around a less than 1% improvement over the target of Part L 2021.

### EUI

Energy Use Intensity (EUI) is defined as an annual measure of the total energy consumed within a building. This, therefore, is the total of both regulated and unregulated energy consumption. However, it does not include energy used for electric vehicle charging or any reductions due to on-site renewable energy generation. This total is then divided by the Gross Internal Area (GIA) to be expressed in kWh/m<sup>2</sup>/year.

The regulated energy consumption for the proposed development has been taken from the 'Be Green' SAP Worksheet provided in Appendix 2 to this report. This equates to 23,517kWh/year for all regulated energy uses (space heating, DHW heating, lighting and ventilation).

The unregulated energy consumption, as per Section 3.2 of this report, has been calculated using SAP10.2 Appendix L equations L13 and L20. This comes to a total of 7,008kWh/year. Adding this to the regulated energy as calculated above gives a total of 30,525kWh/year – and accounts for all unregulated energy used for cooking, appliances and small power. This equates to an EUI of 63.4kWh/m<sup>2</sup>/year.

It should be noted that the targets for these metrics (both EUI and Space Heating Demand) are based on modelling using the PassivHaus Planning Package. This uses a different set of modelling conventions, as well as producing a different set of performance figures even for the same building – particularly when it comes to the unregulated energy. For the proposed development the predicted unregulated energy, as calculated using SAP10.2, gives an EUI of 14.5 which makes the target of 35.0 for all energy consumption seem difficult to achieve when using SAP as the modelling approach.

#### **Space Heating Demand**

The space heating demand of the flats has been taken directly from Box 99 (Space Heating Requirement) of the DER calculations in the 'Be Green' SAP worksheet as provided in Appendix 2 to this report.

## 4.0 Running Costs

Section 3 of this report has identified the proposed energy strategy for the development. This section of the report will detail the steps that have been taken to protect the individual occupants/consumers from high energy costs.

In line with the energy hierarchy the proposed development has prioritised energy demand reduction as the main means by which this will be done. The proposed specification at the 'Be Lean' stage of the energy hierarchy exceeds the requirements of the 2021 Part L by 25%. This will ensure that the energy consumption of the properties within the development is reduced, limiting the impact of any price rises or energy cost increases in future.

No communal heating system has been specified for this development. The use of these systems can lock building occupants into restrictive contracts for space heating, where there is no ability for occupants to 'shop around' for different suppliers. In addition, there is sometimes no ability for occupants to even turn off heating systems, depending on the specific billing arrangements. Ensuring that each unit has an individual electricity connection and meter gives the occupants the greatest flexibility to use only the energy they require and access the most competitive energy tariffs available on the market.

## 5.0 Overheating

The expected risk of overheating associated with the proposed development has been assessed using the Good Homes Alliance Overheating Risk Tool. The completed tool can be found in Appendix 4, but a summary of the key factors increasing the risk of overheating for the proposed development can be found below:

- *The site is in the Southeast of England.*
- *The site is in Greater London.*
- *While all windows are able to be opened in the day, only bedroom windows are openable at night for security reasons.*
- *The dwelling is not a flat.*
- *There is no communal heating system set up for this scheme.*
- *The estimated glazing ratio for the east-, south-, and west-facing facades is less than 35%.*
- *The dwelling is dual aspect.*

Similarly, the counterbalancing factors that reduce the likelihood of overheating can be found in Appendix 4, but a summary of those proposed for the development can be found below:

- *The site surroundings feature significant blue/green infrastructure.*
- *The window and openings support effective ventilation.*

The result of this is that the GHA tool estimates a low likelihood of overheating. As this proposed development will fall under the new 2021 Part O of the Building Regulations, more detailed design work will need to be undertaken post-planning to further reduce this risk to ensure that compliance is achieved with Part O.

## 6.0 Water Consumption

Water is a precious commodity even in the UK and with ever increasing demand for clean drinking water measures need to be taken to safeguard future supplies.

Approximately 50% of the water consumed in domestic dwellings is not used for consumption, but for activities like washing and toilet flushing etc. Measures to reduce the amount of potable water used for these activities reduce the demand for potable water and make better use of this limited resource.

In line with the requirement of policy DMEI15 of the Hillingdon Development Management Policies document 2014 and Policy SI5 of the London Plan 2021, water use in residential units should be reduced to 110 per litres per person per day (which includes 5 litres/person/day for external water use). This reduction in water use will be achieved through specification of water use fittings that do not exceed the following flow rates.

Taps (other than kitchen taps)  
Kitchen Taps  
Showers  
Baths (with shower over)  
WCs (Flush Volume)  
  
Washing Machine  
Dishwasher

4.00(litres/min)  
8.00(litres/min)  
9.00(litres/min)  
170(litres to overflow)  
4.00(litres)  
2.60(litres)  
8.17(litres/kg dry load)  
1.25(litres/place setting)

For full details of the consumption of this specification please see Appendix 5 to this report.

## Appendix 1

'Be Lean' SAP Worksheets



# Full SAP Calculation Printout

Plot Reference	Farm Road	Issued on Date	24/11/2025
Assessment Reference	Be Lean	Plot Type Ref	Farm Road
Plot Address	Farm Road, Northwood, HA6 2NZ	SAP Version	10.2
SAP Rating	96 A	DER	12.31
Environmental	85 B	% DER < TER	24.94
CO <sub>2</sub> Emissions (t/year)	5.09	DFEE	83.73
Compliance Check	See BREL	% DFEE < TFEE	0.23
% DPER < TPER	34.60	DPER	57.87
Assessor Details	Mr. Andrew Taylor	TPER	88.48
Client		Assessor ID	P741-0001

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

## 1. Overall dwelling characteristics

Main dwelling  
Ground floor  
First floor  
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)  
Dwelling volume

	Area (m <sup>2</sup> )	Storey height (m)	Volume (m <sup>3</sup> )
236.3700 (1b)	x 3.8600 (2b)	= 912.3882 (1b) - (3b)	
245.3900 (1c)	x 7.9600 (2c)	= 1953.3044 (1c) - (3c)	
(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 2865.6926 (5)	(4)	

## 2. Ventilation rate

Number of open chimneys  
Number of open flues  
Number of chimneys / flues attached to closed fire  
Number of flues attached to solid fuel boiler  
Number of flues attached to other heater  
Number of blocked chimneys  
Number of intermittent extract fans  
Number of passive vents  
Number of flueless gas fires

	m <sup>3</sup> per hour
0 * 80 =	0.0000 (6a)
0 * 20 =	0.0000 (6b)
0 * 10 =	0.0000 (6c)
0 * 20 =	0.0000 (6d)
0 * 35 =	0.0000 (6e)
0 * 20 =	0.0000 (6f)
0 * 10 =	0.0000 (7a)
0 * 10 =	0.0000 (7b)
0 * 40 =	0.0000 (7c)
Air changes per hour	
0.0000 / (5) =	0.0000 (8)
Yes	
Blower Door	
2.5000 (17)	
0.1250 (18)	
0 (19)	

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =

Pressure test  
Pressure Test Method  
Measured/design AP50  
Infiltration rate  
Number of sides sheltered

	Air changes per hour
0.0000 / (5) =	0.0000 (8)
Yes	
Blower Door	
2.5000 (17)	
0.1250 (18)	
0 (19)	

Shelter factor  
Infiltration rate adjusted to include shelter factor

(20) = 1 - [0.075 x (19)] =	1.0000 (20)
(21) = (18) x (20) =	0.1250 (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	1.1900	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj inflit rate	0.1594	0.1562	0.1531	0.1375	0.1344	0.1187	0.1187	0.1156	0.1250	0.1344	0.1406	0.1469 (22b)

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

Effective ac 0.2589 0.2557 0.2526 0.2370 0.2339 0.2182 0.2182 0.2151 0.2245 0.2339 0.2401 0.2464 (25)

## 3. Heat losses and heat loss parameter

Element	Gross m <sup>2</sup>	Openings m <sup>2</sup>	NetArea m <sup>2</sup>	U-value W/m <sup>2</sup> K	A x U W/K	K-value kJ/m <sup>2</sup> K	A x K kJ/K
Main dwelling							
Windows			121.1400	0.9615	116.4808		(27)
Solid Door			6.7800	1.0000	6.7800		(26)
Rooflight			12.6000	1.1450	14.4275		(27a)
Ground Floor			236.3700	0.1000	23.6370	75.0000	17727.7500 (28a)
Floor-to-Garage			25.7600	0.1357	3.4968	20.0000	515.2000 (28b)
Exposed Floor			3.7100	0.1500	0.5565	20.0000	74.2000 (28b)
External Walls	706.6500	127.9200	578.7300	0.1800	104.1714	150.0000	86809.5000 (29a)
Wall-to-Garage	43.0400		43.0400	0.1600	6.8864	150.0000	6456.0000 (29a)
Sloped Roof	285.3500	12.6000	272.7500	0.1200	32.7300	9.0000	2454.7500 (30)
Plane Roof	20.4400		20.4400	0.1200	2.4528	9.0000	183.9600 (30)
Total net area of external elements Aum(A, m <sup>2</sup> )			1321.3200				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		311.6192		(33)
Main dwelling							
Internal Walls - GF			393.1000			9.0000	3537.9000 (32c)

