Energy and Sustainability Strategy

112 Hollow Way, Oxford, OX4 2NL

PR11113

Date: 30/11/2023

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Notice

Document History

Client: *Project 51 Architecture*
Project: *112 Hollow Way, Oxford, OX4 2NL*
Document title: Energy & Sustainability Strategy
ERS reference: PR11113

Revision	Remarks	Author	Checked	Approved	Date
00		Riley Dixon	SM	Yes	30/11/2023

Contents

Executive summary

ERS Consultants Ltd has been appointed to prepare an Energy & Sustainability Statement for the site located at 112 Hollow Way, Oxford, OX4 2NL.

The proposal is for the development of a small dwelling. This report will be focusing on implementing careful design and sustainable measures; so that the project creates an attractive new residential unit which will address current housing need within the development area.

Proposed schedule of accommodation is as follows:

Total Number of Dwellings = 1x No. 2-bedroom house

Total combined floor area for habitable dwellings: 76.28m²

This energy and sustainability strategy outlines the key measures to be incorporated in the design, in regards to sustainability, carbon emissions, renewable energy and environmental impact of the considered development in accordance and with guidance from the following documents and policies:

- Oxford City local plan (Policy RE1)
- The National Planning Policy Framework (NPPF) July 2021

In line with Oxford City Local plan Policy RE1, the development would need to achieve a 40% reduction in regulated CO_2 emissions over a Part L baseline.

This energy & sustainability statement will demonstrate how a selection of sustainable energy efficient measures and low-carbon technologies are used in the reduction of carbon emissions for the development.

A detailed calculation has been undertaken to establish the energy consumption and carbon emissions of the proposed development.

The methodology used to determine the expected operational CO_2 emissions for the development is in accordance with the standard three-step Energy Hierarchy and the CO_2 savings achieved for each step are outlined below:

Baseline – (CO2 emissions Part L of the Building Regulation)

Initially in the energy assessment, it must be established that the regulated CO_2 emissions of the development comply with Part L 2021 standards. This uses the approved compliance software SAP10.2. For this development the baseline regulated CO2 emissions calculated for the site are **0.95 Tonnes CO_2/Year.**

Be Lean – Use less energy

The second step addresses, reduction in energy demand through the adoption of passive and active design measures.

Emphasis will be put on the buildings fabric performance in order to reduce energy consumption, as less heating and cooling will be lost through the high performance fabric hence reducing the demand. Fabric first measures include levels of insulation beyond Building Regulation 2021 requirements which will help in achieving low air tightness levels, as well as using enhanced construction detailing.

With the addition of the lean fabric improvements the energy regulated CO_2 emissions are shown to reduce by **56.62% (0.41 Tonnes CO_2/Year)** for the proposed dwelling.

Be Clean – Supply energy efficiently

Once demand for energy has been minimised, all planning applications must demonstrate how their energy systems will exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly to reduce CO2 emissions.

When selecting the proposed heating system, it is imperative to consider carbon dioxide emissions, as all combustion processes can emit oxides of Nitrogen (NOx) and, solid or liquid fuelled appliances (such as those using biomass or biodiesel) can also emit Particulate Matter. These pollutants contribute to Oxford's poor air quality and can have negative impacts on the health of local residents and occupiers of the development. It is important that these impacts are taken into account in determining the heating strategy of a development.

In this project there will be no direct heating networks or CHP incorporated so therefore, the Be Clean scenario will not further reduce CO2 emissions on site for the proposed development. This means there are no changes to be implemented at the Be Clean stage, as the proposed heating system (SAP default air-source heat pump) will remain as per the previous stage and energy assessment guidance.

As there is no change from the previous stage, the CO2 emissions remain the same as Be Lean at **56.62% (0.41 Tonnes CO_2/Year)** for the proposed site.

Be Green – Use renewable energy

At this stage of the project, various low-zero carbon options were considered to meet the required reduction. As an air-source heat pump is proposed, the reduction target is exceeded, and the criteria wanting the implementation of low/zero carbon technology has been satisfied. This means that no PV is required for the purposes of this energy statement.

At this stage, to demonstrate savings made by using a more efficient heat pump, a Mitsubishi Ecodan unit has been factored into the calculations.

By implementing this change, the regulated carbon emissions have been reduced to **0.37 Tonnes CO_2/Year, equal to a 60.79% reduction from the baseline.**

This concludes this proposed development using the proposed specification in this report completes the **40% Carbon Emissions Reduction** against **Part L Building Regulations standards by using the Part L 2021 carbon emission factors**.

Energy & carbon demand summary

Table 1 Energy and Carbon Reductions for Site Wide Reduction				
	Primary energy kWh/year	Energy Consumption Savings (%)	Total CO_2 Emissions (Tonnes CO_2/Year)	CO_2 Emissions Savings (%)
Baseline	4966.91		0.95	
Be Lean	4318.43	13.06%	0.41	56.62%
Be Clean	4318.43	0.00%	0.41	0.00%
Be Green	3900.14	8.42%	0.37	4.34%
Total Reduction		**21.48%**		**60.97%**

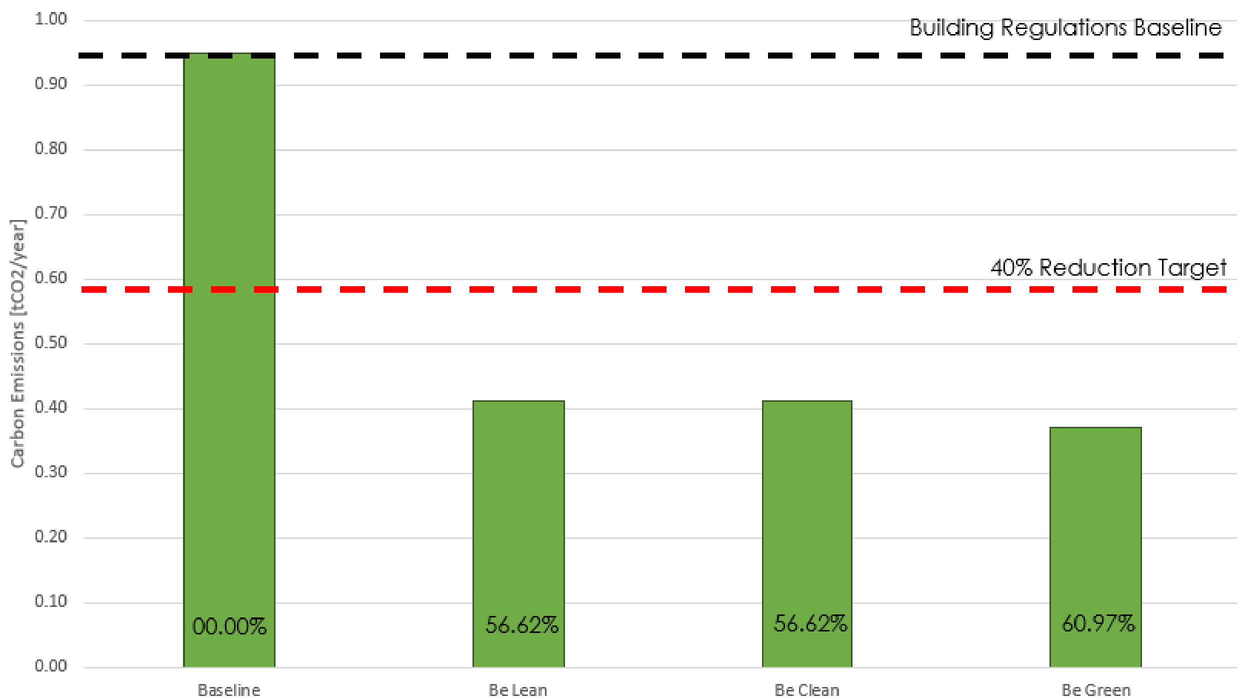


Fig.1 CO_2 Reduction for Site-wide carbon reduction

SAP calculations always refer to 'regulated' energy loads, which are those addressed by building regulations, 'unregulated' loads, for example is energy used by white goods and cooking.

As shown in Table 1, the provisional baseline annual carbon dioxide emissions of the proposed development have been calculated to achieve **0.95 Tonnes CO_2/Year** for the site. Through the design development this has been reduced by **60.97% (0.37 Tonnes CO_2/Year).**

Table 2: Proposed Fabric Specifications			
Fabric Construction and Insulation			
Element	**Type**	**U-Value**	
Heat Loss Floor	Ground Floor - Solid	0.12	
External Walls	Cavity Wall	0.18	
Dormer Walls	Timber Frame	0.18	
Sloped Roof	Pitched – insulated at rafters	0.14	
Plane Roof	Pitched – insulated at joists	0.12	
Dormer Roof	Flat	0.14	
Windows	Window	Double glazed, argon filled, 16mm unit with low-e coat; G-Value of 63%;	1.30
Rooflights	Roof Window	Double glazed, argon filled, 16mm unit with low-e coat; G-Value of 63%;	1.30
Solid Door	Solid Door	Half glazed, argon filled, 16mm door unit with low-e coat; G-Value of 63%;	1.30

Table 3: Proposed System Specifications

Space Heating

Main Heating System	Mitsubishi Electric Ecodan 6.0 kW PUZ-WM60VAA air-source heat pump used supplying radiators and underfloor heating system; Unit should be sized appropriately for as built stage;
Heating Controls	Time and temperature zone control;
Secondary Heating	n/a;

Water Heating

Heat source	From Main Heating	**Cylinder Size**	180 litres	**Heat Loss**	1.86 kWh/Day
WWHRS Instantaneous System 1	N/A	**WWHRS Instantaneous System 2**	N/A		
Water Use <=125 l/p/d	Yes	**Cold Water Source**	From Mains		
Shower(s)	Combination boiler or unvented hot water system	**Flow Rate [l/min]**	8 l/min	Connected to the Hot Water Cylinder	
Bath Count	1	Cylinder Pipework is fully insulated where possible; Full cylinder heating controls installed;			
Solar Thermal	Not Installed;				

Ventilation

Mechanical Ventilation System	Intermittent Extract;	**Number of Wetrooms, excluding kitchen**	2
Cooling system	Not installed;		
Pressure Test Blower Door	5.00m³/hm² @ 50 Pa Please note ERS can provide Air Leakage Testing		

Other

Detailing (linear thermal bridging junctions – formerly ACDs)	Enhanced construction details from the insulation manufacturer have been used where available. The dwelling must be constructed to this standard, and the relevant forms must be completed as building work progresses. Any deviation from this will require an update to the SAP calculations as the psi-values will change; **Building Alliance Recognised Constructions Details; Masonry Cavity Wall Full Fill; 150mm/0.32W/mK/0.19W/mK;**							
Lighting	**No. Fittings**	16	**Power [W]**	2	**Efficacy [lm/W]**	75	**Capacity [lm]**	150
Tariff and Meters	Standard	**Smart Electricity Meter**	Yes	**Smart Gas Meter**	No			
PV/Renewables	Not required for proposal;							

Please note: There may be upgrades compared to your original specification to achieve building regulation approval under the relevant Approved Document Part L. Failure to implement these upgrades may result in a Building Regulation Failure at final stage. Please ensure any changes to the specification are made through this office to ensure ongoing compliance.

Introduction

Site & proposal

The site is located at **112 Hollow Way, Oxford, OX4 2NL**

Gross Internal Area for the dwelling: 76.28m²

The approximate site location of the proposed development is shown in the site plan Fig.2.

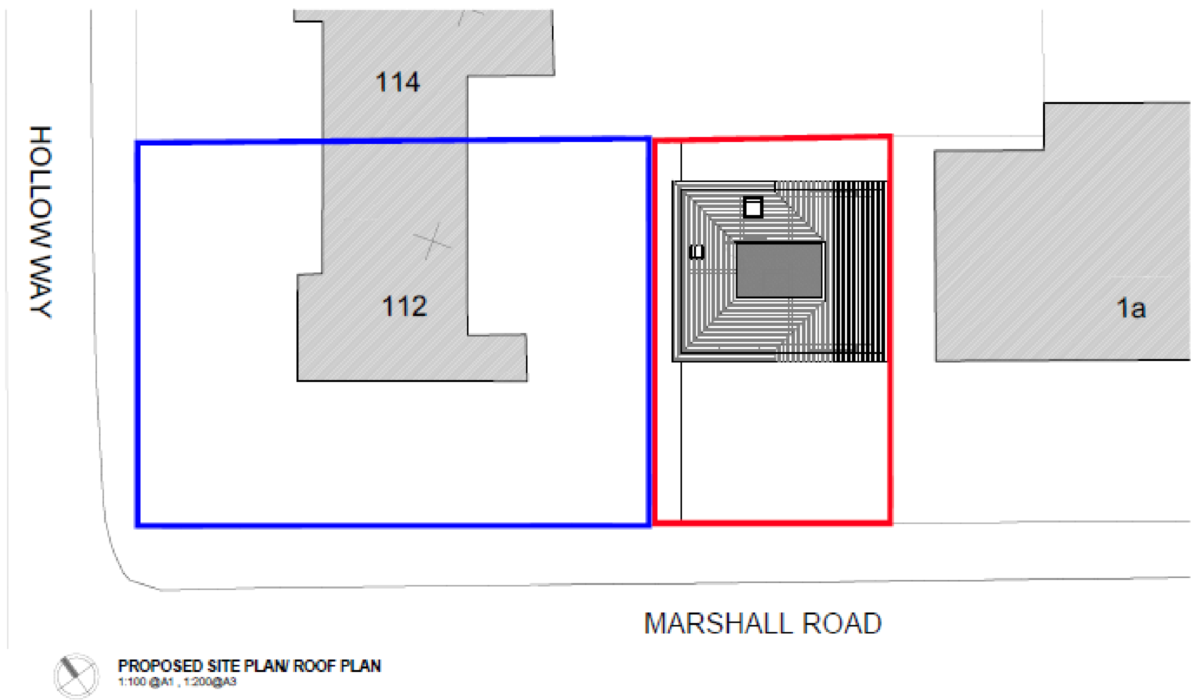


Fig.2 Site Plan

Policy context

This energy and sustainability statement will seek to respond to the energy policies that apply to this development. The most relevant applicable energy policies in the context of the proposed development are presented below.