# Full SAP Calculation Printout

Internal Walls - FF	1181.0500	9.0000	10629.4500 (32c)									
Internal Floor - FF	215.9200	18.0000	3886.5600 (32d)									
Internal Ceiling - GF	215.9200	9.0000	1943.2800 (32e)									
$(28) \dots (30) + (32) + (32a) \dots (32e) = 134018.5500 (34)$												
$278.6004 (35)$												
Heat capacity Cm = Sum(A x k)												
Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K												
List of Thermal Bridges												
K1 Element	Length	Psi value	Total									
E2 Other lintels (including other steel lintels)	63.9200	0.3120	19.9430									
E3 Sill	53.8700	0.0210	1.1313									
E4 Jamb	140.1800	0.0160	2.2429									
E5 Ground floor (normal)	74.1200	0.1120	8.3014									
E20 Exposed floor (normal)	16.0300	0.3200	5.1296									
E21 Exposed floor (inverted)	14.2800	0.3200	4.5696									
E6 Intermediate floor within a dwelling	45.3500	0.0020	0.0907									
E11 Eaves (insulation at rafter level)	23.9200	0.0180	0.4306									
E13 Gable (insulation at rafter level)	49.7200	0.0610	3.0329									
E10 Eaves (insulation at ceiling level)	51.7900	0.0650	0.3764									
E12 Gable (insulation at ceiling level)	8.6600	0.0970	0.8400									
E16 Corner (normal)	103.4300	0.0510	5.2749									
E17 Corner (inverted - internal area greater than external area)	66.1900	-0.0910	-6.0233									
E24 Eaves (insulation at ceiling level - inverted)	5.5100	0.1500	0.8265									
R4 Ridge (vaulted ceiling)	20.2000	0.0000	0.0000									
R5 Ridge (inverted)	12.5900	0.1200	1.5108									
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			47.6773 (36)									
Point Thermal bridges			(36a) = 0.0000									
Total fabric heat loss			(33) + (36) + (36a) = 359.2965 (37)									
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Sep	Oct	Nov	Dec
(38)m 244.8125	241.8573	238.9020	224.1258	221.1706	206.3943	206.3943	203.4391	212.3048	221.1706	227.0811	232.9916 (38)	
Heat transfer coeff												
604.1090	601.1538	598.1985	583.4223	580.4671	565.6908	565.6908	562.7356	571.6013	580.4671	586.3776	592.2881 (39)	
Average = Sum(39)m / 12 =												582.6835
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP (average)	1.2540	1.2478	1.2417	1.2110	1.2043	1.1742	1.1742	1.1681	1.1065	1.2049	1.2172	1.2294 (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												3.3682 (42)
Hot water usage for mixer showers												
116.6801 114.9267	112.3715	107.4827	103.8748	99.8514	97.5645	100.1003	102.8800	107.2000	112.1938	116.2331 (42a)		
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (42b)	
Hot water usage for other uses	49.1239 47.3346	46.5513	43.7649	41.9786	40.1923	40.1923	41.9786	43.7649	45.5513	47.3376	49.1239 (42c)	
Average daily hot water use (litres/day)												152.2333 (43)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	165.8041	162.2643	157.9228	151.2476	145.8535	140.0437	137.7568	142.0789	146.6450	152.7513	159.5314	165.3570 (44)
Energy conte	262.5931	231.0622	242.7214	207.0504	196.3468	172.2001	166.5049	175.9234	180.8279	207.2820	227.2818	258.9091 (45)
Energy content (annual)												Total = Sum(45)m = 2528.8032
Distribution loss (46)m = 0.15 x (45)m	39.3890	34.6593	36.4082	31.0576	29.4520	25.8300	24.9907	26.3885	27.1242	31.0923	34.0923	38.8364 (46)
Water storage loss (or HIU loss)												250.0000 (47)
Store volume												2.2200 (48)
a) If manufacturer declared loss factor is known (kWh/day):												0.5400 (49)
Temperature factor from Table 2b												1.1988 (55)
Enter (49) or (54) in (55)												
Total storage loss	37.1628	33.5664	37.1628	35.9640	37.1628	35.9640	37.1628	37.1628	35.9640	37.1628	35.9640	37.1628 (56)
If cylinder contains solar storage												
37.1628 33.5664	37.1628	35.9640	37.1628	35.9640	37.1628	37.1628	35.9640	37.1628	35.9640	37.1628	35.9640	37.1628 (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												
323.0183 285.6398	303.1466	265.5264	256.7720	230.6761	227.0301	236.3486	239.3039	267.7072	285.7578	319.3343 (62)		
WWHRS	-78.5423	-69.4635	-72.7382	-60.2301	-56.1323	-48.0328	-45.0231	-47.8775	-49.6966	-58.5868	-66.3717	-77.0878 (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	244.1760	216.1763	230.4085	205.2964	200.6397	182.6433	182.0070	188.4711	189.6074	209.1205	219.3861	242.2465 (64)
12 Total per year (kWh/year)												Total per year (kWh/year) = Sum(64)m = 2510.4787 (64)
Electric shower(s)	0.0000	0.0000	0.0600	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	135.6524	120.4902	129.0450	115.6251	113.6255	104.0373	103.7363	106.8347	106.9061	117.2614	122.3520	134.4274 (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 168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	299.0478	331.0887	299.0478	309.0161	299.0478	309.0161	299.0478	299.0478	309.0161	299.0478	309.0161	299.0478 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	592.8957	599.0181	583.5443	550.5384	508.8744	469.7162	443.5560	437.4036	452.9075	485.9133	527.5773	566.7356 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411 (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)	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287 (71)
Water heating gains (Table 5)	182.3285	179.3010	173.4476	160.5904	152.7224	144.4963	139.4305	143.5950	148.4807	157.6094	169.9333	180.6820 (72)
Total internal gains	1150.7953	1185.9610	1132.5630	1096.6681	1037.1679	996.7518	955.5576	953.5697	983.9275	1019.0939	1083.0500	1122.9887 (73)

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## 6. Solar gains

[Jan]	Area m <sup>2</sup>	Solar flux Table 6a W/m <sup>2</sup>	Specific data or Table 6b g	Specific data or Table 6c FF	Access factor Table 6d	Gains W
North	38.4000	10.6334	0.4000	0.7000	0.7700	79.2308 (74)
East	10.4000	19.6403	0.4000	0.7000	0.7700	39.6344 (76)
South	55.4900	46.7521	0.4000	0.7000	0.7700	503.3926 (78)
West	16.8500	19.6403	0.4000	0.7000	0.7700	64.2153 (80)
East	6.3000	26.6072	0.4000	0.7000	1.0000	42.2416 (82)
West	6.3000	26.6072	0.4000	0.7000	1.0000	42.2416 (82)
<b>Solar gains</b>	<b>770.9563</b>	<b>1349.7941</b>	<b>1937.1491</b>	<b>2540.4151</b>	<b>2965.3566</b>	<b>2994.4857</b>
<b>Total gains</b>	<b>1921.7516</b>	<b>2535.7552</b>	<b>3069.7121</b>	<b>3637.0832</b>	<b>4002.5245</b>	<b>3991.2375</b>

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)											
Utilisation factor for gains for living area, mil, m (see Table 9a)											
Jan	61.7156	62.0190	62.3253	63.9038	64.2292	65.9069	65.9069	66.2530	66.2254	64.2292	63.5818
tau	5.1144	5.1346	5.1550	5.2603	5.2819	5.3938	5.3938	5.4169	5.3484	5.2819	5.2388
alpha											
util living area	0.9998	0.9992	0.9969	0.9850	0.9372	0.7997	0.6273	0.6962	0.9221	0.9940	0.9995
MIT	19.3619	19.5655	19.8718	20.2976	20.6669	20.9129	20.9813	20.9686	20.7854	20.2890	19.7613
Th 2	19.8771	19.8819	19.8868	19.9112	19.9161	19.9407	19.9407	19.9456	19.9368	19.9161	19.9063
util rest of house	0.9998	0.9989	0.9956	0.9776	0.9046	0.7077	0.4888	0.5586	0.8677	0.9902	0.9993
MIT 2	18.3750	18.5822	18.8916	19.3317	19.6838	19.9007	19.9363	19.9370	19.8057	19.3304	18.7969
Living area fraction											
MIT	18.6783	18.8844	19.1929	19.5286	19.9860	20.2118	20.2575	20.2541	20.1068	19.6250	19.0933
Temperature adjustment											
adjusted MIT	18.5283	18.7344	19.0429	19.4786	19.8360	20.0618	20.1075	20.1041	19.9568	19.4750	18.9433

## 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9996	0.9984	0.9941	0.9736	0.9015	0.7196	0.5118	0.5810	0.8694	0.9878	0.9989	0.9998 (94)
Useful gains	1921.0492	2531.7940	3051.5369	3541.0648	3608.4322	2871.9173	1955.9231	2031.4084	2721.0296	2505.0786	2011.1243	1777.8431 (95)
Ext. temp.	4.3000	4.9040	6.5000	8.9000	11.7000	14.8000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	8595.4502	8316.6251	7503.1185	6171.8027	4722.6674	3089.6974	1984.1507	2084.4239	3347.7461	5151.6602	6944.6719	8488.1088 (97)
Space heating kwh	4965.7543	3887.4065	3311.9767	1894.1313	828.9910	0.0000	0.0000	0.0000	0.0000	1969.0567	3552.1543	4992.4377 (98a)
Space heating requirement - total per year (kWh/year)												25401.9085
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	4965.7543	3887.4065	3311.9767	1894.1313	828.9910	0.0000	0.0000	0.0000	0.0000	1969.0567	3552.1543	4992.4377 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												25401.9085
Space heating per m <sup>2</sup>												(98c) / (4) = 52.7273 (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 %)												88.9000 (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	4965.7543	3887.4065	3311.9767	1894.1313	828.9910	0.0000	0.0000	0.0000	0.0000	1969.0567	3552.1543	4992.4377 (98)
Space heating efficiency (main heating system 1)	88.9000	88.9000	88.9000	88.9000	88.9000	0.0000	0.0000	0.0000	0.0000	88.9000	88.9000	88.9000 (210)
Space heating fuel (main heating system)	5585.7754	4372.7857	3725.5081	2130.6314	932.4983	0.0000	0.0000	0.0000	0.0000	2214.9120	3995.6741	5615.7904 (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	244.4760	216.1763	230.4085	205.2964	200.6397	182.6433	182.0070	188.4711	189.6074	209.1205	219.3861	242.2465 (64)
Efficiency of water heated (217)m	88.3803	88.3170	88.1812	87.8238	86.7808	79.0000	79.0000	79.0000	79.0000	87.8431	88.2567	88.3874 (217)
Fuel for water heating, kWh/month	274.6182	244.7732	261.2897	233.7594	231.2029	231.1941	230.3887	238.5710	240.0094	238.0612	248.5774	274.0735 (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 (221)
Pumps and Fa	493.5317	445.7005	493.5317	477.6113	493.5317	477.6113	493.5317	493.5317	477.6113	493.5317	477.6113	493.5317 (231)
Lighting	81.0056	64.9857	58.5124	42.8687	33.1130	27.0536	30.2068	39.2639	51.0000	66.9147	75.5800	83.2569 (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 (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 (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 (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 (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 (233b)

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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)
(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												28573.5753 (211)
Space heating fuel - main system 2												0.0000 (213)
Space heating fuel - secondary												0.0000 (215)
Efficiency of water heater												79.0000
Water heating fuel used												2948.5186 (219)
Space cooling fuel												0.0000 (221)
Electricity for pumps and fans:												
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.6375)												
mechanical ventilation fans (SFP = 1.6375)												
central heating pump												5724.9374 (230a)
main heating flue fan												41.0000 (230c)
Total electricity for the above, kWh/year												45.0000 (230e)
Electricity for lighting (calculated in Appendix L)												5810.3374 (231)
Energy saving/generation technologies (Appendices M ,N and Q)												653.7612 (232)
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												-11683.1795 (236)
Energy used												0.0000 (237)
Total delivered energy for all uses												26303.6130 (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	28573.5753	0.2100	6000.4508 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2948.5186	0.2100	619.1889 (264)
Space and water heating			6619.6397 (265)
Pumps, fans and electric keep-hot	5810.9374	0.1387	806.0487 (267)
Energy for lighting	653.7612	0.1443	94.3579 (268)
Appendix Q item 'PV' - energy saved	-9999.0000	0.1360	-1359.8640 (270)
Appendix Q item 'PV' - energy used	0.0000	0.0000	0.0000 (271)
Appendix Q item 'PV' - energy saved	-1684.1795	0.1360	-229.0484 (270)
Appendix Q item 'PV' - energy used	0.0000	0.0000	0.0000 (271)
Total CO2, kg/year			5931.1339 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			12.3100 (273)

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

	Energy Primary energy factor kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	28573.5753	1.1300	32288.1401 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2948.5186	1.1300	3331.8260 (278)
Space and water heating			35619.9661 (279)
Pumps, fans and electric keep-hot	5810.9374	1.5128	8790.7861 (281)
Energy for lighting	653.7612	1.5338	1002.7608 (282)
Appendix Q item 'PV' - energy saved	-9999.0000	1.5010	-15008.4990 (284)
Appendix Q item 'PV' - energy used	0.0000	0.0000	0.0000 (285)
Appendix Q item 'PV' - energy saved	-1684.1795	1.5010	-2527.9534 (284)
Appendix Q item 'PV' - energy used	0.0000	0.0000	0.0000 (285)
Total Primary energy kWh/year			27877.0605 (286)
Dwelling Primary energy Rate (DPER)			57.8700 (287)

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

### 1. Overall dwelling characteristics

Main dwelling	Area (m <sup>2</sup> )	Storey height (m)	Volume (m <sup>3</sup> )
Ground floor	236.3700 (1b)	x 3.8600 (2b)	= 912.3882 (1b) - (3b)
First floor	245.3900 (1c)	x 7.9600 (2c)	= 1953.3044 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	481.7600		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 2865.6926 (5)

### 2. Ventilation rate

	m <sup>3</sup> 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)



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Total heat required for water heating calculated for each month													
296.9674	262.4716	278.4381	243.8373	235.7163	211.6936	208.4011	217.0585	219.8678	246.0255	262.6573	293.5945	(62)	
WWHRS	-47.4145	-41.9338	-43.9106	-36.3597	-33.8860	-28.9965	-27.1796	-28.9027	-30.0008	-35.3677	-40.0673	-46.5364	(61a)
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	(63a)
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	249.5529	220.5378	234.5275	207.4776	201.8304	182.6971	181.2215	188.1558	189.8670	210.6579	222.5900	247.0580	(64)
												2536.1735	(64)
												2536.1735	(64)
												2536.1735	(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)

Heat gains from water heating, kWh/month													
124.4106	110.4566	118.2496	105.9168	104.0446	95.2290	94.9623	97.8409	97.9470	107.4724	112.1744	123.2891	(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	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	299.0478	331.0887	299.0478	309.0161	299.0478	309.0161	299.0478	299.0478	309.0161	299.0478	309.0161	299.0478	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	592.8957	599.0481	583.5443	550.5384	508.8744	469.1162	443.5560	437.4036	452.9075	485.9133	527.5793	566.7356	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	(71)
Water heating gains (Table 5)	167.2185	164.3700	158.9376	147.1067	139.8449	132.2625	127.6375	131.5066	136.0344	144.4522	155.7978	165.7111	(72)
Total internal gains	1135.6853	1171.0301	1118.0530	1083.1844	1024.2904	984.5180	943.7646	941.4813	971.4843	1005.9366	1068.9145	1108.0178	(73)

## 6. Solar gains

[Jan]	Area m <sup>2</sup>	Solar flux Table 6a W/m <sup>2</sup>	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W						
North	32.6400	10.6334	0.6300	0.7000	0.7700	106.0703 (74)						
East	8.8600	19.6403	0.6300	0.7000	0.7700	53.1205 (76)						
South	47.1700	46.7521	0.6300	0.7000	0.7700	673.9668 (78)						
West	14.3100	19.6403	0.6300	0.7000	0.7700	85.8932 (80)						
East	5.3600	26.6072	0.6300	0.7000	1.0000	56.4982 (82)						
West	5.3500	26.6072	0.6300	0.7000	1.0000	56.4982 (82)						
Solar gains	1032.0472	1806.8760	2593.0464	3400.4627	3969.1903	4008.1524	3836.3400	3403.6069	2872.3389	2030.4358	1245.2845	877.1898 (83)
Total gains	2167.7325	2977.9060	3711.0984	4483.6471	4993.4807	4992.6704	4780.1046	4345.0882	3843.8231	3036.3724	2314.1990	1985.2076 (84)

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													
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	41.5468	41.6433	41.7384	42.1906	42.2763	42.6799	42.6799	42.7555	42.5235	42.2763	42.1033	41.9239	
util living area	3.7698	3.7762	3.7826	3.8127	3.8184	3.8453	3.8453	3.8504	3.8349	3.8184	3.8069	3.7949	
	0.9994	0.9979	0.9937	0.9785	0.9353	0.8559	0.6997	0.7610	0.9279	0.9901	0.9986	0.9996	(86)
MIT	18.6624	18.9121	19.3085	19.8454	20.3530	20.7397	20.9083	20.8705	20.5443	19.8704	19.1702	18.6316	(87)
Th 2	19.4264	19.4294	19.4323	19.4461	19.4487	19.4607	19.4607	19.4630	19.4561	19.4487	19.4435	19.4380	(88)
util rest of house	0.9992	0.9971	0.9907	0.9671	0.8957	0.7250	0.5013	0.5745	0.8642	0.9832	0.9979	0.9994	(89)
MIT 2	16.7571	17.0789	17.5873	18.2752	18.8937	19.3131	19.4365	19.4218	19.1325	18.3159	17.4188	16.7247	(90)
Living area fraction	0.9994	0.9979	0.9937	0.9785	0.9353	0.8559	0.6997	0.7610	0.9279	0.9901	0.9986	0.9996	(91)
MIT	17.3427	17.6424	18.1163	18.7578	19.3422	19.7516	19.8889	19.8671	19.5664	18.7936	17.9571	17.3108	(92)
Temperature adjustment	17.3427	17.6424	18.1163	18.7578	19.3422	19.7516	19.8889	19.8671	19.5664	18.7936	17.9571	17.3108	(93)

## 8. Space Heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9986	0.9854	0.9868	0.9598	0.8921	0.7505	0.5640	0.6325	0.8705	0.9785	0.9966	0.9990	(94)
Useful gains	2164.6674	2964.0843	3681.9622	4303.3317	4454.7707	3747.1284	2696.1398	2748.3768	3345.9487	2971.1240	2306.4243	1983.2168	(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	11704.1205	11408.1311	10376.2851	8711.1097	6739.5367	4500.1334	2872.9713	3023.2985	4792.7661	7225.8665	9614.0934	11659.4032	(97)
Space heating kWh	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827	(98a)
Space heating requirement - total per year (kWh/year)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827	(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)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827	(98c)
Space heating kWh	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827	(98c)
Space heating per m <sup>2</sup>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(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)

# Full SAP Calculation Printout

Efficiency of main space heating system 1 (in %)  
 Efficiency of main space heating system 2 (in %)  
 Efficiency of secondary/supplementary heating system, %