- Oxford City local plan (Policy RE1)
- The National Planning Policy Framework (NPPF) July 2021

All the aforementioned policies focus on zero carbon targets for residential developments with a minimum 40% on site reduction beyond Part L 2021.

Calculation methodology

The sections below present the methodology followed in determining carbon emissions reduction savings for the proposed scheme.

The methodology employed by the energy and sustainability statement is in line with the GLA's Guidance on preparing energy assessments.

The baseline CO_2 emissions are first established, i.e., the emissions of a scheme that is compliant with Part L 2021 of the Building Regulations.

The approved software used to model and calculates the energy performance and carbon emissions are SAP 10 Online version by Elmhurst Energy Systems Ltd.

To calculate our results for the site-wide development a suitable sample number of units is selected and the results are scaled up as per the proposed development Gross Internal Area.

The TER which is used as the baseline figure for the carbon reductions for each domestic element is multiplied by its floor area to establish the total baseline emissions.

Baseline:

The property baseline uses the same heating system as per the designed counterpart; therefore, in this exercise the baseline models use an Air Source Heat Pump as the main source of heating on the calculations. The full specification of the baseline can be found in Table 1.1 of the Approved Document L Volume, 2021 Edition.

Be Lean: use less energy

The demand for energy is reduced through a range of passive and active energy efficiency measures; as part of this step the dwelling fabric u-values and glazing have been improved to a high standard, in addition to this suitable heating systems are utilised as per the specifications in Table 2 and 3.

Be Clean: supply energy efficiently

As much of the remaining energy demand is supplied as efficiently as possible in the previous stage, we consider the option of communal and network-based heating strategies, but due to high costs and the scale of the development this is not a viable option.

Be Green: use renewable energy

Renewable and low-zero carbon technologies are incorporated to offset part of the carbon emissions of the development. The uptake of renewable technologies is based on feasibility and viability considerations, including their compatibility with the energy system determined in the previous step.

The implementation of the Energy Hierarchy determines the total regulated carbon savings that can be feasibly and viably achieved on site.

The 40% improvement for the development against the baseline emissions is compared to the relevant targets for each element and in case of a shortfall; savings through off-site measures should be achieved.

The Conclusions section summarizes the energy strategy and associated carbon savings for the proposed development.

The carbon emissions factors used in all calculations in this document are those used for Part L of the Building Regulations. The relevant factors are reproduced in Table 4 below.

Table 4 Carbon Emission Factors for selected fuel type

Fuel	Emissions kg CO2e per kWh	Primary energy factor
Mains Gas	0.210	1.130
Bulk/Bottled LPG	0.241	1.141
Liquid Fuels	0.024	1.286
Heating Oil	0.298	1.180
Wood Pellets	0.053	1.325
Grid Electricity	0.136	1.501

* Table extracted from the document SAP Version 10.2 (21-04-2022). Table 12: Fuel prices, emission factors and primary energy factors, Page 189. this can be found in the appendix of the report.

Be Lean – Use less energy

The proposals incorporate a range of passive and active design measures that will reduce the energy demand for space conditioning, hot water, and lighting.

Measures will also be put in place to reduce the risk of overheating, the regulated carbon saving achieved in this step of the Energy Hierarchy is **56.62%** when compared against the baseline level for the development.

Passive design measures

Materials and Waste

A site waste management plan that provides details of waste minimisation, sorting, reuse and recycling procedures is required for all levels in the planning guidance. Sustainable waste management should follow the hierarchy described in *BS 5906: Waste management in buildings. Code of practice*. This outlines the following principles in decreasing order of desirability:

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

Space is provided and appropriately designed to foster greater levels of recycling of domestic waste.

Using Recycled/Recyclable Materials and Sourcing them Responsibly

The following measures will be put in place to minimise environmental impact

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

Regard will be given to reducing the use of virgin materials, such as ensuring a recycled aggregate of content 10-15% in concrete, for example.

Specifically, the following notes have been made on the durability and recycling potential of project materials:

- Brick in the wall finishes has a long usable life and can be reclaimed / re-used in the future. It can also be recycled although it is a more a down-cycle into rubble material for aggregates.
- Window glass, carpeting, and concrete can also be down-cycled.
- The hard landscaping has many timber elements (seats, benches, fences, the acoustic fence) which is a renewable material and is likely to be FSC certified. It can also be recycled or down-cycled into chipboard / crushed timber.
- Off-site construction and Prefabrication; An effective way of managing materials efficiency is through off-site construction or 'Prefabrication', meaning that major components of buildings are manufactured off-site and assembled on-site. This has many benefits, as factory environments help to ensure quality of construction, reduce waste because of spoilage on site (e.g., due to poor storage practices or inclement weather) and encouraging the re-use of materials that otherwise may be wasted. This will be actively explored particularly in relation to the houses.
- Similarly, the use of pre-made sections, such as pre-cast floor slabs in the flatted element will reduce waste and maximise material efficiency. A study by the HSE concluded that waste reductions approaching 70% were possible when compared with traditional techniques.
- The design seeks to use prefabrication for some internal spaces and will be used, subject to the availability of skilled labour and resources within a reasonable distance of the site.

- The design utilises stacking, repeating floor plans where possible within the site constraints, making the use of modular construction possible. If this is a viable option it would reduce transport journeys, reduce site congestion and increase safety.

Environmentally conscious materials

- Materials with the lowest environmental impact tend to have only minimal processing requirements and contain as many naturally occurring constituents as possible. The design team will ensure that 'good practice' is implemented in the specification of materials, making conscious decisions to specify more natural products and wider environmental impact of the materials will be considered when choosing between different options. This could include reviewing Environmental Product Declarations.

- Furthermore, efforts will be made to use materials with low/zero Global Warming Potential (GWP), low Ozone Depletion Potential (ODP) and low embodied energy.

- Local and responsible sourcing Transport associated with extracting, processing and delivering materials can contribute significantly to their carbon and environmental footprint. A robust system of responsible materials sourcing will ensure that native materials will be used as a matter of preference, before any are sourced internationally. It is reasonable to expect as well that deliveries will be made using fuel efficient vehicles.

- The responsible sourcing of materials will be a key consideration in the selection of suppliers, and a sustainable procurement strategy will be produced for the development prior to construction.

- Materials from suppliers who participate in responsible sourcing schemes such as the BRE BES 6001:2008 Responsible Sourcing Standard will be prioritised where economically possible.

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

Enhanced U-values

The heat loss of different building fabric elements is dependent upon their U-value. A building with low U-Values provide better levels of insulation and reduced heating demand during the cooler months.

The proposed development will incorporate high levels of insulation and high-performance glazing beyond Part L 2021 targets and notional building specifications, to reduce the demand for space conditioning (heating and/or cooling).

Table 5 demonstrates the improved performance of the proposed building fabric beyond the Building Regulations requirements.

Table 5 Proposed fabric U-Values		
Domestic (U-Values in W/m²k)		
Element	**Part L 2021 Building Regulation**	**Proposed**
Wall	0.26	0.18 (External Wall)
Floor	0.18	0.12 (Ground floor)
Roof	0.16	0.14 (Sloped Roof) 0.12 (Plane Roof)
Windows/ Glazed Doors	1.60	1.30
Rooflights	2.20	1.30
These u-values are recommended but may change during the construction stage, to meet site constraints, any worsening of the u-values must ensure the required 40% reduction in Carbon is met before completion;		

Air tightness improvement

Heat loss may also occur due to air infiltration. Although this cannot be eliminated altogether, good construction detailing and the use of best practice construction techniques can minimise the amount of air infiltration.

The proposed development will aim to improve upon the Part L 2021 minimum standards for air tightness by targeting air permeability rates of **5.00m³/m².h at 50Pa for the unit**, should the air test be below 3.00m³/m².h at 50Pa Mechanical ventilation will be required.

Reducing the need for artificial lighting

The development has been designed to maximize daylight in all habitable spaces as a way of improving the health and wellbeing of its occupants.

Natural light Natural lighting reduces the energy used for artificial lighting and creates a healthier internal environment. Issues to consider include how much of the sky is visible through a window (the more, the better), the dimensions of the interior living/working space and distance from the window, and the proportion of glazed surfaces. The depth of the room is an important factor in determining the amount of natural light received. Naturally dark rooms may be lit naturally through measures such as sun tubes which 'pipe' sunlight from sunny areas to internal areas.

Glare created by natural or artificial light can be uncomfortable for people both inside and outside a building. This can be minimised if considered early in the design process through building layout (e.g., low eaves height) or building design (e.g. blinds, brise soleil screening). If considered together with a lighting strategy this can reduce energy consumption.

All of the habitable areas will benefit from suitable level glazed fenestration to increase the amount of daylight within the internal spaces where possible. This is expected to reduce the need for artificial lighting whilst delivering pleasant, healthy spaces for occupants.

Active design measures

High efficacy & low energy lighting

Where artificial lighting will be needed it will low energy lighting without compensating for luminance, and will accommodate LED.

Water

Policy RE1 requires water efficiency in new development to meet the highest national standard. For residential development, this is defined in the supporting text as the 'optional Building Regulation' for water efficiency in new dwellings, which is 110 litres per day per person, or a tighter standard if one becomes available nationally. If a new, tighter national standard is introduced, this will be adopted automatically by virtue of Policy RE1.

There are presently no other national standards for non-residential developments than those in the Building Regulations. However, the principle of water efficiency in line with the waste hierarchy applies to all developments. As a result, all developments should seek to reduce demand through efficiency measures, and then meet remaining demand from sustainable sources wherever possible.

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

Reducing water use

Development, whether new construction or change of use and refurbishment, can save water by including measures such as:

- systems for greywater reuse
- aerated washbasin/kitchen taps and shower heads,
- tapered and low-capacity baths,
- sensor and low flush toilets, shower timers, and,
- water efficient white goods and appliances such as washing machines and dishwashers.

Water use during construction can be reduced through measures including:

- closed loop wheel washers,
- waterless wheel washing using angled steel grids to remove debris,
- high pressure low volume power hoses, recirculating water where possible,
- limiting the water used for flushing building services by stopping it as soon as the flush water turns clear, and employing a regime for monitoring water use and water waste.

Choosing the best location for a boiler can reduce water consumption and heat loss. By minimising the length of hot water pipes the volume of water that must be drawn off each time a tap or shower is used can be reduced. Positioning hot water pipes above pipes carrying cold water will reduce heat transfer. Further heat loss can be reduced by insulating the piping.

For all new dwellings, a completed "water efficiency calculator for new dwellings" worksheet that accords with Part G of the building regulations' Approved Documents should be provided prior to occupation. The calculation must demonstrate that the new dwellings will achieve a maximum water usage of 110 litres per person per day.

Rainwater harvesting

Rainwater harvesting is the collection of rainwater directly from a surface it falls on (e.g., a roof). Once collected and stored it can be used for non-potable purposes such as watering gardens, supplying washing machines and flushing toilets, thereby reducing consumption of potable water. Potable water is produced through a purification process and is pumped over large distances, both of which require energy and result in embodied carbon that is not present in water harvested locally. In a residential development, rainwater can be captured for domestic use using water butts connected to a down pipe. Larger systems can use water stored in underground water tanks.

Schemes should be designed to include space for water storage. In residential developments, down pipes should be carefully placed so that water collection and use is convenient for residents.

Greywater re-use

Water that is recycled from bathrooms and kitchens for non-potable uses is known as greywater. Greywater systems must ensure treatment on a regular basis to prevent a build-up of bacteria, and some systems are powered, which entails an energy cost. As a result, greywater reuse is generally less preferable than water use minimisation measures.

Water recycling systems are better suited to new developments rather than retrofitting in existing buildings because of the excavation required for storage tanks and changes needed to the plumbing system, and they are generally more cost effective for new developments and developments of a larger scale.

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

Controls and Monitoring

Advanced lighting and space conditioning controls will be incorporated, specifically:

- For areas of infrequent use, occupant sensors will be fitted for lighting, whereas day lit areas will incorporate daylight sensors where appropriate;
- Heating and cooling systems controls will comprise time and temperature controls, both centrally for the whole building, and locally for each space;
- Smart metering to be installed on all new dwellings for adequate monitoring;

Overheating Risk analysis

Passive solar gain refers to the process whereby a building is heated by the sun, either directly from sunlight passing through a window and heating the inside of the building, or indirectly as sunlight warms the external fabric of the building and the heat travels to the interior. The level of passive solar gain can significantly impact upon the quality of a building, how it is used and the energy needed for it to be inhabited comfortably. Passive solar gain can reduce the need for mechanical heating, which in turn reduces energy use and carbon emissions.

Key factors that influence passive solar gain include the physical characteristics of the site, immediate surroundings, orientation of buildings, external design, internal layout and the construction materials used.

Whilst passive solar gain can reduce the carbon emissions associated with heating, if used incorrectly it can lead to overheating, which in turn can lead to the installation of mechanical cooling equipment (e.g., air conditioning). Mechanical cooling increases energy consumption and requires maintenance, resulting in costs and carbon emissions. Mechanical cooling units also produce heat that requires dissipation. The need for mechanical cooling can be avoided or lessened by designing-in passive ventilation and passive cooling measures. Developments should not incorporate mechanical cooling unless passive measures have been fully explored and appraised and proposals that include mechanical cooling should clearly demonstrate that passive measures would not be adequate.

The potential overheating for the development is to be assessed in accordance to Part O of the Building Regulation at the post-planning stage when the design is confirmed and finalised. Utilising the simplified approach is the first protocol to ensure the scheme does not over heat, where the simplified approach fails to meet the required reduction, a dynamic simulation will need to be undertaken. Overheating analysis will begin after the planning stage.

The following list includes some of the key considerations in the design of new schemes:

- Rooms that are most frequently occupied should benefit from a southerly aspect, but with appropriate measures to avoid overheating.

- Orientation and layout of habitable rooms, and window size and orientation, should be carefully considered in relation to the path of the sun.

- Rooms that include a concentration of heat generating appliances (e.g., kitchens) or are less frequently occupied (e.g. bathrooms) should be located in the cooler part of the building, generally the northern side.

- Conservatories and atria can be used to assist natural ventilation in the summer by drawing warm air upward to roof vents, and to collect heat during the spring and autumn.

- Deep projections that overshadow windows should be avoided, particularly on south facing elevations. Projections should be sized appropriately so that they provide shading from the sun during the hottest part of the year but allow solar gain in the colder months.

- Where there is a chance that overheating can occur (e.g., due to large expanses of glazing on roofs and south facing elevations), design measures such as roof overhangs, brise soleil, external shuttering, photochromatic and thermochromic glass and a lighter colour palette can help.

- Zonal heating and ventilation systems and controls can be used allowing areas subject to high solar gain to occupy their own temperature control zone. Dynamic controls reduce energy waste.

- Use of materials to build in thermal mass to absorb excess heat during warmer periods and release it slowly during cooler periods (e.g., day/night, summer/winter).

- Buildings should be designed for passive ventilation:
    - cross ventilation with windows located on opposite walls and/or roof mounted turbines or wind cowls that assist with circulation of air by drawing air through windows or top floor openings and
    - passive stack ventilation (PSV) that uses pressure differences to draw in fresh air from outside to replace rising warm air which is released from the top of the building. A heat exchanger can be placed where the air escapes the building to reduce heat loss.

Be Lean CO_2 emissions & savings

By means of energy efficiency measures and suitable heating systems, regulated CO_2 emissions for the property are shown to reduce by **56.62%** compared to the baseline.

Be Clean – Supply energy efficiently

There are no changes from the previous stage, however research into low carbon energy sources is still completed as a due diligence for the alternative solutions. Carbon Emissions Reduction is shown to remain at **56.62%** compared to the baseline.

Low Carbon Energy Sources

Combined Heat and Power (CHP)

The presence of a year-round base hot water generation heat load in residential units is favourable to CHP. To date, there are readily available micro gas fired CHP units (such as EC power) on the market. At this stage gas fired CHP will be provisionally incorporated into the development's LZC strategy, however, the carbon reductions due to CHP are extremely sensitive to the system design, unit selection and running time.

CHP (Combined Heat & Power) is a great technology to use, however the system itself needs to run on a 24-hour basis. The heat generated would be exceeding the demand and needs for this site, and would require to have an outlet area which can profit from this excess; however, this development does not have a space that benefit from this; therefore, this option has considered not feasible for this development.

Heat Networks

All new developments should look connect, or be connection ready, where a heat distribution network already exists. The investigation of opportunities should cover all scales and should not be limited to district heating systems.

Where such networks exist and developments should propose to connect to them, the energy statement should set out details showing how connection will occur (a connection strategy). Where such networks exist, and developments do not propose to connect to them, the energy statement must set out clear reasons as to why the connection is not feasible, or why an alternative source of energy would be more sustainable.

The development is currently located in a site where local heat networks are present, so therefore it is concluded that connection into a heat network is not feasible.

Be Green – Use renewable energy

Renewable technologies feasibility study

Methods of generating on-site renewable energy (Green) were assessed, once Lean and Clean measures were considered.

This section provides an overview of the technologies considered, a brief assessment of their feasibility, a proposed mixture of suitable technologies.

The proposed development will benefit from an energy efficient building fabric which will reduce the energy consumption of the proposed development in the first instance.

A range of renewable technologies were subsequently considered including:

- Biomass;
- Ground/water source heat pumps;
- Wind energy;
- Photovoltaic panels, and,
- Solar thermal panels.

In determining the appropriate renewable technology for the site, the following factors were considered:

- CO_2 savings achieved;
- Site constraints;
- Financial benefit
- Any potential visual impacts

Demand profiles

The balance of technologies chosen will depend on the development's energy demand patterns.

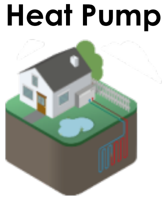
Keeping in mind that the space heating energy demand changes according to the season. While hot water energy demand will provide a significant base load throughout the year.

Electrical demand is likely to be moderate throughout the year. Lighting loads will be highest during the evening but will continue at reduced levels throughout the night and during the day.

Feasibility

At this early stage in the design, it is possible only to outline the likely feasibility of specific technologies. Further descriptions of the LZC technologies below are included in Appendix A.

Table 6. Renewable and Low Zero Carbon Technologies

Renewable Technology	Comments	Lifetime (Years)	Maintenance	External Impact	Site Feasibility	Adopted for Site
BIOMASS 	Burning of wood pellets releases high NOx emissions and there are limitations for their storage and delivery within an urban location.	20	High	High	1	☐
PV 	PV panels would generate significant carbon savings, whilst having minimal impact on the appearance of the building. While feasible, these are not required.	25	Low	Med	9	☐
Solar Thermal 	Solar thermal array mounted on the roof may contribute to carbon reductions, but will reduce the amount of available roof space where Photo voltaics are proposed	25	Low	Med	7	☐
Air/Ground Source Heat Pump 	Ground loops requires space, additional time at the beginning of the construction process and very high capital costs, however in terms of the air source heat pump solution is a viable and cost-effective solution to meet the required carbon reductions.	20	Med	Low	9	▣
Wind 	Due to insufficient open area for installation of a stand-alone wind turbine and planning issues this option has not considered in this development.	25	Med	High	0	☐

Detailed assessment of Photovoltaic Panels

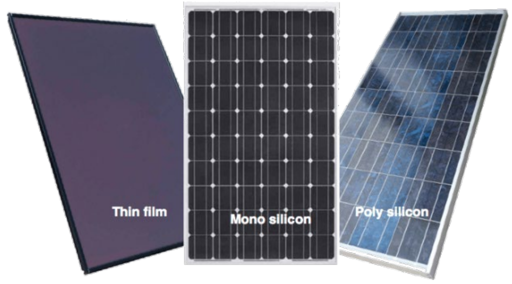


Fig 3. Photovoltaic Panels

Four types of solar cells are available on the market at present and these are mono-crystalline, polycrystalline, thin film and hybrid panels as seen in Figure 3. Although mono-crystalline and hybrid cells are the most expensive, they are also the most efficient with an efficiency rate of 12-20%. Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but can be produced as thin and flexible sheets.

Air Source Heat Pumps is considered as a highly efficient low zero carbon technology solution to meet the required carbon reductions for the houses.

Photovoltaic Panel is considered a suitable technology as the development provides an extent of roof space for the installation of PV panels; however, they were not required in order to meet the reduction, which was met using a highly efficient air-source heat pump.

Be Green CO_2 emissions & savings

After the Be Green stage, the incorporation of a highly efficient Mitsubishi heat pump furthers the reduction to **60.97% from the baseline**, with overall emissions being **0.37 Tonnes CO_2/Year.**

Flood zone risk assessment for planning

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

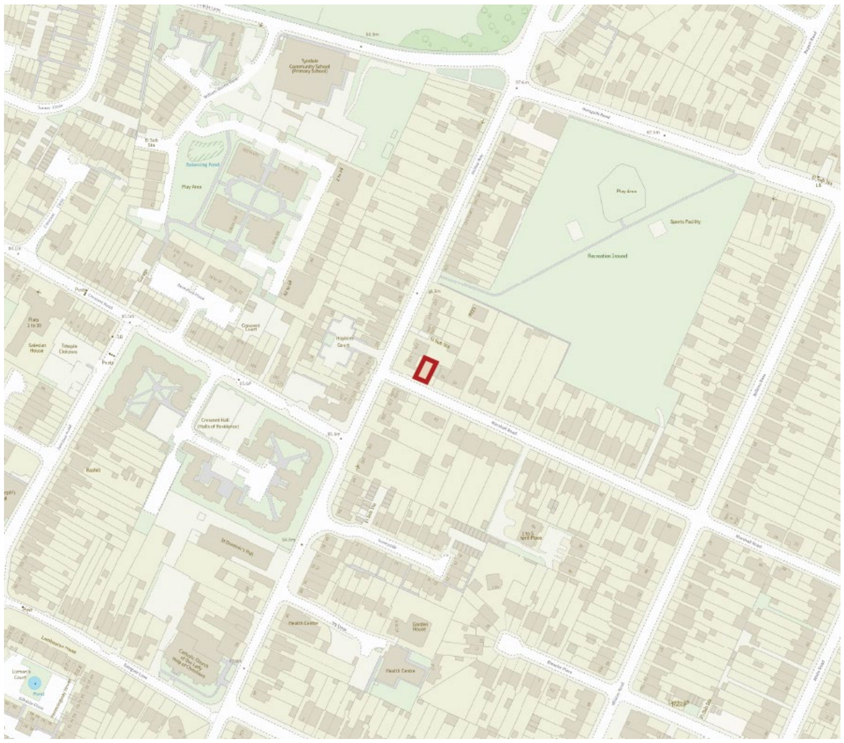


Fig 4. Environment Agency Flood Zone Interactive Map

The whole of the development lies within flood zone 1 of the Environment Agency's flood risk map as seen in fig. 4. Land located within flood zone 1 is at low risk of flooding having an associated annual probability of flooding of less than 1 in 1000 (0.1%).

Study approach

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

Flood vulnerability

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

Biodiversity

Biodiversity is globally recognised as a foundation of healthy ecosystems, and biodiversity conservation is increasingly becoming one of the significant aims of environmental management.

Oxford is a city with a rich natural environment; the two rivers and their valleys and areas of real significance in terms of landscape and biodiversity are located in close proximity to large parts of the community.

Green spaces are particularly valuable in a compact city, and will become more important with the population increasing. The Local Plan focuses on ensuring that green spaces are as high-quality and as multi-functional as possible, in addition to this it is to be a key design factor to be considered with each new proposed development. The biodiversity element will aim to provide a network of green spaces connecting wildlife corridors and green accessible routes.

The most important sites and species for biodiversity and geodiversity must be protected and due care must be made to ensure that the proposal does not negatively impact these sensitive locations.

The City Council will require an assessment of the proposals impact on biodiversity, where appropriate, this assessment is not a mandatory requirement for all developments and should be required where needed will demonstrate on-site mitigation measures and then compensation measures to off-set any losses resulted by the proposed development.

Sustainable Urban Drainage Systems (SuDS)

SuDS offer multiple benefits – they can help to manage flood risk, improve water quality, provide opportunities for water efficiency, enhance landscape and visual quality, provide amenity value and offer opportunities for biodiversity. The design of SuDS should explore fully the potential to deliver these benefits.

SuDS limit the volume and rate of surface water entering the public sewer system. They therefore have the potential to play an important role in helping to ensure the sewerage network has the capacity to cater for population growth and is resilient to the effects of climate change.

Conclusion

Following the implementation of the three-step Energy Hierarchy, the regulated CO_2 savings for the site are calculated at **60.97%**, against Part L 2021 SAP 10 performance standards. The baseline annual emissions of the site on this development have been calculated to be **0.95 Tonnes CO_2/Year**. By incorporating on-site renewable/ LZC technologies the total CO2 emissions will be reduced to **0.37 Tonnes CO_2/Year**.

Overall, the proposed development has been designed to meet energy policies set out by the proposed development local and national planning requirements, which demonstrates the client and the design team's commitment to enhancing sustainability of the scheme.

The new development will be designed with a high level of insulation and low air permeability to reduce heat loss as much as is practically possible, also the use of low energy lighting and A – Rated White goods are essential for the reduction of energy consumption.

The control strategy throughout the proposed site must be carefully designed to ensure the most economical operation of all equipment.

To achieve the required reduction of carbon emissions, several options were considered, however the best option in regards to site location and the development size, was the installation of an Air Source Heat Pump. Different possible renewable energy options have been identified; bearing in mind that selection is a complex process which requires a more detailed estimation of energy demand patterns; therefore, further analysis will be undertaken as the design progresses.

The proposed development site is not in a close proximity of an existing heat network making this an unviable solution to improve the heating system in the dwelling at time of this application.

The dwelling is to have suitable meter/smart meter management installed on every household, so that the homeowner can benefit from accurate savings to allow for suitable management of energy usage.

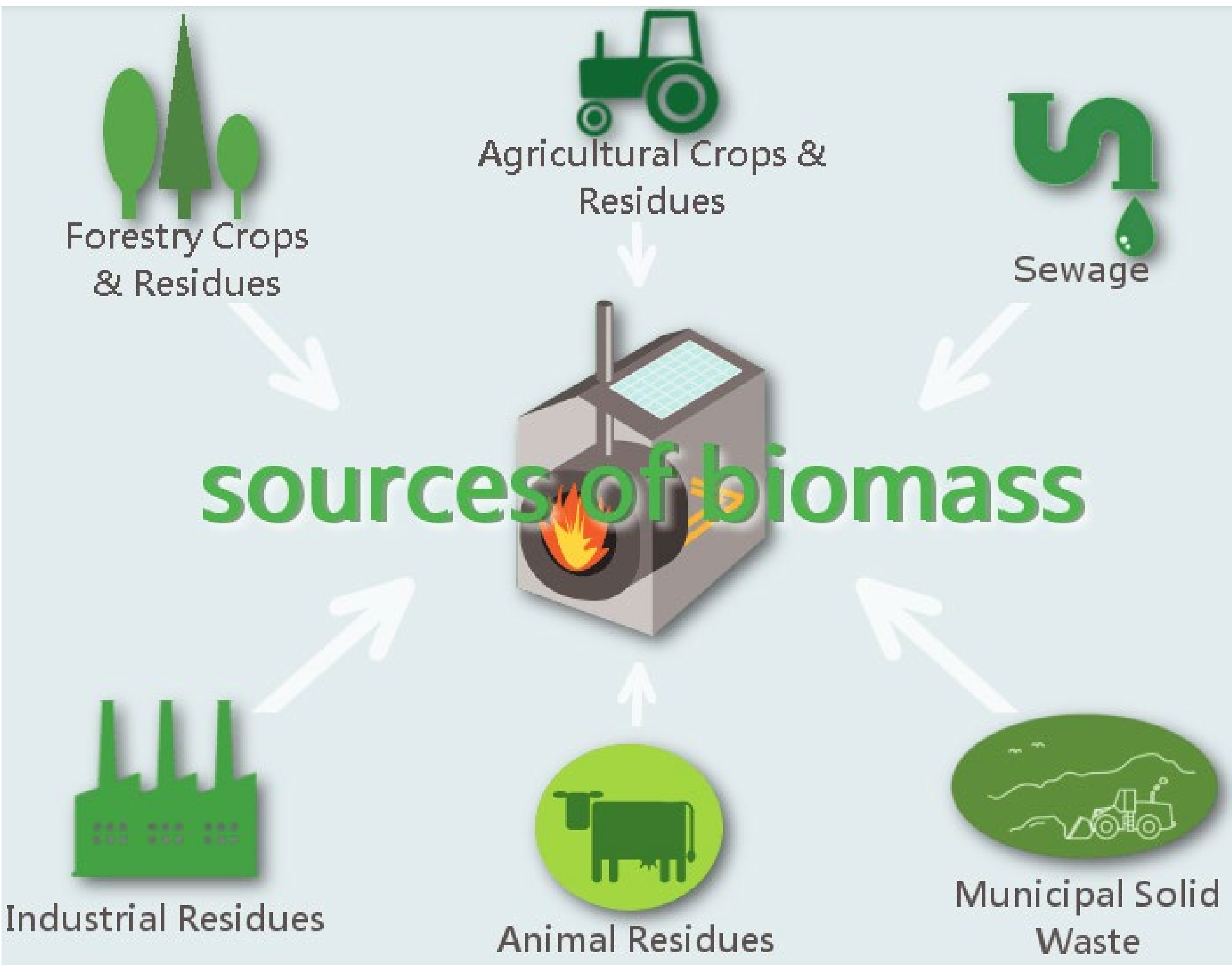
Post construction the dwelling is to have suitable testing to be provided to ensure the dwellings satisfy the requirements of this document and building regulation standards at the time of completion. This report is to be provided along with as As-Built SAP worksheets, EPC and Air testing, for all conditioned spaces in the development.