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (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)	7689.4400	6147.7784	5412.1953	3438.3534	1841.6749	0.0000	0.0000	0.0000	0.0000	3429.6083	5700.4569	7799.6562 (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	249.5529	220.5378	234.5275	207.4776	201.8304	182.6971	181.2215	188.1558	189.8670	210.6579	222.5900	247.0580 (64)	
Efficiency of water heater	(217)m	88.4611	88.4269	88.3532	88.1897	87.7497	79.0000	79.8000	79.8000	79.8000	88.1795	88.3954	89.8000 (216)
Fuel for water heating, kWh/month	282.1046	249.4013	265.4433	235.2630	230.0070	228.9438	227.0946	235.7842	237.9286	238.8967	251.8118	279.2596 (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 (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	62.1362	49.8480	44.8826	32.8829	25.3997	20.7518	23.1705	30.1178	39.1201	51.3277	57.9745	63.8632 (232)	
Electricity generated by PVs (Appendix M) (negative quantity)	(233)a)m	-173.0683	-223.1245	-293.3323	-300.3334	-300.4139	-271.6690	-267.3952	-262.7366	-252.9165	-238.8846	-182.1995	-152.1045 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	(234)a)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)	(235)a)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)	(233)b)m	-173.0239	-351.5016	-677.2953	-980.3629	-1280.7465	-1278.2876	-1264.0196	-1082.6297	-809.9412	-493.5496	-227.7503	-137.8931 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	(234)b)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)	(235)b)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												41459.1634 (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												2961.9385 (219)	
Space cooling fuel												0.0000 (221)	

Electricity for pumps and fans:  
 Total electricity for the above, kWh/year  
 Electricity for lighting (calculated in Appendix L)

Electricity saving/generation technologies (Appendices M ,N and Q)												
PV generation												-11683.1795 (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												33325.3974 (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	41459.1634	0.2100	8706.4243 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2961.9385	0.2100	622.0071 (264)
Space and water heating			9328.4314 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	501.4750	0.1443	72.3783 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-2918.1782	0.1366	-398.7491
PV Unit electricity exported	-8765.0013	0.1268	-1110.9915
Total			-1509.7406 (269)
Total CO2, kg/year			7902.9984 (272)
EPC Target Carbon Dioxide Emission Rate (TDER)			16.4000 (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	41459.1634	1.1300	46848.8546 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2961.9385	1.1300	3346.9905 (278)
Space and water heating			50195.8451 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	501.4750	1.5338	769.1790 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-2918.1782	1.5051	-4392.2132
PV Unit electricity exported	-8765.0013	0.4653	-4078.4195
Total			-8470.6327 (283)
Total Primary energy kWh/year			42624.4923 (286)
Target Primary Energy Rate (TPER)			88.4800 (287)

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COMMENT ONLY**

## Appendix 2

'Be Green' SAP Worksheets



# Full SAP Calculation Printout



Plot Reference	Farm Road	Issued on Date	24/11/2025
Assessment Reference	Be Green	Plot Type Ref	Farm Road
Plot Address	Farm Road, Northwood, HA6 2NZ	SAP Version	10.2
SAP Rating	58 D	DER	7.30
Environmental	91 B	% DER < TER	TER
CO <sub>2</sub> Emissions (t/year)	3.2	DFEE	83.73
Compliance Check	See BREL	% DFEE < TFEE	TFEE
% DPER < TPER	14.30	DPER	75.33
Assessor Details	Mr. Andrew Taylor	TPER	16.40
Client		Assessor ID	5741-0001

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

## 1. Overall dwelling characteristics

Main dwelling  
Ground floor  
First floor  
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)  
Dwelling volume

	Area (m <sup>2</sup> )	Storey height (m)	Volume (m <sup>3</sup> )
236.3700 (1b)	x 3.8600 (2b)	= 912.3882 (1b) - (3b)	
245.3900 (1c)	x 7.9600 (2c)	= 1953.3044 (1c) - (3c)	
(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 2865.6926 (5)	(4)	

## 2. Ventilation rate

Number of open chimneys  
Number of open flues  
Number of chimneys / flues attached to closed fire  
Number of flues attached to solid fuel boiler  
Number of flues attached to other heater  
Number of blocked chimneys  
Number of intermittent extract fans  
Number of passive vents  
Number of flueless gas fires

	m <sup>3</sup> per hour
0 * 80 =	0.0000 (6a)
0 * 20 =	0.0000 (6b)
0 * 10 =	0.0000 (6c)
0 * 20 =	0.0000 (6d)
0 * 35 =	0.0000 (6e)
0 * 20 =	0.0000 (6f)
0 * 10 =	0.0000 (7a)
0 * 10 =	0.0000 (7b)
0 * 40 =	0.0000 (7c)
Air changes per hour	
0.0000 / (5) =	0.0000 (8)
Yes	
Blower Door	
2.5000 (17)	
0.1250 (18)	
0 (19)	

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =

Pressure test

Pressure Test Method

Measured/design AP50

Infiltration rate

Number of sides sheltered

Shelter factor

Infiltration rate adjusted to include shelter factor

$$(20) = 1 - [0.075 \times (19)] = 1.0000 (20)$$

$$(21) = (18) \times (20) = 0.1250 (21)$$

	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	1.1900	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj inflit rate	0.1594	0.1562	0.1531	0.1375	0.1344	0.1187	0.1187	0.1156	0.1250	0.1344	0.1406	0.1469 (22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 80.1000 (23c)

Effective ac 0.2589 0.2557 0.2526 0.2370 0.2339 0.2182 0.2182 0.2151 0.2245 0.2339 0.2401 0.2464 (25)

## 3. Heat losses and heat loss parameter

Element	Gross m <sup>2</sup>	Openings m <sup>2</sup>	NetArea m <sup>2</sup>	U-value W/m <sup>2</sup> K	A x U W/K	K-value kJ/m <sup>2</sup> K	A x K kJ/K
Main dwelling							
Windows			121.1400	0.9615	116.4808		(27)
Solid Door			6.7800	1.0000	6.7800		(26)
Rooflight			12.6000	1.1450	14.4275		(27a)
Ground Floor			236.3700	0.1000	23.6370	75.0000	17727.7500 (28a)
Floor-to-Garage			25.7600	0.1357	3.4968	20.0000	515.2000 (28b)
Exposed Floor			3.7100	0.1500	0.5565	20.0000	74.2000 (28b)
External Walls	706.6500	127.9200	578.7300	0.1800	104.1714	150.0000	86809.5000 (29a)
Wall-to-Garage	43.0400		43.0400	0.1600	6.8864	150.0000	6456.0000 (29a)
Sloped Roof	285.3500	12.6000	272.7500	0.1200	32.7300	9.0000	2454.7500 (30)
Plane Roof	20.4400		20.4400	0.1200	2.4528	9.0000	183.9600 (30)
Total net area of external elements Aum(A, m <sup>2</sup> )			1321.3200				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		311.6192		(33)
Main dwelling							
Internal Walls - GF			393.1000			9.0000	3537.9000 (32c)

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Internal Walls - FF  
Internal Floor - FF  
Internal Ceiling - GF

1181.0500  
215.9200  
215.9200

9.0000  
18.0000  
9.0000

10629.4500 (32c)  
3886.5600 (32d)  
1943.2800 (32e)

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K

List of Thermal Bridges

K1 Element  
E2 Other lintels (including other steel lintels)  
E3 Sill  
E4 Jamb  
E5 Ground floor (normal)  
E20 Exposed floor (normal)  
E21 Exposed floor (inverted)  
E6 Intermediate floor within a dwelling  
E11 Eaves (insulation at rafter level)  
E13 Gable (insulation at rafter level)  
E10 Eaves (insulation at ceiling level)  
E12 Gable (insulation at ceiling level)  
E16 Corner (normal)  
E17 Corner (inverted - internal area greater than external area)  
E24 Eaves (insulation at ceiling level - inverted)  
R4 Ridge (vaulted ceiling)  
R5 Ridge (inverted)

Thermal bridges (Sum(L x Psi) calculated using Appendix K)

Point Thermal bridges

Total fabric heat loss

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m	244.8125	241.8573	238.9020	224.1258	221.1706	206.3943	206.3943	203.4391	212.3048	221.1706	227.0811	232.9916 (38)
Heat transfer coeff	604.1090	601.1538	598.1985	583.4223	580.4671	565.6908	565.6908	562.7356	571.6013	580.4671	586.3776	592.2881 (39)
Average = Sum(39)m / 12 =	582.6835											

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.2540	1.2478	1.2417	1.2110	1.2043	1.1742	1.1742	1.1681	1.1665	1.2049	1.2172	1.2294 (40)
HLP (average)												1.2095
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

## 4. Water heating energy requirements (kWh/year)

Assumed occupancy

Hot water usage for mixer showers 116.6801 114.9267 112.3715 107.4827 103.8748 99.8514 97.5645 100.1003 102.8800 107.2000 112.1938 116.2331 (42a)

Hot water usage for baths 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (42b)

Hot water usage for other uses 49.1239 47.3346 46.5513 43.7649 41.9786 40.1923 40.1923 41.9786 43.7649 45.5513 47.3376 49.1239 (42c)

Average daily hot water use (litres/day)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	165.8041	162.2643	157.9228	151.2476	145.8535	140.0437	137.7568	142.0789	146.6450	152.7513	159.5314	165.3570 (44)
Energy conte	262.5931	231.0622	242.7214	207.0504	196.3468	172.2001	166.5049	175.9234	180.8279	207.2820	227.2818	258.9091 (45)
Energy content (annual)												Total = Sum(45)m = 2528.8032

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

39.3890 34.6593 36.4082 31.0576 29.4520 25.8300 24.9907 26.3885 27.1242 31.0923 34.0923 38.8364 (46)

Water storage loss (or RIU loss)

Store volume 0.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day) 2.2200 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.1988 (55)

Total storage loss 37.1628 33.5664 37.1628 35.9640 37.1628 35.9640 37.1628 37.1628 35.9640 37.1628 35.9640 37.1628 (56)

If cylinder contains solar storage 37.1628 33.5664 37.1628 35.9640 37.1628 35.9640 37.1628 37.1628 35.9640 37.1628 35.9640 37.1628 (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