Appendix A - Low or Zero Carbon Energy Sources

Biomass As a fuel

Biomass is a renewable energy source, generated from burning wood, plants and other organic matter, such as manure or household waste. It releases CO2 when burned, but considerably less than fossil fuels. We consider biomass a renewable energy source, if the plants or other organic materials being burned are replaced.

Biomass is known for its versatility, given it can be used to generate heat, electricity, be used in combined heat and power units and be used as liquid fuel. In domestic settings, it tends to be found in the form of wood-fuelled heating systems.



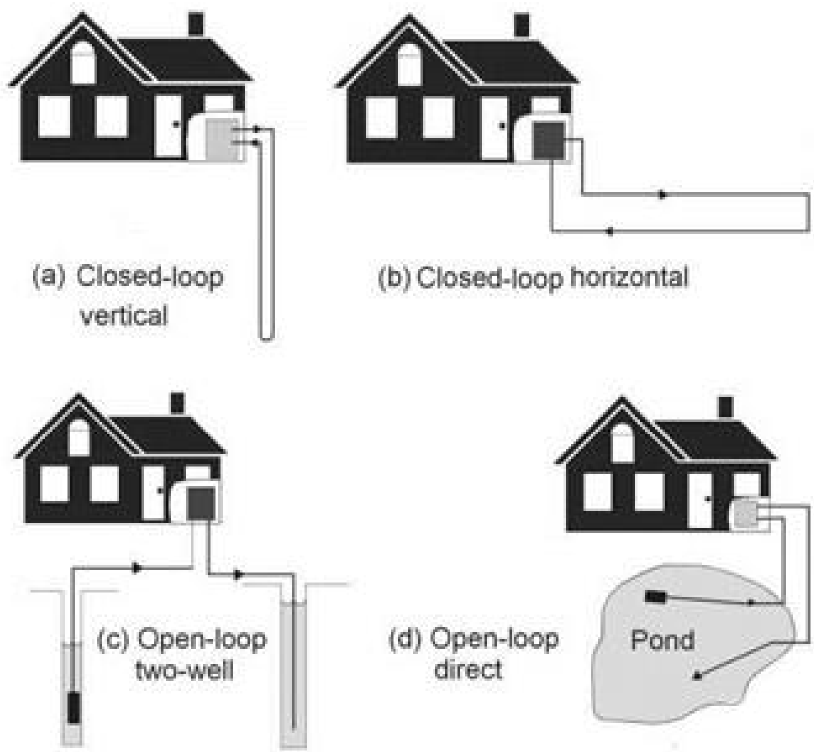
Geothermal Energy:

Geothermal energy technologies use the heat energy stored in ground; either for direct-use applications: such as using the grounds' heat to defrost a driveway or the indirect use with additional equipment such as a geothermal heat pump. Most commercial installations couple a heat pump with the ground to upgrade the low-grade heat from the ground or ground water to a higher-grade heat, where it can be used for heating purposes.

The suitability of a ground source system depends heavily on the type of earth coupling heat exchange system used:

Ground source earth coupling options

The right choice of appropriate heat exchanger depends on several factors such as: size of space heating/hot water system, available site area for the heat exchangers, and local ground conditions. Due to the specialist nature of this technology, we recommend that a specialist is employed to size the heat exchangers based on a desk-top study of the site's geological conditions – this normally being required in advance of any other contractor appointment.



Vertical Closed Loop System

A frequently used and simple ground source heat exchanger, for a small to medium size project, is a closed loop vertical system. The system comprises of vertically drilled boreholes, usually up to 100 m deep, into which are inserted two polyethylene pipes with a U-shape connector at the base of the hole – effectively providing a flow down to the bottom of the hole and return back up to the surface. All the flow and return loops are connected together across the site - completing the entire heat exchange loop.

Water is pumped around the loop and is then circulated around the heat pump to achieve the required heat exchange. The distance between boreholes is dependent on ground conditions but is typically a minimum of a 6mx6m grid, to prevent overlapping of the heat exchange process between loops.

Horizontal Closed Loop System

Horizontal closed loop heat exchangers are usually applied to small projects such as individual houses, which usually require a relatively low heat output. Consisting of horizontal trenches 1.5-2m deep, with either straight pipes or 'slinky' coiled pipes, these require significant excavation work and significant site area to achieve appreciable outputs as such are not normally suited to medium to large projects.

Vertical Open Boreholes System

A further option is a vertical open borehole system. The system involves the abstraction and discharge of natural ground water using boreholes; into which pumps are inserted, connected to collapsible pipework. Each borehole pump abstracts ground water, circulates it around the heat pump and then discharges the water back to the ground via an absorbing well, some distance from the original abstraction borehole. The system is capable of providing very high rates of heat exchange for a relatively small number of boreholes, which makes it very efficient in terms of site area required. However, this depends greatly on the availability of ground water, which in turn varies according to location. A major downside of this system is that the extraction of water from deep boreholes via pumps consumes a lot of energy, as the water has to be physically lifted to the surface by the pump – this in effect reduces the carbon emissions saved by this system as a whole.

Ground source heat exchange options in summary:

Vertical loop system - closed boreholes

- moderate heat capacity
- relatively low installation cost

Vertical open system - open boreholes

- high heat capacity
- high running energy
- high installation cost

Horizontal loop system – straight pipes

- low capacity,
- high installation cost
- extensive ground excavation work

Horizontal coiled loop system – 'slinky' pipes

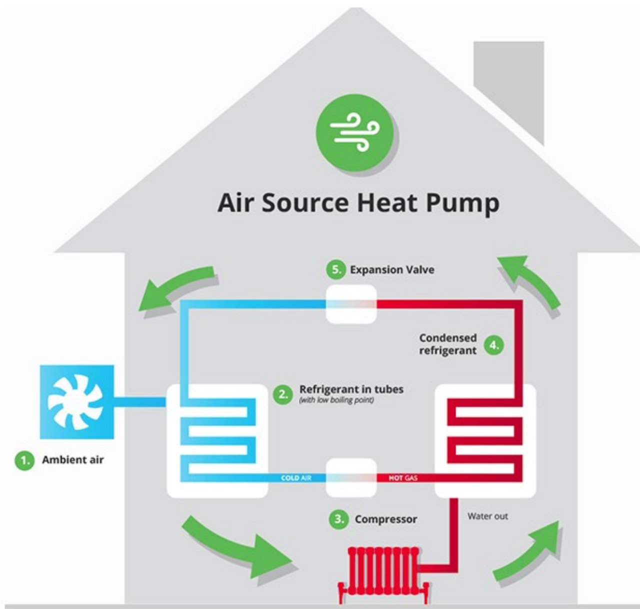
- good capacity
- low installation cost
- extensive ground excavation work

Air Source Heat Pumps

Heat pumps are basically refrigeration units which work in reverse – instead of cooling being produced and heat rejected, the unit produces heat and rejects cooling. Conventional heat pumps use air as the medium to reject this 'coolth' to atmosphere. Ground source units use the ground as a means of improving the unit efficiency because the ground is a constant 11-13 °C at depths of 50m down – this suits the heat pump much better during the coldest weather than the extremes of air temperature. Reversible heat pumps can also be used for cooling, however this is not being considered further for this project.

A heat pump consumes electrical power to drive the compressor and other ancillary elements. The ratio between total energy input and heat energy output of the heat pump is a measure of its efficiency – usually referred to as 'Coefficient of Performance' - COP. A ground source heat pump has a higher COP than an air cooled heat pump – this additional energy effectively being the grounds' natural contribution to the system.

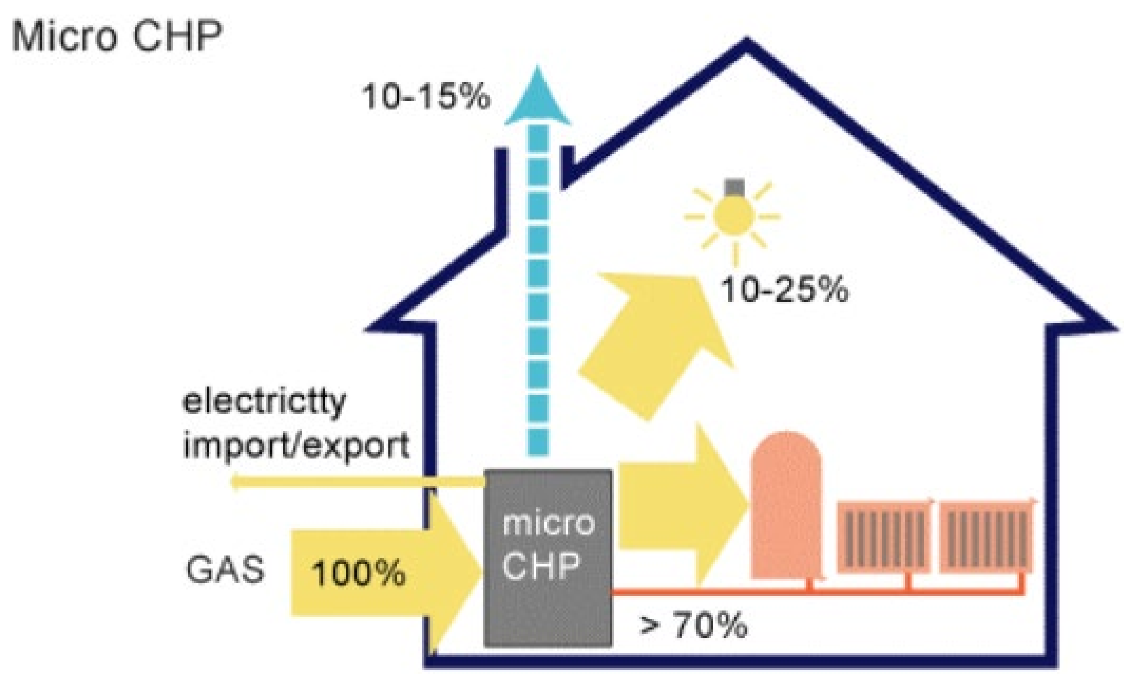
The heat produced by a heat pump is usually used to either provide space heating say to underfloor heating or radiators or the heat is used to generate domestic hot water via a storage vessel.



CHP

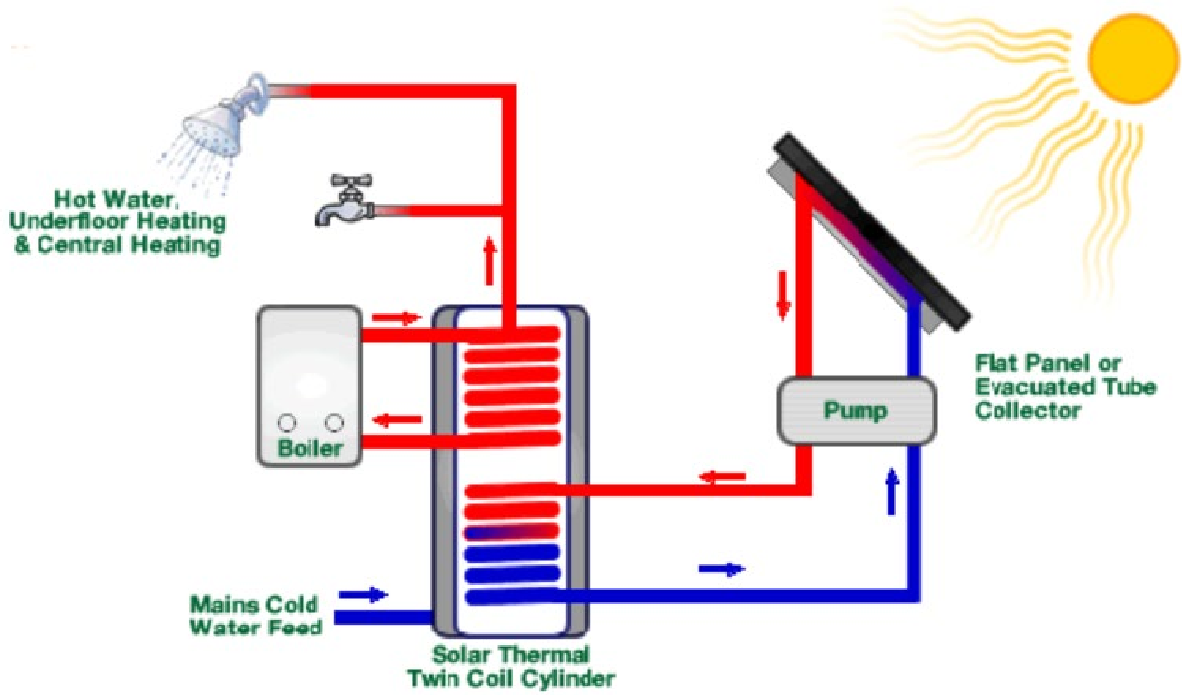
Combined heat and power (CHP) is a process involving simultaneous generation of heat and electricity, where the heat generated in the process in harnessed via heat recovery equipment. CHP at the large commercial size is now fairly common in premises which have a simultaneous demand for heating and electricity for long periods, such as hospitals, recreational centres and hotels. In addition, small CHP systems are now becoming available for individual houses, group residential units and small non-domestic premises. Compared with using centrally generated electricity supplied via the grid, CHP can offer a more efficient and economic method of supplying energy demand, if installed and operated appropriately, owing to the utilization of heat which is normally rejected to the atmosphere from central generating stations, and by reducing network distribution losses due to local generation and use.

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



Solar thermal collectors

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



Photovoltaic

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

Currently, a PV system will cost between £1500 and £2500 per kWp, and frequently part of this cost can be offset owing to the displacement of a conventional cladding material. Costs have fallen significantly since the first systems were installed (1980s) and are predicted to fall further still.

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

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials on a low-cost backing such as glass, stainless steel or plastic. As much less semiconductor material is required as for crystalline silicon cells, material costs are potentially much lower. Efficiencies are much lower, around 4–5%, although this can be boosted to 8–10% by depositing two or three layers of thin film material. Thin film production also requires less handling as the films are produced as large, complete modules and not as individual cells that have to be mounted in frames and wired together. Hence, there is the potential for significant cost reductions with volume production.

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

Wind energy

Wind power is the most successful and fastest spreading renewable energy technology in the UK with a number of individual and group installations of varying size, capacity and location. Traditionally, turbines are installed in non-urban areas with a strong trend for large offshore wind farms. In parallel with the design and development of ever-bigger machines, which are deemed to be more efficient and cost-effective, it is being increasingly recognized that smaller devices installed at the point of use, i.e. urban settings, can play an important role in reducing carbon emissions if they become mainstream.

At present there is a wide range of available off-the-shelf wind products, many manufactured in the UK and EU with proven good performance and durability. The dominant type is horizontal axis wind turbines (HAWT), which are typically ground mounted. Vertical axis wind turbines (VAWT) have limited market presence and there is a trade-off between lower efficiency and potentially higher resistance to extreme conditions. Capacity ranges from 500W to more than 1.5MW, but, for practical purposes and in built-up areas in particular, machines of more than 1kW and below 500kW are likely to be considered.
Wind technology is also currently one of the most cost-effective renewable energy technologies, which is attributable to the large scale of installations reducing the unit output cost. Individual building or community wind projects, although smaller, have the advantage of feeding electricity directly into the building's electricity circuit, thus sparing costly distribution network development and avoiding distribution losses. The downside is the still high capital cost per kW installed for smaller turbines, plus location constraints, such as visual intrusion and noise. The wind regime in urban areas is also a concern owing to higher wind turbulence which reduces the potential electricity output.

In most cases, wind turbines are connected to the electricity grid and all generated energy is used regardless of the building demand fluctuations. The output largely depends on the wind speed and the correlation between the two is a cube function. This means that in short periods of above-average wind speeds the generation increases exponentially. As a result, it is difficult to make precise calculations of the annual output of a turbine, but average figures can provide useful guidance to designers and architects. In reasonably windy areas (average wind speed of 6m/s) the expected output from 1kW installed is about 2500kWh annually.

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

Building-integrated wind turbines are starting to be a reality in the UK, but potential projects may face difficulties with obtaining planning permission. There are a few examples now of permitted development rights for certain rooftop turbines in some local councils. A number of horizontal axis devices specifically designed for building integration are now available commercially, having design and reliability parameters relevant to the urban context. Building-mounted vertical axis devices are under development. At present, turbines installed near buildings, as well as community installations for groups of buildings, should be regarded as the larger wind energy source related to buildings, when they contribute to the carbon emissions from these premises using 'private wire' networks. However, the contribution of several building-integrated turbines in a development is likely to become significant in the next few years.

Appendix B-Fuel prices and emission factors

	Standing Charge £	Unit Price p/kWh	Emission Kg CO2 p/kWh	PE Factor	Fuel Code
Gas fuels:					
mains gas	92	3.64	0.210	1.130	1
bulk LPG	62	6.74	0.241	1.141	2
bottled LPG (for main heating system)		9.46	0.241	1.141	3
bottled LPG (for secondary heating)		11.20	0.241	1.133	5
LPG subject to Special Condition 11F (a)	92	3.64	0.241	1.163	9
biogas (including anaerobic digestion)	62	6.74	0.024	1.286	7
Liquid fuels:					
heating oil		4.94	0.298	1.180	4
bio-liquid HVO from used cooking oil (d)		6.79	0.036	1.180	71
bio-liquid FAME from animal/vegetable oils (e)		6.79	0.018	1.180	73
B30K (0		5.49	0.214	1.136	75
bioethanol from any biomass source		47	0.105	1.472	76
Solid fuels: (g)					
house coal		5.58	0.395	1.064	11
anthracite		4.19	0.395	1.064	15
manufactured smokeless fuel		5.91	0.366	1.261	12
wood logs		5.12	0.028	1.046	20
wood pellets (in bags for secondary heating)		6.91	0.053	1.325	22
wood pellets (bulk supply for main heating)		6.25	0.053	1.325	23
wood chips		3.72	0.023	1.046	21
dual fuel appliance (mineral and wood)		4.77	0.087	1.049	10
Electricity: (a)					
standard tariff	81 30	16.49	0.136 (s)	1.5010t)	
7-hour tariff (high rate) (h)	7 32	19.60	0.136 (s)	1.5010t)	
7-hour tariff (low rate) (h)		9.40 31	0.136 (s)	1.501 (t)	
10-hour tariff (high rate) (">	21 34	20.54	0.136 (s)	1.501 (t)	
10-hour tariff (low rate) fib)		12.27 33	0.136 (a)	1.501 (0	
18-hour tariff (high rate) (">	26 38	17.41	0.136 (s)	1.501 (0	
18-hour tariff (low rate) 00		14.17 40	0.136 (s)	1.501 (t)	
24-hour heating tariff	26 35	14.04	0.136 (s)	1.501 0)	
electricity sold to grid, PV		5.59 (0 60	0.136 (s)	0.501 0)	
electricity sold to grid, other		5.59 () 36	0.136 (s)	0.501 0)	
electricity, any tariff 0)		N/A 39	0.136 (s)	1.501 0t)	
Heat networks: (k)	92 0)				
heat from boilers - mains gas		4.44 51	0.210	1.130	
heat from boilers - LPG		4.44 52	0.241	1.141	
heat from boilers - oil (assumes 'gas oil')		4.44 53	0.335	1.180	
heat from boilers that can use mineral oil or biodiesel		4.44 56	0.335	1.180	
heat from boilers using HVO from used cooking oil		4.44	0.036	1.180	

	57		
heat from boilers FAME from animal/vegetable oils (a)	4.44 58	0.018	1.180
heat from boilers - B30D 0)	4.44 55	0.269	1.090
heat from boilers - coal	4.44 54	0.375	1.064
heat from electric heat pump	4.44 41	0.136 (s)	1.501 0)
heat recovered from waste combustion	4.44 42	0.015 0')	0.063
heat from boilers - biomass	4.44 43	0.029	1.037
heat from boilers - biogas (landfill or sewage gas)	4.44 44	0.024	1.286
heat recovered from power station	3.77 45	0.015 0')	0.063
high grade heat recovered from process (Appendix C4.3)	3.77 47	0.011	0.051
low grade heat recovered from process (Appendix C4.4)	3.77 49	0.136 001)	1.501 (001)
heat recovered from geothermal or other natural processes	3.77 46	0.011	0.051
heat from **CHP**	3.77 48	as above0D	as above0D

Appendix C, D, E, F, G and H

This appendix contains the following reports used in producing the content of this Energy and Sustainability Statement.

Appendix C- Flood risk map for planning to show the location of the site with regards to the relevant flood zone areas.

Appendix D- SAP calculation reports for the selected units that were used to base the calculations on for this report. (All hierarchy steps)

Appendix E- PEA Reports showing the draft EPC rating (Be Green Only)

Appendix F- BREL Compliance Report (Be Green Only)

Appendix G- Floor Plans and Elevations used for the SAP Calculations

Appendix H- Sample Water Calculations

Flood map for planning

Your reference	Location (easting/northing)	Created
<Unspecified>	**454845/204626**	**29 Nov 2023 16:25**

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger that 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Environment Agency

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
454845/204626

Scale
1:2500

Created
29 Nov 2023 16:25

Selected area

Flood zone 3

Flood zone 2

Flood zone 1

Flood defence

Main river

Water storage area

0 20 40 60m

Full SAP Calculation Printout

elmhurst energy

Property Reference	PR11113 - 112 Hollow Way				Issued on Date	30/11/2023
Assessment Reference	001-Be Lean		Prop Type Ref		112 Hollow Way	
Property	112, Hollow Way, Oxford, Oxfordshire, OX4 2NL					

SAP Rating	79 C	DER	5.40	TER	12.45
Environmental	96 A	% DER < TER			56.63
CO_2 Emissions (t/year)	0.37	DFEE	40.33	TFEE	40.70
Compliance Check	See BREL	% DFEE < TFEE			0.92
% DPER < TPER	13.05	DPER	56.61	TPER	65.11

Assessor Details	Mr. Riley Dixon	Assessor ID	AG83-0001
Client			

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

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		38.1400 (1b)	x	2.6300 (2b)	=	100.3082 (1b) - (3b)	
First floor		38.1400 (1c)	x	2.4000 (2c)	=	91.5360 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	76.2800						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	191.8442	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1564	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4064	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3149	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4016	0.3937	0.3858	0.3464	0.3386	0.2992	0.2992	0.2913	0.3149	0.3386	0.3543	0.3701	(22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.30)			13.6900	1.2357	16.9173			(27)
Door			1.9100	1.3000	2.4830			(26a)
NW SR Rooflights			0.4700	1.2357	0.5808			(27a)
NE SR Rooflights			0.6300	1.2357	0.7785			(27a)
Ground Floor			38.1400	0.1200	4.5768	75.0000	2860.5000	(28a)
External Wall	113.9900	14.1000	99.8900	0.1800	17.9802	60.0000	5993.4000	(29a)
Dormer Wall	2.4400	1.5000	0.9400	0.1800	0.1692	9.0000	8.4600	(29a)
Sloped Roof	17.6800	1.1000	16.5800	0.1400	2.3212	9.0000	149.2200	(30)
Plane Roof	26.3100		26.3100	0.1200	3.1572	9.0000	236.7900	(30)
Dormer Roof	2.0400		2.0400	0.1400	0.2856	9.0000	18.3600	(30)
Total net area of external elements Aum(A, m2)			200.6000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	49.2498			(33)
Internal Wall - Block			53.1400			75.0000	3985.5000	(32c)
Internal Wall - Timber			63.9100			9.0000	575.1900	(32c)
Internal Floor			38.1400			18.0000	686.5200	(32d)
Internal Ceiling			38.1400			9.0000	343.2600	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	14857.2000	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		194.7719	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	9.9700	0.0190	0.1894	
E3 Sill	7.2600	0.0220	0.1597	
E4 Jamb	19.6600	0.0170	0.3342	
E5 Ground floor (normal)	24.8600	0.0610	1.5165	
E6 Intermediate floor within a dwelling	24.8600	0.0010	0.0249	
R1 Head of roof window	2.6800	0.2400	0.6432	
R2 Sill of roof window	2.6800	0.2400	0.6432	
R3 Jamb of roof window	5.4800	0.2400	1.3152	
E11 Eaves (insulation at rafter level)	16.1900	0.0180	0.2914	
E12 Gable (insulation at ceiling level)	4.6000	0.0430	0.1978	
E13 Gable (insulation at rafter level)	2.2400	0.0430	0.0963	
E16 Corner (normal)	19.8800	0.0420	0.8350	
R4 Ridge (vaulted ceiling)	2.5800	0.1200	0.3096	
R5 Ridge (inverted)	2.5800	0.1200	0.3096	
R7 Flat ceiling (inverted)	1.4900	0.1200	0.1788	
R9 Roof to wall (flat ceiling)	1.4900	0.3200	0.4768	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				7.5216 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	56.7714 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	36.7583	36.5601	36.3659	35.4534	35.2827	34.4879	34.4879	34.3407	34.7940	35.2827	35.6280	35.9891	(38)
Heat transfer coeff	93.5297	93.3315	93.1373	92.2248	92.0541	91.2593	91.2593	91.1121	91.5654	92.0541	92.3994	92.7605	(39)
Average = Sum(39)m / 12 =												92.2240	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2261	1.2235	1.2210	1.2090	1.2068	1.1964	1.1964	1.1944	1.2004	1.2068	1.2113	1.2161	(40)
HLP (average)												1.2090	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.3885	(42)
Hot water usage for mixer showers	64.2668	63.3010	61.8936	59.2009	57.2137	54.9976	53.7380	55.1347	56.6658	59.0452	61.7958	64.0206	(42a)
Hot water usage for baths	27.7601	27.3478	26.7672	25.6967	24.8952	24.0064	23.5263	24.1028	24.7305	25.6816	26.7741	27.6662	(42b)
Hot water usage for other uses	39.0905	37.6691	36.2476	34.8261	33.4046	31.9832	31.9832	33.4046	34.8261	36.2476	37.6691	39.0905	(42c)
Average daily hot water use (litres/day)												120.5266	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.1174	128.3178	124.9084	119.7237	115.5135	110.9872	109.2475	112.6422	116.2224	120.9743	126.2389	130.7773	(44)
Energy conte	207.6579	182.7229	191.9796	163.8958	155.5034	136.4717	132.1254	139.4745	143.3139	164.1610	179.8505	204.7657	(45)
Energy content (annual)										Total = Sum(45)m =		2001.9222	
Distribution loss (46)m = 0.15 x (45)m	31.1487	27.4084	28.7969	24.5844	23.3255	20.4708	19.8188	20.9212	21.4971	24.6242	26.9776	30.7148	(46)
Water storage loss:													
Store volume												180.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8600	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.0044	(55)
Total storage loss	31.1364	28.1232	31.1364	30.1320	31.1364	30.1320	31.1364	31.1364	30.1320	31.1364	30.1320	31.1364	(56)
If cylinder contains dedicated solar storage	31.1364	28.1232	31.1364	30.1320	31.1364	30.1320	31.1364	31.1364	30.1320	31.1364	30.1320	31.1364	(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	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(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	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(64)
								Total per year (kWh/year) = Sum(64)m =				2642.4242	(64)
12Total per year (kWh/year)												2642	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	112.5653	100.0629	107.3523	96.6106	95.2239	87.4920	87.4507	89.8943	89.7671	98.1026	101.9155	111.6036	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	107.6111	119.1409	107.6111	111.1981	107.6111	111.1981	107.6111	107.6111	111.1981	107.6111	111.1981	107.6111	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	211.4907	213.6853	208.1549	196.3815	181.5196	167.5515	158.2200	156.0254	161.5557	173.3292	188.1911	202.1592	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	(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)	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	(71)
Water heating gains (Table 5)	151.2974	148.9031	144.2907	134.1813	127.9891	121.5167	117.5413	120.8257	124.6765	131.8583	141.5493	150.0049	(72)
Total internal gains	532.2266	543.5566	521.8841	503.5883	478.9472	459.0937	442.1997	443.2895	456.2577	474.6260	502.7658	521.6025	(73)