323.0183 285.6398 303.1466 265.5264 256.7720 230.6761 227.0301 236.3486 239.3039 267.7072 285.7578 319.3343 (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 323.0183 285.6398 303.1466 265.5264 256.7720 230.6761 227.0301 236.3486 239.3039 267.7072 285.7578 319.3343 (64)

Total per year (kWh/year) 3240.2612 (64)

Electric shower(s) 0.0000 0.0000 0.0600 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 = 3240 (64)

Heat gains from water heating, kWh/month 135.6524 120.4902 129.0450 115.6251 113.6255 104.0373 103.7363 106.8347 106.9061 117.2614 122.3520 134.4274 (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	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109 (66)

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

299.0478 331.0887 299.0478 309.0161 299.0478 309.0161 299.0478 299.0478 309.0161 299.0478 309.0161 299.0478 299.0478 (67)

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

592.8957 599.0181 583.5443 550.5384 508.8744 469.7162 443.5560 437.4036 452.9075 485.9133 527.5773 566.7356 (68)

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

39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 39.8411 (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)

-134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 -134.7287 (71)

Water heating gains (Table 5)

182.3285 179.3010 173.4476 160.5904 152.7224 144.4963 139.4305 143.5950 148.4807 157.6094 169.9333 180.6820 (72)

Total internal gains 1150.7953 1185.9610 1132.5630 1096.6681 1037.1679 996.7518 955.5576 953.5697 983.9275 1019.0939 1083.0500 1122.9887 (73)

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## 6. Solar gains

[Jan]	Area m <sup>2</sup>	Solar flux Table 6a W/m <sup>2</sup>	Specific data or Table 6b g	Specific data or Table 6c FF	Access factor Table 6d	Gains W
North	38.4000	10.6334	0.4000	0.7000	0.7700	79.2308 (74)
East	10.4000	19.6403	0.4000	0.7000	0.7700	39.6344 (76)
South	55.4900	46.7521	0.4000	0.7000	0.7700	503.3926 (78)
West	16.8500	19.6403	0.4000	0.7000	0.7700	64.2153 (80)
East	6.3000	26.6072	0.4000	0.7000	1.0000	42.2416 (82)
West	6.3000	26.6072	0.4000	0.7000	1.0000	42.2416 (82)
<b>Solar gains</b>	<b>770.9563</b>	<b>1349.7941</b>	<b>1937.1491</b>	<b>2540.4151</b>	<b>2965.3566</b>	<b>2994.4857</b>
<b>Total gains</b>	<b>1921.7516</b>	<b>2535.7552</b>	<b>3069.7121</b>	<b>3637.0832</b>	<b>4002.5245</b>	<b>3991.2375</b>

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)											
Utilisation factor for gains for living area, mil, m (see Table 9a)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	61.7156	62.0190	62.3253	63.9038	64.2292	65.9069	65.9069	66.2530	66.2254	66.5818	62.9473
alpha	5.1144	5.1346	5.1550	5.2603	5.2819	5.3938	5.3938	5.4169	5.3484	5.2819	5.1965
util living area	0.9998	0.9992	0.9969	0.9850	0.9372	0.7997	0.6273	0.6962	0.9221	0.9940	0.9995
MIT	19.3619	19.5655	19.8718	20.2976	20.6669	20.9129	20.9813	20.9686	20.7854	20.2890	19.7613
Th 2	19.8771	19.8819	19.8868	19.9112	19.9161	19.9407	19.9407	19.9456	19.9368	19.9161	19.8965
util rest of house	0.9998	0.9989	0.9956	0.9776	0.9046	0.7077	0.4888	0.5586	0.8677	0.9902	0.9993
MIT 2	18.3750	18.5822	18.8916	19.3317	19.6838	19.9007	19.9363	19.9370	19.8057	19.3304	18.7969
Living area fraction											fLA = Living area / (4) = 0.3074 (91)
MIT	18.6783	18.8844	19.1929	19.6286	19.9860	20.2118	20.2575	20.2541	20.1068	19.6250	19.0933
Temperature adjustment											0.0000
adjusted MIT	18.6783	18.8844	19.1929	19.6286	19.9860	20.2118	20.2575	20.2541	20.1068	19.6250	19.0933
											18.6810 (93)

## 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9997	0.9985	0.9944	0.9751	0.9071	0.7338	0.5321	0.6017	0.8787	0.9887	0.9990	0.9998 (94)
Useful gains	1921.0839	2531.9899	3052.4824	3546.4203	3630.7380	2928.7238	2033.6472	2103.8188	2750.2671	2507.2699	2011.2530	1777.8640 (95)
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.8000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	8686.0665	8406.7981	7592.8483	6259.3161	4809.7375	3174.5510	2659.0044	2168.8343	3433.4863	5238.7303	7032.6285	8576.9520 (97)
Space heating kWh	5033.1471	3947.8711	3378.0322	1953.2849	877.1756	0.0000	0.0000	0.0000	0.0000	2032.2066	3615.3904	5058.5215 (98a)
Space heating requirement - total per year (kWh/year)												25895.6294
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	5033.1471	3947.8711	3378.0322	1953.2849	877.1756	0.0000	0.0000	0.0000	0.0000	2032.2066	3615.3904	5058.5215 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												25895.6294
Space heating per m <sup>2</sup>												(98c) / (4) = 53.7521 (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 %)	170.0000 (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	5033.1471	3947.8711	3378.0322	1953.2849	877.1756	0.0000	0.0000	0.0000	0.0000	2032.2066	3615.3904	5058.5215 (98)
Space heating efficiency (main heating system 1)	170.0000	170.0000	170.0000	170.0000	170.0000	0.0000	0.0000	0.0000	0.0000	170.0000	170.0000	170.0000 (210)
Space heating fuel (main heating system)	2960.6747	2322.2771	1987.0778	1148.9911	515.9857	0.0000	0.0000	0.0000	0.0000	1195.4156	2126.7002	2975.6009 (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	
Efficiency of water heater (217)m	323.0183 285.6398 303.1466 265.5264 256.7720 230.6761 227.0301 236.3486 239.3039 267.7072 285.7578 319.3343 (64)
Fuel for water heating, kWh/month	170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 170.0000 (217)
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 Fan (466.2276 439.1733 486.2276 470.5428 486.2276 470.5428 486.2276 486.2276 470.5428 486.2276 470.5428 486.2276 (231)	
Lighting (81.0056 64.9857 58.5124 42.8687 33.1130 27.0536 30.2068 39.2639 51.0000 66.9147 75.5800 83.2569 (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)	

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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)
(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												15232.7232 (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												1906.0360 (219)
Space cooling fuel												0.0000 (221)
Electricity for pumps and fans:												
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.6375)												
mechanical ventilation fans (SFP = 1.6375)												
Total electricity for the above, kWh/year												
Electricity for lighting (calculated in Appendix L)												
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												23517.4578 (238)

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

Space heating - main system 1	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Total CO2 associated with community systems	15232.7232	0.1549	2359.3243 (261)
Water heating (other fuel)	1906.0360	0.1410	0.0000 (373)
Space and water heating	5724.9374	0.1387	268.6804 (264)
Pumps, fans and electric keep-hot	653.7612	0.1443	2628.0047 (265)
Energy for lighting			794.1194 (267)
Total CO2, kg/year			94.3579 (268)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			3516.4820 (272)
			7.3000 (273)

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

Space heating - main system 1	Energy Primary energy factor	Primary energy
Total CO2 associated with community systems	1.5734	23967.5214 (275)
Water heating (other fuel)	1.5212	0.0000 (473)
Space and water heating	1.5128	2899.5247 (278)
Pumps, fans and electric keep-hot	1.5338	26867.0461 (279)
Energy for lighting		8660.6853 (281)
Total Primary energy kWh/year		1002.7608 (282)
Dwelling Primary energy Rate (DPER)		36530.4921 (286)
		75.8300 (287)

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

### 1. Overall dwelling characteristics

Main dwelling	Area (m <sup>2</sup> )	Storey height (m)	Volume (m <sup>3</sup> )
Ground floor	236.3700 (1b)	x 3.8600 (2b)	= 912.3882 (1b) - (3b)
First floor	245.3900 (1c)	x 7.9600 (2c)	= 1953.3044 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	481.7600		
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	2865.6926 (5)

### 2. Ventilation rate

	m <sup>3</sup> per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
Number of blocked chimneys	0 * 20 = 0.0000 (6f)
Number of intermittent extract fans	4 * 10 = 40.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) = 0.0140 (8)
Pressure test	Yes
Pressure Test Method	5.0000 (17)
Measured/design AP50	0.2640 (18)
Infiltration rate	0 (19)
Number of sides sheltered	

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Shelter factor  
Infiltration rate adjusted to include shelter factor

	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 inflit rate	0.3365	0.3299	0.3233	0.2904	0.2838	0.2508	0.2508	0.2442	0.2640	0.2838	0.2970	0.3102 (22b)
Effective ac	0.5566	0.5544	0.5523	0.5422	0.5403	0.5314	0.5314	0.5298	0.5348	0.5403	0.5441	0.5481 (25)