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6. Solar gains

[Jan]	Area	Solar flux	g	FF	Access	Gains

	m2	Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	factor Table 6d	W	
Northeast	5.6400	11.2829	0.6300	0.7000	0.7700	19.4479	(75)
Southwest	7.5500	36.7938	0.6300	0.7000	0.7700	84.8973	(79)
Northwest	0.5000	11.2829	0.6300	0.7000	0.7700	1.7241	(81)
Northeast	0.6300	26.0000	0.6300	0.7000	1.0000	6.5012	(82)
Northwest	0.4700	26.0000	0.6300	0.7000	1.0000	4.8501	(82)

Solar gains	117.4207	211.2836	317.4222	438.1680	529.8355	542.6734	516.2955	445.6947	359.0650	241.3085	142.7347	99.1129	(83)
Total gains	649.6472	754.8402	839.3062	941.7563	1008.7827	1001.7672	958.4952	888.9843	815.3228	715.9345	645.5006	620.7154	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	44.1250	44.2187	44.3109	44.7494	44.8323	45.2228	45.2228	45.2958	45.0716	44.8323	44.6648	44.4909	
alpha	3.9417	3.9479	3.9541	3.9833	3.9888	4.0149	4.0149	4.0197	4.0048	3.9888	3.9777	3.9661	
util living area	0.9814	0.9660	0.9362	0.8609	0.7292	0.5532	0.4114	0.4590	0.6878	0.8966	0.9667	0.9842	(86)
MIT	19.7607	19.9499	20.2119	20.5378	20.7707	20.8853	20.9140	20.9092	20.8332	20.5248	20.0904	19.7296	(87)
Th 2	19.8991	19.9012	19.9032	19.9128	19.9146	19.9229	19.9229	19.9244	19.9197	19.9146	19.9110	19.9072	(88)
util rest of house	0.9767	0.9578	0.9207	0.8283	0.6716	0.4709	0.3142	0.3573	0.6068	0.8645	0.9572	0.9803	(89)
MIT 2	18.4700	18.7091	19.0358	19.4323	19.6880	19.8014	19.8209	19.8203	19.7589	19.4293	18.8965	18.4368	(90)
Living area fraction									fLA = Living area / (4) =			0.2254	(91)
MIT	18.7609	18.9887	19.3008	19.6814	19.9320	20.0457	20.0672	20.0657	20.0010	19.6762	19.1655	18.7282	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7609	18.9887	19.3008	19.6814	19.9320	20.0457	20.0672	20.0657	20.0010	19.6762	19.1655	18.7282	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9703	0.9491	0.9104	0.8204	0.6726	0.4806	0.3275	0.3711	0.6134	0.8561	0.9487	0.9745	(94)
Useful gains	630.3778	716.4355	764.0744	772.6430	678.5424	481.4971	313.9317	329.8841	500.1137	612.9319	612.4029	604.9083	(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	1352.5212	1314.9216	1192.2362	994.3145	757.7858	496.9680	316.4175	333.9889	540.3287	835.4979	1114.8476	1347.6402	(97)
Space heating kWh	537.2747	402.1827	318.5523	159.6035	58.9571	0.0000	0.0000	0.0000	0.0000	165.5891	361.7602	552.5925	(98a)
Space heating requirement - total per year (kWh/year)												2556.5121	
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	537.2747	402.1827	318.5523	159.6035	58.9571	0.0000	0.0000	0.0000	0.0000	165.5891	361.7602	552.5925	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2556.5121	
Space heating per m2											(98c) / (4) =	33.5148	(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 %)	219.3000	(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	537.2747	402.1827	318.5523	159.6035	58.9571	0.0000	0.0000	0.0000	0.0000	165.5891	361.7602	552.5925	(98)
Space heating efficiency (main heating system 1)	219.3000	219.3000	219.3000	219.3000	219.3000	0.0000	0.0000	0.0000	0.0000	219.3000	219.3000	219.3000	(210)
Space heating fuel (main heating system)	244.9953	183.3939	145.2587	72.7786	26.8842	0.0000	0.0000	0.0000	0.0000	75.5080	164.9613	251.9802	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(64)
Efficiency of water heater												190.4000	(216)
(217)m	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	190.4000	(217)
Fuel for water heating, kWh/month	137.6348	121.7738	129.4004	113.7289	110.2428	99.3255	97.9644	101.8242	102.9191	114.7898	122.1084	136.1158	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	29.8221	23.9244	21.5412	15.7820	12.1905	9.9597	11.1206	14.4550	18.7756	24.6345	27.8247	30.6509	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1165.7602	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	190.4000	
Water heating fuel used	1387.8279	(219)
Space cooling fuel	0.0000	(221)

Electricity for pumps and fans:

Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	240.6812	(232)

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

PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	2794.2692	(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	1165.7602	0.1559	181.7089	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1387.8279	0.1409	195.5220	(264)
Space and water heating			377.2309	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	240.6812	0.1443	34.7377	(268)
Total CO2, kg/year			411.9687	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			5.4000	(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	1165.7602	1.5771	1838.4726	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1387.8279	1.5209	2110.7964	(278)
Space and water heating			3949.2689	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	240.6812	1.5338	369.1649	(282)
Total Primary energy kWh/year			4318.4338	(286)
Dwelling Primary energy Rate (DPER)			56.6100	(287)

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

1. Overall dwelling characteristics

	Area (m2)			Storey height (m)			Volume (m3)	
Ground floor	38.1400	(1b)	x	2.6300	(2b)	=	100.3082	(1b) - (3b)
First floor	38.1400	(1c)	x	2.4000	(2c)	=	91.5360	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 76.2800								(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	191.8442	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1564	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4064	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3149	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4016	0.3937	0.3858	0.3464	0.3386	0.2992	0.2992	0.2913	0.3149	0.3386	0.3543	0.3701	(22b)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Semi-glazed door			1.9100	1.0000	1.9100			(26a)
TER Opening Type (Uw = 1.20)			13.6900	1.1450	15.6756			(27)
NW SR Rooflights			0.4700	1.5918	0.7481			(27a)
NE SR Rooflights			0.6300	1.5918	1.0028			(27a)
Ground Floor			38.1400	0.1300	4.9582			(28a)
External Wall	113.9900	14.1000	99.8900	0.1800	17.9802			(29a)
Dormer Wall	2.4400	1.5000	0.9400	0.1800	0.1692			(29a)
Sloped Roof	17.6800	1.1000	16.5800	0.1100	1.8238			(30)
Plane Roof	26.3100		26.3100	0.1100	2.8941			(30)
Dormer Roof	2.0400		2.0400	0.1100	0.2244			(30)
Total net area of external elements Aum(A, m2)			200.6000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	47.3864			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 194.7719 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	9.9700	0.0500	0.4985
E3 Sill	7.2600	0.0500	0.3630
E4 Jamb	19.6600	0.0500	0.9830
E5 Ground floor (normal)	24.8600	0.1600	3.9776
E6 Intermediate floor within a dwelling	24.8600	0.0000	0.0000
R1 Head of roof window	2.6800	0.0800	0.2144
R2 Sill of roof window	2.6800	0.0600	0.1608
R3 Jamb of roof window	5.4800	0.0800	0.4384
E11 Eaves (insulation at rafter level)	16.1900	0.0400	0.6476
E12 Gable (insulation at ceiling level)	4.6000	0.0600	0.2760
E13 Gable (insulation at rafter level)	2.2400	0.0800	0.1792
E16 Corner (normal)	19.8800	0.0900	1.7892
R4 Ridge (vaulted ceiling)	2.5800	0.0800	0.2064
R5 Ridge (inverted)	2.5800	0.0400	0.1032
R7 Flat ceiling (inverted)	1.4900	0.0400	0.0596
R9 Roof to wall (flat ceiling)	1.4900	0.0400	0.0596

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 9.9565 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 57.3429 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	36.7583	36.5601	36.3659	35.4534	35.2827	34.4879	34.4879	34.3407	34.7940	35.2827	35.6280	35.9891	(38)
Heat transfer coeff	94.1012	93.9030	93.7088	92.7963	92.6256	91.8308	91.8308	91.6836	92.1369	92.6256	92.9709	93.3320	(39)

Average = Sum(39)m / 12 = 92.7955

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2336	1.2310	1.2285	1.2165	1.2143	1.2039	1.2039	1.2019	1.2079	1.2143	1.2188	1.2235	(40)
HLP (average)												1.2165	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.3885 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	64.2668	63.3010	61.8936	59.2009	57.2137	54.9976	53.7380	55.1347	56.6658	59.0452	61.7958	64.0206	(42a)
Hot water usage for baths	27.7601	27.3478	26.7672	25.6967	24.8952	24.0064	23.5263	24.1028	24.7305	25.6816	26.7741	27.6662	(42b)
Hot water usage for other uses	39.0905	37.6691	36.2476	34.8261	33.4046	31.9832	31.9832	33.4046	34.8261	36.2476	37.6691	39.0905	(42c)

Average daily hot water use (litres/day) 120.5266 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.1174	128.3178	124.9084	119.7237	115.5135	110.9872	109.2475	112.6422	116.2224	120.9743	126.2389	130.7773	(44)
Energy conte	207.6579	182.7229	191.9796	163.8958	155.5034	136.4717	132.1254	139.4745	143.3139	164.1610	179.8505	204.7657	(45)

Energy content (annual) Total = Sum(45)m = 2001.9222

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	31.1487	27.4084	28.7969	24.5844	23.3255	20.4708	19.8188	20.9212	21.4971	24.6242	26.9776	30.7148	(46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.5520 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8381 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(56)
If cylinder contains dedicated solar storage	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	256.9006	227.2001	241.2223	211.5500	204.7461	184.1259	181.3680	188.7172	190.9681	213.4037	227.5047	254.0083	(62)
WWHRS	-29.3801	-25.9840	-27.2089	-22.5301	-20.9972	-17.9675	-16.8416	-17.9094	-18.5898	-21.9154	-24.8275	-28.8360	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	227.5205	201.2161	214.0133	189.0199	183.7489	166.1584	164.5264	170.8078	172.3782	191.4883	202.6772	225.1723	(64)

Total per year (kWh/year) = Sum(64)m = 2308.7274 (64)

12Total per year (kWh/year) 2309 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	108.4404	96.3372	103.2274	92.6187	91.0990	83.5002	83.3258	85.7694	85.7752	93.9777	97.9236	107.4787	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	107.6111	119.1409	107.6111	111.1981	107.6111	111.1981	107.6111	107.6111	111.1981	107.6111	111.1981	107.6111	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	211.4907	213.6853	208.1549	196.3815	181.5196	167.5515	158.2200	156.0254	161.5557	173.3292	188.1911	202.1592	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	(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)	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	(71)
Water heating gains (Table 5)	145.7532	143.3589	138.7464	128.6371	122.4449	115.9725	111.9971	115.2815	119.1323	126.3141	136.0051	144.4606	(72)
Total internal gains	526.6823	538.0124	516.3398	498.0441	473.4030	453.5495	436.6555	437.7453	450.7135	469.0817	497.2216	516.0582	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	5.6400	11.2829	0.6300	0.7000	0.7700	19.4479	(75)
Southwest	7.5500	36.7938	0.6300	0.7000	0.7700	84.8973	(79)
Northwest	0.5000	11.2829	0.6300	0.7000	0.7700	1.7241	(81)
Northeast	0.6300	26.0000	0.6300	0.7000	1.0000	6.5012	(82)
Northwest	0.4700	26.0000	0.6300	0.7000	1.0000	4.8501	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	117.4207	211.2836	317.4222	438.1680	529.8355	542.6734	516.2955	445.6947	359.0650	241.3085	142.7347	99.1129	(83)
Total gains	644.1030	749.2960	833.7620	936.2120	1003.2384	996.2230	952.9510	883.4401	809.7785	710.3902	639.9564	615.1712	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	43.8570	43.9496	44.0407	44.4738	44.5557	44.9413	44.9413	45.0135	44.7920	44.5557	44.3902	44.2185	
alpha	3.9238	3.9300	3.9360	3.9649	3.9704	3.9961	3.9961	4.0009	3.9861	3.9704	3.9593	3.9479	
util living area	0.9820	0.9670	0.9379	0.8640	0.7339	0.5583	0.4160	0.4641	0.6933	0.8995	0.9678	0.9847	(86)
MIT	19.4301	19.6831	20.0347	20.4732	20.7899	20.9470	20.9871	20.9803	20.8751	20.4556	19.8713	19.3879	(87)
Th 2	19.8932	19.8953	19.8973	19.9068	19.9086	19.9169	19.9169	19.9185	19.9137	19.9086	19.9050	19.9012	(88)
util rest of house	0.9774	0.9590	0.9227	0.8318	0.6763	0.4752	0.3173	0.3610	0.6121	0.8680	0.9585	0.9809	(89)
MIT 2	18.0960	18.4152	18.8532	19.3843	19.7322	19.8849	19.9122	19.9105	19.8274	19.3795	18.6630	18.0479	(90)
Living area fraction										fLA = Living area / (4) =		0.2254	(91)
MIT	18.3966	18.7009	19.1194	19.6297	19.9706	20.1242	20.1544	20.1516	20.0635	19.6220	18.9353	18.3499	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3966	18.7009	19.1194	19.6297	19.9706	20.1242	20.1544	20.1516	20.0635	19.6220	18.9353	18.3499	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9689	0.9475	0.9093	0.8224	0.6798	0.4918	0.3394	0.3838	0.6242	0.8580	0.9475	0.9732	(94)
Useful gains	624.0702	709.9511	758.1496	769.9382	682.0029	489.9144	323.4267	339.0950	505.4506	609.5048	606.3512	598.6952	(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	1326.5102	1295.9459	1182.5530	995.6739	766.0650	507.2959	326.4071	343.9610	549.4567	835.6658	1100.3367	1320.6381	(97)
Space heating kWh	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(98a)
Space heating requirement - total per year (kWh/year)												2518.2909	
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	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2518.2909	
Space heating per m2										(98c) / (4) =		33.0138	(99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(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)	566.2138	426.6398	342.0977	176.0886	67.7597	0.0000	0.0000	0.0000	0.0000	182.3010	385.3408	581.9345	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	227.5205	201.2161	214.0133	189.0199	183.7489	166.1584	164.5264	170.8078	172.3782	191.4883	202.6772	225.1723	(64)
Efficiency of water heater												79.8000	(216)