### 3. Heat losses and heat loss parameter

Element	Gross m <sup>2</sup>	Openings m <sup>2</sup>	Net Area m <sup>2</sup>	U-value W/m <sup>2</sup> K	A x U W/K	K-value kJ/m <sup>2</sup> K	A x K kJ/K
Main dwelling							
TER Opaque door			6.7800	1.0000	6.7800	117.9046	(26)
TER Opening Type			102.9700	1.1450	117.9046	17.0318	(27)
TER Roof Window			10.7000	1.1450	117.9046	30.7284	(27a)
Ground Floor			236.3700	0.1300	30.7284	3.3488	(28a)
Floor-to-Garage			25.7600	0.1300	3.3488	0.4823	(28b)
Exposed Floor			3.7100	0.1300	0.4823		(28b)
External Walls	706.6500	109.7500	566.9000	0.1800	107.4420	107.4420	(29a)
Wall-to-Garage	43.0400		43.0400	0.1800	7.7472	7.7472	(29a)
Sloped Roof	285.3500	10.7000	274.6500	0.1100	30.2115	30.2115	(30)
Plane Roof	20.4400		20.4400	0.1100	2.2484	2.2484	(30)
Total net area of external elements Aum(A, m <sup>2</sup> )			1321.3200				(31)
Fabric heat loss, W/K = Sum (A x U)					(26) ... (30) + (32) =	323.9247	(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	63.9200	0.0500	3.1960
E3 Sill	53.8700	0.0500	2.6935
E4 Jamb	140.1800	0.0500	7.0090
E5 Ground floor (normal)	74.1200	0.1600	11.8592
E20 Exposed floor (normal)	16.0300	0.3200	5.1296
E21 Exposed floor (inverted)	14.2800	0.3200	4.5696
E6 Intermediate floor within a dwelling	45.3500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	23.9200	0.0400	0.9568
E13 Gable (insulation at rafter level)	49.7200	0.0800	3.9776
E10 Eaves (insulation at ceiling level)	5.7900	0.0600	0.3474
E12 Gable (insulation at ceiling level)	8.6600	0.0600	0.5196
E16 Corner (normal)	103.4300	0.0900	9.3087
E17 Corner (inverted - internal area greater than external area)	66.1900	-0.0900	-5.9571
E24 Eaves (insulation at ceiling level - inverted)	5.5200	0.2400	1.3224
R4 Ridge (vaulted ceiling)	20.2000	0.0800	1.6160
R5 Ridge (inverted)	12.5900	0.0400	0.5036

Thermal bridges (Sum(L x Psi)) calculated using Appendix K)

Point Thermal bridges

Total fabric heat loss

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m	526.3948	524.3152	522.2767	512.7022	510.9109	502.5718	502.5718	501.0275	505.7839	510.9109	514.5348	518.3234 (38)
Heat transfer coeff	897.3714	895.2918	893.2534	883.6788	881.8875	873.5484	873.5484	872.0041	876.7605	881.8875	885.5114	889.3000 (39)
Average = Sum(39)m / 12 =												883.6703

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.8627	1.8584	1.8541	1.8343	1.8306	1.8132	1.8132	1.8100	1.8199	1.8306	1.8381	1.8459 (40)
HLP (average)												1.8343
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

### 4. Water Heating energy requirements (kWh/year)

Assumed occupancy

Hot water usage for mixer showers

Hot water usage for baths

Hot water usage for other uses

Average daily hot water use (litres/day)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot Water use	152.8396	149.4946	145.4371	139.3051	134.3118	128.9491	126.9163	130.9567	135.2139	140.8401	147.0654	152.4422 (44)
Energy conte	242.0606	212.8784	223.5313	196.7017	180.8095	158.5580	153.4943	162.1517	166.7322	191.1188	209.5217	238.6877 (45)
Energy content (annual)												Total = Sum(45)m = 2330.2459

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

Water storage loss (or HIU loss):

Store volume

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

Temperature factor from Table 2b

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

Total storage loss

If cylinder contains dedicated solar storage

Primary loss

Combi loss

Total heat required for water heating calculated for each month

WWRHS

PV diverter

Solar input

FGHRS

Output from w/h

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)

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Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)  
 Heat gains from water heating, kWh/month 124.4106 110.4566 118.2496 105.9168 104.0446 95.2290 94.9623 97.8409 97.9470 107.4724 112.1744 123.2891 (65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109	168.4109 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	299.0478	331.0887	299.0478	309.0161	299.0478	309.0161	299.0478	299.0478	309.0161	299.0478	309.0161	299.0478 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	592.8957	599.0481	583.5443	550.5384	508.8744	469.7162	443.5560	437.4936	452.9075	485.9133	527.5773	566.7356 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411	39.8411 (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)	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287	-134.7287 (71)
Water heating gains (Table 5)	167.2185	164.3700	158.9376	147.1067	139.8449	132.2625	127.6375	131.5066	136.0374	144.4522	155.7978	165.7111 (72)
Total internal gains	1135.6853	1171.0301	1118.0530	1083.1844	1024.2904	984.5180	943.7646	941.4813	971.4843	1005.9366	1068.9145	1108.0178 (73)

## 6. Solar gains

[Jan]	Area m <sup>2</sup>	Solar flux Table 6a W/m <sup>2</sup>	Specific data or Table 6b	Specific data or Table 6c	FF	Access factor Table 6d	Gains W					
North	32.6400	10.6334	0.6300	0.7000	0.7700	106.0703 (74)						
East	8.8500	19.6403	0.6300	0.7000	0.7700	53.1205 (76)						
South	47.1700	46.7521	0.6300	0.7000	0.7700	673.9668 (78)						
West	14.3100	19.6403	0.6300	0.7000	0.7700	85.8932 (80)						
East	5.3500	26.6072	0.6300	0.7000	1.0000	56.4982 (82)						
West	5.3500	26.6072	0.6300	0.7000	1.0000	56.4982 (82)						
Solar gains	1032.0472	1806.8760	2593.0454	3409.4627	3969.1903	4008.1524	3836.3400	3403.6069	2872.3389	2030.4358	1245.2845	877.1898 (83)
Total gains	2167.7325	2977.9060	3711.0984	4483.6471	4993.4807	4992.6704	4780.1046	4345.0882	3843.8231	3036.3724	2314.1990	1985.2076 (84)

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												
Utilisation factor for gains for living area, $\eta_{11,m}$ (see Table 9a)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	41.5468	41.6433	41.7384	42.1906	42.2763	42.6799	42.6799	42.7555	42.5235	42.2763	42.1033	41.9239
alpha	3.7698	3.7762	3.7826	3.8127	3.8184	3.8453	3.8453	3.8504	3.8349	3.8184	3.8069	3.7949
util living area	0.9994	0.9979	0.9937	0.9785	0.9353	0.8399	0.8997	0.7610	0.9279	0.9901	0.9986	0.9996 (86)
MIT	18.6624	18.9121	19.3085	19.8454	20.3630	20.7397	20.9083	20.8705	20.5443	19.8704	19.1702	18.6316 (87)
Th 2	19.4264	19.4294	19.4323	19.4461	19.4487	19.4607	19.4607	19.4630	19.4561	19.4487	19.4435	19.4380 (88)
util rest of house	0.9992	0.9971	0.9907	0.9671	0.8957	0.7250	0.5013	0.5745	0.8642	0.9832	0.9979	0.9994 (89)
MIT 2	16.7571	17.0789	17.5873	18.2752	18.8937	19.3131	19.4365	19.4218	19.1325	18.3159	17.4188	16.7247 (90)
Living area fraction	MIT	17.3427	17.6424	18.1163	18.7578	19.3422	19.7516	19.8889	19.8671	19.5664	18.7936	17.9571 (92)
Temperature adjustment	adjusted MIT	17.3427	17.6424	18.1163	18.7578	19.3422	19.7516	19.8889	19.8671	19.5664	18.7936	17.9571 (93)

## 8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9986	0.9954	0.9868	0.9598	0.8921	0.7505	0.5640	0.6325	0.8705	0.9785	0.9966	0.9990 (94)
Useful gains	2164.6674	2964.0843	3661.9622	4303.3317	4454.7707	3747.1284	2696.1398	2748.3768	3345.9487	2971.1240	2306.4243	1983.2168 (95)
Ext. temp.	4.8000	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	11704.1205	11408.1311	10376.2851	8711.1097	6739.5367	4500.1334	2872.9713	3023.2985	4792.7661	7225.8665	9614.0934	11659.4032 (97)
Space heating kWh	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (98a)
Space heating requirement - total per year (kWh/year)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (98c)
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)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (98c)
Space heating per m <sup>2</sup>												

## 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	7097.3531	5674.3995	4995.4562	3173.6002	1699.8659	0.0000	0.0000	0.0000	3165.5284	5261.5218	7199.0827 (98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000 (210)
Space heating fuel (main heating system)	7689.4400	6147.7784	5412.1953	3438.3534	1841.6749	0.0000	0.0000	0.0000	3429.6083	5700.4569	7799.6562 (211)
Space heating efficiency (main heating system 2)											

# Full SAP Calculation Printout

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	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	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	0.0000	0.0000 (215)	
Water heating														
Water heating requirement	249.5529	220.5378	234.5275	207.4776	201.8304	182.6971	181.2215	188.1558	189.8670	210.6579	222.5900	247.0580 (64)	79.8000 (216)	
Efficiency of water heater	(217)m	88.4611	88.4269	88.3532	88.1897	87.7497	79.8000	79.8000	79.8000	88.1795	88.3954	88.4689 (217)		
Fuel for water heating, kWh/month	282.1046	249.4013	265.4433	235.2630	230.0070	228.9438	227.0946	235.7842	237.9286	238.8967	251.8118	279.2596 (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	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	7.0685 (231)	
Lighting	62.1362	49.8480	44.8826	32.8829	25.3997	20.7518	23.1705	30.1178	39.1201	51.3277	57.9745	63.8632 (232)		
Electricity generated by PVs (Appendix M) (negative quantity)	(233)a)m	-173.0683	-223.1245	-293.3323	-300.3334	-300.4139	-271.6690	-267.3052	-262.7866	-252.9165	-238.8846	-182.1995	-152.1045 (233a)	
Electricity generated by wind turbines (Appendix M) (negative quantity)	(234)a)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)	(235)a)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	-173.0239	-351.5016	-677.2953	-988.3629	-1280.7465	-1278.2876	-1264.0196	-1082.6297	-809.9412	-493.5496	-227.7503	-137.8931 (233b)	
Electricity generated by wind turbines (Appendix M) (negative quantity)	(234)b)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)	(235)b)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													41459.1634 (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													2961.9385 (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)													501.4750 (232)
Energy saving/generation technologies (Appendices M, N and Q)													
PV generation													-11683.1795 (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													-0.0000 (236)
Energy saved or generated													0.0000 (237)
Energy used													33325.3974 (238)
Total delivered energy for all uses													