(217)m	85.8629	85.5376	84.9305	83.7230	81.9080	79.8000	79.8000	79.8000	79.8000	83.7711	85.3076	85.9371	(217)
Fuel for water heating, kWh/month													
	264.9813	235.2371	251.9865	225.7682	224.3355	208.2186	206.1734	214.0449	216.0128	228.5852	237.5841	262.0200	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	22.3595	17.9376	16.1508	11.8328	9.1400	7.4674	8.3378	10.8378	14.0772	18.4701	20.8619	22.9809	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-35.6400	-50.2256	-72.1743	-81.1360	-87.4873	-81.6640	-80.6509	-76.1325	-68.1673	-57.4149	-39.1729	-30.8149	(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	-20.2045	-42.4944	-84.4434	-126.8044	-167.6443	-168.4326	-166.4539	-140.9520	-103.3325	-60.7687	-26.9755	-15.9783	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	2728.3759	(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	2774.9474	(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)	180.4537	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1885.1651	(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	3884.6119	(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	2728.3759	0.2100	572.9589	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2774.9474	0.2100	582.7390	(264)
Space and water heating			1155.6979	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	180.4537	0.1443	26.0450	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-760.6805	0.1346	-102.3804	
PV Unit electricity exported	-1124.4846	0.1259	-141.5742	
Total			-243.9546	(269)
Total CO2, kg/year			949.7176	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			12.4500	(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	2728.3759	1.1300	3083.0647	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2774.9474	1.1300	3135.6906	(278)
Space and water heating			6218.7553	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	180.4537	1.5338	276.7858	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-760.6805	1.4974	-1139.0612	
PV Unit electricity exported	-1124.4846	0.4621	-519.6750	
Total			-1658.7363	(283)
Total Primary energy kWh/year			4966.9057	(286)
Target Primary Energy Rate (TPER)			65.1100	(287)

Full SAP Calculation Printout

elmhurst energy

Property Reference	PR11113 - 112 Hollow Way	Issued on Date	30/11/2023
Assessment Reference	003-Be Green	Prop Type Ref	112 Hollow Way
Property	112, Hollow Way, Oxford, Oxfordshire, OX4 2NL		

SAP Rating	80 C	DER	4.86	TER	12.45
Environmental	96 A	% DER < TER			60.96
CO_2 Emissions (t/year)	0.34	DFEE	40.33	TFEE	40.70
Compliance Check	See BREL	% DFEE < TFEE			0.92
% DPER < TPER	21.47	DPER	51.13	TPER	65.11

Assessor Details	Mr. Riley Dixon	Assessor ID	AG83-0001
Client			

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	38.1400 (1b)	x	2.6300 (2b)	=	100.3082	(1b) - (3b)
First floor	38.1400 (1c)	x	2.4000 (2c)	=	91.5360	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 76.2800						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	191.8442	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1564	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4064	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3149	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4016	0.3937	0.3858	0.3464	0.3386	0.2992	0.2992	0.2913	0.3149	0.3386	0.3543	0.3701	(22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.30)			13.6900	1.2357	16.9173			(27)
Door			1.9100	1.3000	2.4830			(26a)
NW SR Rooflights			0.4700	1.2357	0.5808			(27a)
NE SR Rooflights			0.6300	1.2357	0.7785			(27a)
Ground Floor			38.1400	0.1200	4.5768	75.0000	2860.5000	(28a)
External Wall	113.9900	14.1000	99.8900	0.1800	17.9802	60.0000	5993.4000	(29a)
Dormer Wall	2.4400	1.5000	0.9400	0.1800	0.1692	9.0000	8.4600	(29a)
Sloped Roof	17.6800	1.1000	16.5800	0.1400	2.3212	9.0000	149.2200	(30)
Plane Roof	26.3100		26.3100	0.1200	3.1572	9.0000	236.7900	(30)
Dormer Roof	2.0400		2.0400	0.1400	0.2856	9.0000	18.3600	(30)
Total net area of external elements Aum(A, m2)			200.6000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		49.2498			(33)
Internal Wall - Block			53.1400			75.0000	3985.5000	(32c)
Internal Wall - Timber			63.9100			9.0000	575.1900	(32c)
Internal Floor			38.1400			18.0000	686.5200	(32d)
Internal Ceiling			38.1400			9.0000	343.2600	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	14857.2000	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		194.7719	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	9.9700	0.0190	0.1894	
E3 Sill	7.2600	0.0220	0.1597	
E4 Jamb	19.6600	0.0170	0.3342	
E5 Ground floor (normal)	24.8600	0.0610	1.5165	
E6 Intermediate floor within a dwelling	24.8600	0.0010	0.0249	
R1 Head of roof window	2.6800	0.2400	0.6432	
R2 Sill of roof window	2.6800	0.2400	0.6432	
R3 Jamb of roof window	5.4800	0.2400	1.3152	
E11 Eaves (insulation at rafter level)	16.1900	0.0180	0.2914	
E12 Gable (insulation at ceiling level)	4.6000	0.0430	0.1978	
E13 Gable (insulation at rafter level)	2.2400	0.0430	0.0963	
E16 Corner (normal)	19.8800	0.0420	0.8350	
R4 Ridge (vaulted ceiling)	2.5800	0.1200	0.3096	
R5 Ridge (inverted)	2.5800	0.1200	0.3096	
R7 Flat ceiling (inverted)	1.4900	0.1200	0.1788	
R9 Roof to wall (flat ceiling)	1.4900	0.3200	0.4768	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			7.5216	(36)
Point Thermal bridges		(36a) =	0.0000	
Total fabric heat loss		(33) + (36) + (36a) =	56.7714	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	36.7583	36.5601	36.3659	35.4534	35.2827	34.4879	34.4879	34.3407	34.7940	35.2827	35.6280	35.9891	(38)
Heat transfer coeff	93.5297	93.3315	93.1373	92.2248	92.0541	91.2593	91.2593	91.1121	91.5654	92.0541	92.3994	92.7605	(39)
Average = Sum(39)m / 12 =												92.2240	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2261	1.2235	1.2210	1.2090	1.2068	1.1964	1.1964	1.1944	1.2004	1.2068	1.2113	1.2161	(40)
HLP (average)												1.2090	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.3885	(42)
Hot water usage for mixer showers	64.2668	63.3010	61.8936	59.2009	57.2137	54.9976	53.7380	55.1347	56.6658	59.0452	61.7958	64.0206	(42a)
Hot water usage for baths	27.7601	27.3478	26.7672	25.6967	24.8952	24.0064	23.5263	24.1028	24.7305	25.6816	26.7741	27.6662	(42b)
Hot water usage for other uses	39.0905	37.6691	36.2476	34.8261	33.4046	31.9832	31.9832	33.4046	34.8261	36.2476	37.6691	39.0905	(42c)
Average daily hot water use (litres/day)												120.5266	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.1174	128.3178	124.9084	119.7237	115.5135	110.9872	109.2475	112.6422	116.2224	120.9743	126.2389	130.7773	(44)
Energy conte	207.6579	182.7229	191.9796	163.8958	155.5034	136.4717	132.1254	139.4745	143.3139	164.1610	179.8505	204.7657	(45)
Energy content (annual)										Total = Sum(45)m =		2001.9222	
Distribution loss (46)m = 0.15 x (45)m	31.1487	27.4084	28.7969	24.5844	23.3255	20.4708	19.8188	20.9212	21.4971	24.6242	26.9776	30.7148	(46)
Water storage loss:													
Store volume												180.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8600	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.0044	(55)
Total storage loss	31.1364	28.1232	31.1364	30.1320	31.1364	30.1320	31.1364	31.1364	30.1320	31.1364	30.1320	31.1364	(56)
If cylinder contains dedicated solar storage	31.1364	28.1232	31.1364	30.1320	31.1364	30.1320	31.1364	31.1364	30.1320	31.1364	30.1320	31.1364	(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	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(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	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(64)
								Total per year (kWh/year) = Sum(64)m =				2642.4242	(64)
12Total per year (kWh/year)												2642	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							0.0000	(64a)
Heat gains from water heating, kWh/month	112.5653	100.0629	107.3523	96.6106	95.2239	87.4920	87.4507	89.8943	89.7671	98.1026	101.9155	111.6036	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	107.6111	119.1409	107.6111	111.1981	107.6111	111.1981	107.6111	107.6111	111.1981	107.6111	111.1981	107.6111	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	211.4907	213.6853	208.1549	196.3815	181.5196	167.5515	158.2200	156.0254	161.5557	173.3292	188.1911	202.1592	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	(71)
Water heating gains (Table 5)	151.2974	148.9031	144.2907	134.1813	127.9891	121.5167	117.5413	120.8257	124.6765	131.8583	141.5493	150.0049	(72)
Total internal gains	529.2266	540.5566	518.8841	500.5883	475.9472	459.0937	442.1997	443.2895	456.2577	471.6260	499.7658	518.6025	(73)