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP													
Space heating - main system 1													
Total CO2 associated with community systems													
Water heating (other fuel)													
Space and water heating													
Pumps, fans and electric keep-hot													
Energy for lighting													
Energy saving/generation technologies													
PV Unit electricity used in dwelling													-398.7491
PV Unit electricity exported													-1110.9915
Total													-1509.7406 (269)
Total CO2, kg/year													7902.9984 (272)
EPC Target Carbon Dioxide Emission Rate (TER)													16.4000 (273)

13a. Primary energy - Individual heating systems including micro-CHP													
Space heating - main system 1													
Total CO2 associated with community systems													
Water heating (other fuel)													
Space and water heating													
Pumps, fans and electric keep-hot													
Energy for lighting													
Energy saving/generation technologies													
PV Unit electricity used in dwelling													-4392.2132
PV Unit electricity exported													-4078.4195
Total													-8470.6327 (283)
Total Primary energy kWh/year													42624.4923 (286)
Target Primary Energy Rate (TPER)													88.4800 (287)

## Appendix 3

M & E Specification Information



Farm Road Energy & Sustainability Statement v1.1

# PUZ-WM60VAA(-BS)

Ecodan R32

**Monobloc** Air Source Heat Pump

## Key Features:

- A+++ high efficiency system
- Ultra quiet noise levels
- Maintains full heating capacity at low temperatures
- Zero carbon solution
- MELCloud enabled

## Key Benefits:

- Ultra low running cost
- Flexible product placement
- Confident and quick product selection
- Help to tackle the climate crisis
- Remote control, monitoring, maintenance and technical support



Manufactured in the UK

037-0033-20-01

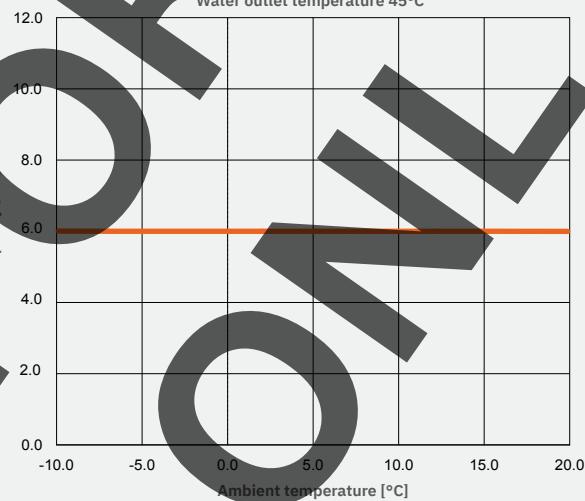


**ecodan**<sup>®</sup>  
Renewable Heating Technology

OUTDOOR UNIT		PUZ-WM60VAA(-BS)
HEAT PUMP SPACE	ErP Rating	A++
HEATER - 55°C	$\eta_s$	142%
	SCOP (MCS)	3.57
HEAT PUMP SPACE	ErP Rating	A+++
HEATER - 35°C	$\eta_s$	190%
	SCOP (MCS)	4.81
HEAT PUMP COMBINATION	ErP Rating	A+
HEATER - Large Profile <sup>1</sup>	$\eta_{wh}$	145%
HEATING <sup>2</sup>	Capacity (kW)	6.0
(A-7/W35)	Power Input (kW)	1.88
	COP	3.20
OPERATING AMBIENT TEMPERATURE (°C DB)		-20 ~ +35
SOUND DATA <sup>3</sup>	Pressure Level at 1m (dBA)	45
	Power Level (dBA) <sup>4</sup>	58
WATER DATA	Pipework Size (mm)	22
	Flow Rate (l/min)	17
	Water Pressure Drop (kPa)	8.0
DIMENSIONS (mm)	Width	1050
	Depth	480
	Height	1020
WEIGHT (kg)		98
ELECTRICAL DATA	Electrical Supply	220-240V, 50Hz
	Phase	Single
	Nominal Running Current [MAX] (A) <sup>5</sup>	5.68 [13]
	Fuse Rating - MCB Sizes (A) <sup>6</sup>	16
REFRIGERANT CHARGE (kg) / CO <sub>2</sub> EQUIVALENT (t)	R32 (GWP 675)	2.2 / 1.45

## NOMINAL HEATING CAPACITY

Water outlet temperature 45°C

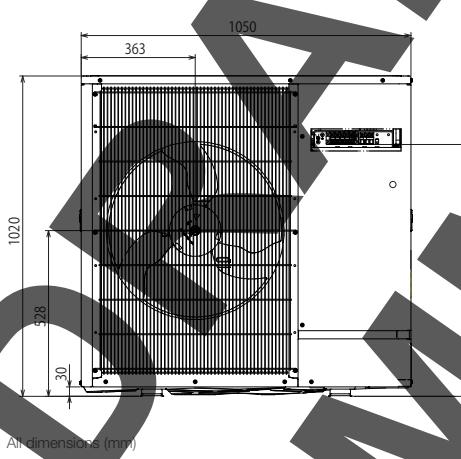


## Notes:

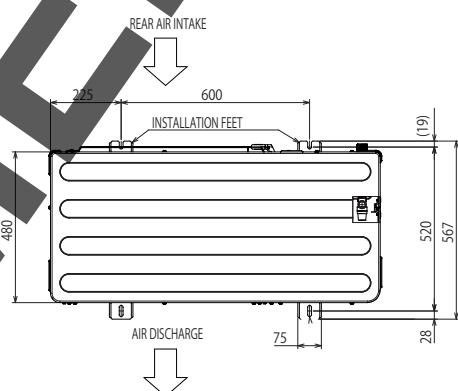
<sup>1</sup> Combination with E-PT20X Cylinder<sup>2</sup> Under normal heating conditions at outdoor temp: -7°CDB / -8°CWB, outlet water temp 35°C, inlet water temp 30°C.<sup>3</sup> Under normal heating conditions at outdoor temp: 7°CDB / 6°CWB, outlet water temp 55°C, inlet water temp 47°C as tested to BS EN14511.<sup>4</sup> Sound power level tested to BS EN12102.<sup>5</sup> Under nominal heating conditions at outdoor temp: 7°C, outlet water temp 35°C.<sup>6</sup> MCB Sizes BS EN60898-2 & BS EN60947-2. $\eta_s$  is the seasonal space heating energy efficiency (SSHEE)  $\eta_{wh}$  is the water heating energy efficiency

## PUZ-WM60VAA(-BS) DIMENSIONS

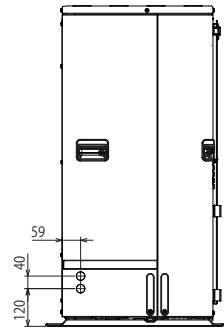
FRONT VIEW



UPPER VIEW



SIDE VIEW



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Note: Refer to 'Installation Manual' and 'Instruction Book' for further 'Technical Information'. The fuse rating is for guidance only and please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/ electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas, R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R1234ze (GWP:7) or R1234yf (GWP:4). These GWP values are based on Regulation (EU) No 511/2014 from IPCC 4th edition. In case of Regulation (EU) No 520/2011 from IPCC 3rd edition, these are as follows. R410A (GWP:1975), R32 (GWP:550), R407C (GWP:1650) or R134a (GWP:1300).

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Model Number: PUHZ-W112YAA  
Certification Period: 09/10/2018 - 08/10/2028

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Technology:

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Ecodan

**PUZ-WM60VAA-BS**

Air Source Heat Pump

HP Keymark

[Visit manufacturer's website](#)

22/06/2020 - 21/06/2030

Certified

FOR  
ONLY

**SCOP Values**

Flow Temperature	SCOP
53°C	3.67
54°C	3.62
<b>55°C</b>	<b>3.57</b>
56°C	0
57°C	0
58°C	0

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Model Number: PUZ-WM112VAA  
Certification Period: 27/07/2020 - 26/07/2030

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Certification Number: 037-0034-20-02  
Model Number: PUZ-WM112VAA-BS  
Certification Period: 27/07/2020 - 26/07/2030

**Ecodan**

Certification Number: 037-0034-20-03  
Model Number: PUZ-WM112YAA  
Certification Period: 27/07/2020 - 26/07/2030

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Model Number: PUZ-HWM140VHA  
Certification Period: 27/07/2020 - 26/07/2030

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Model Number: PUZ-HWM140VHA-BS  
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Model Number: CAHV-P500YA-HPB  
Certification Period: 26/08/2011 - Present

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Certification Period: 07/06/2013 - Present

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Model Number: Ecodan PUHZ SW75VHA / 2kW Hydrobox  
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Model Number: Ecodan PUHZ SW75VHA / 2kW Cylinder  
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Model Number: Ecodan PUHZ SW120VHA / 2kW Hydrobox  
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Certification Number: MCS HP0002/21  
Model Number: PUHZ-W112VHA  
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**Ecodan**

Certification Number: MCS HP0002/22  
Model Number: CRHV-P600YA-HPB  
Certification Period: 23/09/2014 - Present



**Ecodan**

Certification Number: MCS HP0002/23  
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Certification Period: 28/08/2015 - Present

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Certification Number: MCS HP0002/24  
Model Number: PUHZ-W50VHA  
Certification Period: 28/08/2015 - Present

**Ecodan**

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## Appendix 4

GHA Overheating Tool



Farm Road Energy & Sustainability Statement v1.1

# EARLY STAGE OVERHEATING RISK TOOL

Version 1.0, July 2019

This tool provides guidance on how to assess overheating risk in residential schemes at the early stages of design. It is specifically a pre-detail design assessment intended to help identify factors that could contribute to or mitigate the likelihood of overheating.

The questions can be answered for an overall scheme or for individual units. Score zero wherever the question does not apply.

Additional information is provided in the accompanying guidance, with examples of scoring and advice on next steps.

Find out more information and download accompanying guidance at [goodhomes.org.uk/overheating-in-new-homes](http://goodhomes.org.uk/overheating-in-new-homes).



## KEY FACTORS INCREASING THE LIKELIHOOD OF OVERHEATING | KEY FACTORS REDUCING THE LIKELIHOOD OF OVERHEATING

### Geographical and local context

#1 Where is the scheme in the UK? See guidance for map	South east	4	4
	Northern England, Scotland & NI	0	
	Rest of England and Wales	2	

#2 Is the site likely to see an Urban Heat Island effect? See guidance for details	Central London (see guidance)	3	2
	Grtr London, Manchester, B'ham	2	
	Other cities, towns & dense sub-urban areas	1	

### #8 Do the site surroundings feature significant blue/green infrastructure?

Proximity to green spaces and large water bodies has beneficial effects on local temperatures; as guidance, this would require at least 50% of surroundings within a 100m radius to be blue/green, or a rural context

1  
1

### Site characteristics

#3 Does the site have barriers to windows opening? - Noise/Acoustic risks - Poor air quality/smells e.g. near factory or car park or very busy road - Security risks/crime - Adjacent to heat rejection plant	Day - reasons to keep all windows closed	8	0
	Day - barriers some of the time, or for some windows e.g. on quiet side	4	
	Night - reasons to keep all windows closed	8	
	Night - bedroom windows OK to open, but other windows are likely to stay closed	4	

### #9 Are immediate surrounding surfaces in majority pale in colour, or blue/green?

Lighter surfaces reflect more heat and absorb less so their temperatures remain lower; consider horizontal and vertical surfaces within 10m of the scheme

1  
0

### #10 Does the site have existing tall trees or buildings that will shade solar-exposed glazed areas?

Shading onto east, south and west facing areas can reduce solar gains, but may also reduce daylight levels

1  
1

### Scheme characteristics and dwelling design

#4 Are the dwellings flats? Flats often combine a number of factors contributing to overheating risk e.g. dwelling size, heat gains from surrounding areas; other dense and enclosed dwellings may be similarly affected - see guidance for examples	3	0
	0	0

### #11 Do dwellings have high exposed thermal mass AND a means for secure and quiet night ventilation?

Thermal mass can help slow down temperature rises, but it can also cause properties to be slower to cool, so needs to be used with care - see guidance

1  
0

#5 Does the scheme have community heating? i.e. with hot pipework operating during summer, especially in internal areas, leading to heat gains and higher temperatures	3	0
	0	0

### #12 Do floor-to-ceiling heights allow ceiling fans, now or in the future?

Higher ceilings increase stratification and air movement, and offer the potential for ceiling fans

>2.8m and fan installed

2  
0

>2.8m

### Solar heat gains and ventilation

#6 What is the estimated average glazing ratio for the dwellings? (as a proportion of the facade on solar-exposed areas i.e. orientations facing east, south, west, and anything in between). Higher proportions of glazing allow higher heat gains into the space	>65%	12	0
	>50%	7	
	>35%	4	

### #13 Is there useful external shading?

Shading should apply to solar exposed (E/S/W) glazing. It may include shading devices, balconies above, facade articulation etc. See guidance on "full" and "part". Scoring depends on glazing proportions as per #6

Full Part

>65% 6 3

0

>50% 4 2

1

#7 Are the dwellings single aspect? Single aspect dwellings have all openings on the same facade. This reduces the potential for ventilation	Single-aspect	3	0
	Dual aspect	0	

### #14 Do windows & openings support effective ventilation?

Larger, effective and secure openings will help dissipate heat - see guidance

Openings compared to Part F purge rates

= Part F +50% +100%

3

Single-aspect minimum required

3

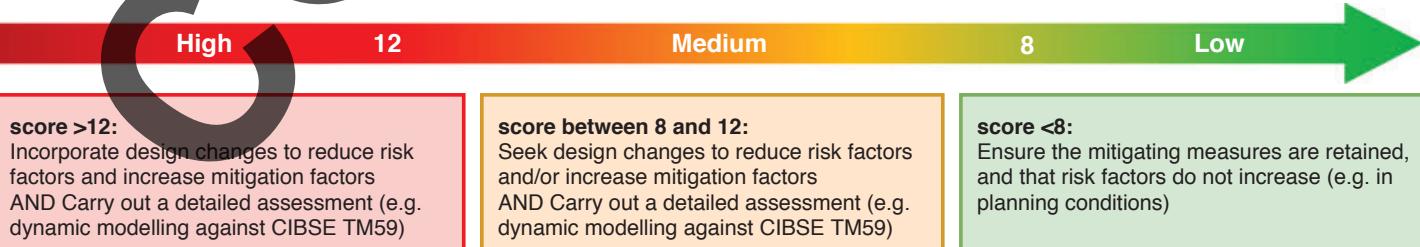
2

3

**TOTAL SCORE** 5 = **Sum of contributing factors:** 10

minus

**Sum of mitigating factors:** 5



## Appendix 5

### Water Consumption Calculations





Job no:			
Date:	15/12/2025		
Assessor name:	Jessica Ambrose		
Registration no:			
Development name:	Farm Road		
Issue Date:			
<input type="button" value="Rainwater"/> <input type="button" value="Greywater"/> <input type="button" value="Results"/>			

## WATER EFFICIENCY CALCULATOR FOR NEW DWELLINGS

(for use with the Code for Sustainable Homes issues Wat 1 for the May 2009 and subsequent versions)

Dwelling Description Detached five-bedroom family home.

### 1st step - Select from options below:

Is a Rain and/or Greywater system specified?	No
Is a shower AND bath present?	No
Has a washing machine been specified?	No
Has a dishwasher been specified?	No

### 2nd step - Build spreadsheet (click button below)

BUILD SPREADSHEET

As soon as this button is pressed the spreadsheet will change according to the options selected previously in the 1st step. Scroll down to see the changes.

### 3rd step - Enter consumption details for the specified fittings

TAPS (excluding kitchen taps)	Fitting type	Flow rate (litres/min)	Number of fittings
1	Taps	4.00	6
2			
3			
4			
Proportionate flow rate (litres/min)			2.80
	Consumption / person / day (Litres)		7.90

BATHS	Fitting type	Capacity to overflow (litres)	Number of fittings
1			
2			
3			
4			
Proportionate capacity to overflow (litres)			0.00
Consumption / person / day (Litres)			0.00
SHOWERS	Fitting type	Flow rate (litres/min)	Number of fittings
1	Showers	9.00	5
2			
3			
4			
Proportionate flow rate (litres/min)			6.30
Consumption / person / day (Litres)			50.40
DISHWASHER			
Where no dishwasher is specified, a default consumption figure of 1.25 litres per place setting is used.			
Consumption / person / day (Litres)			4.50

WASHING MACHINES				
<p>Where no washing machine is specified, a default consumption figure of 8.17 litres per kilogram of dry load is used.</p>				
<p>Where no washing machines have been specified but plumbing for future supply of grey/rainwater was installed, please enter details:</p>				
		Consumption / person / day (Litres)	17.16	
WC's	Fitting Type	Flush Type	Volume**	Number of fittings
1	WCs	Full Flush	4.00	6
		Part Flush	2.60	
2		Full Flush		
		Part Flush		
3		Full Flush		
		Part Flush		
4		Full Flush		
		Part Flush		
Average effective flushing volume (litres)				3.06
Consumption / person / day (Litres)				13.53

KITCHEN SINK TAPS		Fitting Type	Flow rate (litres/minute)	Number of fittings
1	Kitchen Sink Taps	8.00	2	
	2			
	3			
	4			
			Proportionate flow rate (litres/min)	5.60
			Consumption / person / day (Litres)	13.88
WASTE DISPOSAL UNIT				
Is a waste disposal unit specified for the dwelling?		No		
		Consumption / person / day (Litres)		
WATER SOFTENER				
Water Softener in use?		No		
Total capacity used per regeneration (%)				
Water consumed per regeneration (litres)				
Average number of regeneration cycles per day (No.)				
Number of occupants served by the system (No.)				
		Water consumed beyond 4% person / day (Litres)		
		0.00		

## 4th step - Analyse Results

[Go to Start](#)

## INTERNAL WATER CONSUMPTION

NET INTERNAL WATER CONSUMPTION	(litres/person/day)	107.37
RAINWATER ONLY COLLECTION SAVING	(litres/person/day)	0.00
GREYWATER ONLY RECYCLING SAVING	(litres/person/day)	0.00
RAIN/GREYWATER COLLECTION SAVING (combined system)	(litres/person/day)	0.00
NORMALISATION FACTOR	(litres/person/day)	0.91
TOTAL WATER CONSUMPTION	(litres/person/day)	97.7
CSH CREDITS ACHIEVED		3
CSH MANDATORY LEVEL:		Level 3/4

## 17. K COMPLIANCE

EXTERNAL WATER USE	(litres / person / day)	5.00
TOTAL WATER CONSUMPTION	(litres / person / day)	102.7
17. K COMPLIANCE?		Yes

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