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6. Solar gains

[Jan]	Area	Solar flux	g	FF	Access	Gains

	m2	Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	factor Table 6d	W	
Northeast	5.6400	11.2829	0.6300	0.7000	0.7700	19.4479	(75)
Southwest	7.5500	36.7938	0.6300	0.7000	0.7700	84.8973	(79)
Northwest	0.5000	11.2829	0.6300	0.7000	0.7700	1.7241	(81)
Northeast	0.6300	26.0000	0.6300	0.7000	1.0000	6.5012	(82)
Northwest	0.4700	26.0000	0.6300	0.7000	1.0000	4.8501	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	117.4207	211.2836	317.4222	438.1680	529.8355	542.6734	516.2955	445.6947	359.0650	241.3085	142.7347	99.1129	(83)
Total gains	646.6472	751.8402	836.3062	938.7563	1005.7827	1001.7672	958.4952	888.9843	815.3228	712.9345	642.5006	617.7154	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	44.1250	44.2187	44.3109	44.7494	44.8323	45.2228	45.2228	45.2958	45.0716	44.8323	44.6648	44.4909	
alpha	3.9417	3.9479	3.9541	3.9833	3.9888	4.0149	4.0149	4.0197	4.0048	3.9888	3.9777	3.9661	
util living area	0.9816	0.9664	0.9369	0.8619	0.7306	0.5532	0.4114	0.4590	0.6878	0.8977	0.9672	0.9845	(86)
Living	19.7573	19.9467	20.2091	20.5358	20.7696	20.8853	20.9140	20.9092	20.8332	20.5224	20.0871	19.7261	
Non living	18.4656	18.7051	19.0324	19.4301	19.6870	19.8014	19.8209	19.8203	19.7589	19.4266	18.8925	18.4324	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.3643	19.9467	20.2091	20.5358	20.7696	20.8853	20.9140	20.9092	20.8332	20.5224	20.0871	19.9043	(87)
Th 2	19.8991	19.9012	19.9032	19.9128	19.9146	19.9229	19.9229	19.9244	19.9197	19.9146	19.9110	19.9072	(88)
util rest of house	0.9771	0.9583	0.9215	0.8295	0.6730	0.4709	0.3142	0.3573	0.6068	0.8659	0.9578	0.9806	(89)
MIT 2	19.3277	18.7051	19.0324	19.4301	19.6870	19.8014	19.8209	19.8203	19.7589	19.4266	18.8925	18.6981	(90)
Living area fraction									fLA = Living area / (4) =			0.2254	(91)
MIT	19.5613	18.9849	19.2976	19.6792	19.9310	20.0457	20.0672	20.0657	20.0010	19.6736	19.1617	18.9700	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.5613	18.9849	19.2976	19.6792	19.9310	20.0457	20.0672	20.0657	20.0010	19.6736	19.1617	18.9700	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9754	0.9497	0.9111	0.8216	0.6740	0.4806	0.3275	0.3711	0.6134	0.8574	0.9494	0.9762	(94)
Useful gains	630.7264	714.0033	761.9969	771.2369	677.8832	481.4971	313.9317	329.8841	500.1137	611.2834	609.9767	603.0333	(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	1427.3816	1314.5627	1191.9293	994.1120	757.6949	496.9680	316.4175	333.9889	540.3287	835.2583	1114.4921	1370.0691	(97)
Space heating kWh	592.7115	403.5759	319.8697	160.4700	59.3799	0.0000	0.0000	0.0000	0.0000	166.6374	363.2511	570.6746	(98a)
Space heating requirement - total per year (kWh/year)												2636.5702	
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	592.7115	403.5759	319.8697	160.4700	59.3799	0.0000	0.0000	0.0000	0.0000	166.6374	363.2511	570.6746	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2636.5702	
Space heating per m2											(98c) / (4) =	34.5644	(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 %)	293.5107	(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	592.7115	403.5759	319.8697	160.4700	59.3799	0.0000	0.0000	0.0000	0.0000	166.6374	363.2511	570.6746	(98)
Space heating efficiency (main heating system 1)	293.5107	293.5107	293.5107	293.5107	293.5107	0.0000	0.0000	0.0000	0.0000	293.5107	293.5107	293.5107	(210)
Space heating fuel (main heating system)	201.9386	137.4995	108.9806	54.6726	20.2309	0.0000	0.0000	0.0000	0.0000	56.7739	123.7608	194.4306	(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	262.0567	231.8573	246.3784	216.5398	209.9022	189.1157	186.5242	193.8733	195.9579	218.5598	232.4945	259.1645	(64)
Efficiency of water heater												190.1343	(216)
(217)m	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	190.1343	(217)
Fuel for water heating, kWh/month	137.8271	121.9440	129.5812	113.8878	110.3968	99.4643	98.1013	101.9665	103.0629	114.9502	122.2791	136.3060	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	29.8221	23.9244	21.5412	15.7820	12.1905	9.9597	11.1206	14.4550	18.7756	24.6345	27.8247	30.6509	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)

```
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235d)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235d)
Annual totals kWh/year
Space heating fuel - main system 1                                                                                                     898.2875 (211)
Space heating fuel - main system 2                                                                                                       0.0000 (213)
Space heating fuel - secondary                                                                                                           0.0000 (215)
Efficiency of water heater                                                                                                             190.1343
Water heating fuel used                                                                                                               1389.7672 (219)
Space cooling fuel                                                                                                                       0.0000 (221)

Electricity for pumps and fans:
Total electricity for the above, kWh/year                                                                                                0.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                    240.6812 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                            0.0000 (233)
Wind generation                                                                                                                          0.0000 (234)
Hydro-electric generation (Appendix N)                                                                                                   0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                                                           0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                                               -0.0000 (236)
Energy used                                                                                                                              0.0000 (237)
Total delivered energy for all uses                                                                                                   2528.7359 (238)


----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                       Energy       Emission factor            Emissions
                                                                                     kWh/year           kg CO2/kWh          kg CO2/year
Space heating - main system 1                                                        898.2875               0.1561             140.1799 (261)
Total CO2 associated with community systems                                                                                    0.0000 (373)
Water heating (other fuel)                                                          1389.7672               0.1409             195.7952 (264)
Space and water heating                                                                                                      335.9752 (265)
Pumps, fans and electric keep-hot                                                      0.0000               0.0000               0.0000 (267)
Energy for lighting                                                                  240.6812               0.1443              34.7377 (268)
Total CO2, kg/year                                                                                                           370.7129 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                                                4.8600 (273)


----------------------------------------------------------------------------------------------------
13a. Primary energy - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                       Energy Primary energy factor       Primary energy
                                                                                     kWh/year           kg CO2/kWh             kWh/year
Space heating - main system 1                                                        898.2875               1.5777            1417.2302 (275)
Total CO2 associated with community systems                                                                                    0.0000 (473)
Water heating (other fuel)                                                          1389.7672               1.5209            2113.7460 (278)
Space and water heating                                                                                                     3530.9762 (279)
Pumps, fans and electric keep-hot                                                      0.0000               0.0000               0.0000 (281)
Energy for lighting                                                                  240.6812               1.5338             369.1649 (282)
Total Primary energy kWh/year                                                                                               3900.1411 (286)
Dwelling Primary energy Rate (DPER)                                                                                           51.1300 (287)


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



----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
----------------------------------------------------------------------------------------------------
                                                                                           Area          Storey height                Volume
                                                                                           (m2)                    (m)                  (m3)
Ground floor                                                                            38.1400 (1b)    x       2.6300 (2b)    =    100.3082 (1b) - (3b)
First floor                                                                             38.1400 (1c)    x       2.4000 (2c)    =     91.5360 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             76.2800                                                         (4)
Dwelling volume                                                                           (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    191.8442 (5)



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

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

                                                                                                               Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =           30.0000 / (5) =       0.1564 (8)
Pressure test                                                                                                                     Yes
Pressure Test Method                                                                                                      Blower Door
Measured/design AP50                                                                                                           5.0000 (17)
Infiltration rate                                                                                                              0.4064 (18)
Number of sides sheltered                                                                                                           3 (19)

Shelter factor                                                                     (20) = 1  -  [0.075 x (19)]  =       0.7750 (20)
Infiltration rate adjusted to include shelter factor                                        (21) = (18) x (20)  =       0.3149 (21)
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4016	0.3937	0.3858	0.3464	0.3386	0.2992	0.2992	0.2913	0.3149	0.3386	0.3543	0.3701	(22b)
Effective ac	0.5806	0.5775	0.5744	0.5600	0.5573	0.5448	0.5448	0.5424	0.5496	0.5573	0.5628	0.5685	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Semi-glazed door			1.9100	1.0000	1.9100			(26a)
TER Opening Type (Uw = 1.20)			13.6900	1.1450	15.6756			(27)
NW SR Rooflights			0.4700	1.5918	0.7481			(27a)
NE SR Rooflights			0.6300	1.5918	1.0028			(27a)
Ground Floor			38.1400	0.1300	4.9582			(28a)
External Wall	113.9900	14.1000	99.8900	0.1800	17.9802			(29a)
Dormer Wall	2.4400	1.5000	0.9400	0.1800	0.1692			(29a)
Sloped Roof	17.6800	1.1000	16.5800	0.1100	1.8238			(30)
Plane Roof	26.3100		26.3100	0.1100	2.8941			(30)
Dormer Roof	2.0400		2.0400	0.1100	0.2244			(30)
Total net area of external elements Aum(A, m2)			200.6000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	47.3864			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 194.7719 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	9.9700	0.0500	0.4985
E3 Sill	7.2600	0.0500	0.3630
E4 Jamb	19.6600	0.0500	0.9830
E5 Ground floor (normal)	24.8600	0.1600	3.9776
E6 Intermediate floor within a dwelling	24.8600	0.0000	0.0000
R1 Head of roof window	2.6800	0.0800	0.2144
R2 Sill of roof window	2.6800	0.0600	0.1608
R3 Jamb of roof window	5.4800	0.0800	0.4384
E11 Eaves (insulation at rafter level)	16.1900	0.0400	0.6476
E12 Gable (insulation at ceiling level)	4.6000	0.0600	0.2760
E13 Gable (insulation at rafter level)	2.2400	0.0800	0.1792
E16 Corner (normal)	19.8800	0.0900	1.7892
R4 Ridge (vaulted ceiling)	2.5800	0.0800	0.2064
R5 Ridge (inverted)	2.5800	0.0400	0.1032
R7 Flat ceiling (inverted)	1.4900	0.0400	0.0596
R9 Roof to wall (flat ceiling)	1.4900	0.0400	0.0596

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 9.9565 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 57.3429 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	36.7583	36.5601	36.3659	35.4534	35.2827	34.4879	34.4879	34.3407	34.7940	35.2827	35.6280	35.9891	(38)
Heat transfer coeff	94.1012	93.9030	93.7088	92.7963	92.6256	91.8308	91.8308	91.6836	92.1369	92.6256	92.9709	93.3320	(39)
Average = Sum(39)m / 12 =												92.7955	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2336	1.2310	1.2285	1.2165	1.2143	1.2039	1.2039	1.2019	1.2079	1.2143	1.2188	1.2235	(40)
HLP (average)												1.2165	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.3885 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	64.2668	63.3010	61.8936	59.2009	57.2137	54.9976	53.7380	55.1347	56.6658	59.0452	61.7958	64.0206	(42a)
Hot water usage for baths	27.7601	27.3478	26.7672	25.6967	24.8952	24.0064	23.5263	24.1028	24.7305	25.6816	26.7741	27.6662	(42b)
Hot water usage for other uses	39.0905	37.6691	36.2476	34.8261	33.4046	31.9832	31.9832	33.4046	34.8261	36.2476	37.6691	39.0905	(42c)

Average daily hot water use (litres/day) 120.5266 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.1174	128.3178	124.9084	119.7237	115.5135	110.9872	109.2475	112.6422	116.2224	120.9743	126.2389	130.7773	(44)
Energy conte	207.6579	182.7229	191.9796	163.8958	155.5034	136.4717	132.1254	139.4745	143.3139	164.1610	179.8505	204.7657	(45)
Energy content (annual)											Total = Sum(45)m =	2001.9222	
Distribution loss (46)m = 0.15 x (45)m	31.1487	27.4084	28.7969	24.5844	23.3255	20.4708	19.8188	20.9212	21.4971	24.6242	26.9776	30.7148	(46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.5520 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8381 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(56)
If cylinder contains dedicated solar storage	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	256.9006	227.2001	241.2223	211.5500	204.7461	184.1259	181.3680	188.7172	190.9681	213.4037	227.5047	254.0083	(62)
WWHRS	-29.3801	-25.9840	-27.2089	-22.5301	-20.9972	-17.9675	-16.8416	-17.9094	-18.5898	-21.9154	-24.8275	-28.8360	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	227.5205	201.2161	214.0133	189.0199	183.7489	166.1584	164.5264	170.8078	172.3782	191.4883	202.6772	225.1723	(64)

Total per year (kWh/year) = Sum(64)m = 2308.7274 (64)

12Total per year (kWh/year) 2309 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	108.4404	96.3372	103.2274	92.6187	91.0990	83.5002	83.3258	85.7694	85.7752	93.9777	97.9236	107.4787	(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	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	119.4245	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	107.6111	119.1409	107.6111	111.1981	107.6111	111.1981	107.6111	107.6111	111.1981	107.6111	111.1981	107.6111	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	211.4907	213.6853	208.1549	196.3815	181.5196	167.5515	158.2200	156.0254	161.5557	173.3292	188.1911	202.1592	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	34.9424	(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)													
	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	-95.5396	(71)
Water heating gains (Table 5)													
	145.7532	143.3589	138.7464	128.6371	122.4449	115.9725	111.9971	115.2815	119.1323	126.3141	136.0051	144.4606	(72)
Total internal gains													
	526.6823	538.0124	516.3398	498.0441	473.4030	453.5495	436.6555	437.7453	450.7135	469.0817	497.2216	516.0582	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	5.6400	11.2829	0.6300	0.7000	0.7700	19.4479	(75)
Southwest	7.5500	36.7938	0.6300	0.7000	0.7700	84.8973	(79)
Northwest	0.5000	11.2829	0.6300	0.7000	0.7700	1.7241	(81)
Northeast	0.6300	26.0000	0.6300	0.7000	1.0000	6.5012	(82)
Northwest	0.4700	26.0000	0.6300	0.7000	1.0000	4.8501	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	117.4207	211.2836	317.4222	438.1680	529.8355	542.6734	516.2955	445.6947	359.0650	241.3085	142.7347	99.1129	(83)
Total gains	644.1030	749.2960	833.7620	936.2120	1003.2384	996.2230	952.9510	883.4401	809.7785	710.3902	639.9564	615.1712	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	43.8570	43.9496	44.0407	44.4738	44.5557	44.9413	44.9413	45.0135	44.7920	44.5557	44.3902	44.2185	
alpha	3.9238	3.9300	3.9360	3.9649	3.9704	3.9961	3.9961	4.0009	3.9861	3.9704	3.9593	3.9479	
util living area													
	0.9820	0.9670	0.9379	0.8640	0.7339	0.5583	0.4160	0.4641	0.6933	0.8995	0.9678	0.9847	(86)
MIT	19.4301	19.6831	20.0347	20.4732	20.7899	20.9470	20.9871	20.9803	20.8751	20.4556	19.8713	19.3879	(87)
Th 2	19.8932	19.8953	19.8973	19.9068	19.9086	19.9169	19.9169	19.9185	19.9137	19.9086	19.9050	19.9012	(88)
util rest of house													
	0.9774	0.9590	0.9227	0.8318	0.6763	0.4752	0.3173	0.3610	0.6121	0.8680	0.9585	0.9809	(89)
MIT 2	18.0960	18.4152	18.8532	19.3843	19.7322	19.8849	19.9122	19.9105	19.8274	19.3795	18.6630	18.0479	(90)
Living area fraction									fLA = Living area / (4) =			0.2254	(91)
MIT	18.3966	18.7009	19.1194	19.6297	19.9706	20.1242	20.1544	20.1516	20.0635	19.6220	18.9353	18.3499	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3966	18.7009	19.1194	19.6297	19.9706	20.1242	20.1544	20.1516	20.0635	19.6220	18.9353	18.3499	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9689	0.9475	0.9093	0.8224	0.6798	0.4918	0.3394	0.3838	0.6242	0.8580	0.9475	0.9732	(94)
Useful gains	624.0702	709.9511	758.1496	769.9382	682.0029	489.9144	323.4267	339.0950	505.4506	609.5048	606.3512	598.6952	(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													
	1326.5102	1295.9459	1182.5530	995.6739	766.0650	507.2959	326.4071	343.9610	549.4567	835.6658	1100.3367	1320.6381	(97)
Space heating kWh													
	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(98a)
Space heating requirement - total per year (kWh/year)												2518.2909	
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													
	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2518.2909	
Space heating per m2										(98c) / (4) =		33.0138	(99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	522.6154	393.7885	315.7561	162.5298	62.5422	0.0000	0.0000	0.0000	0.0000	168.2638	355.6696	537.1255	(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)													
	566.2138	426.6398	342.0977	176.0886	67.7597	0.0000	0.0000	0.0000	0.0000	182.3010	385.3408	581.9345	(211)
Space heating efficiency (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

Water heating requirement	227.5205	201.2161	214.0133	189.0199	183.7489	166.1584	164.5264	170.8078	172.3782	191.4883	202.6772	225.1723	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.8629	85.5376	84.9305	83.7230	81.9080	79.8000	79.8000	79.8000	79.8000	83.7711	85.3076	85.9371	(217)
Fuel for water heating, kWh/month	264.9813	235.2371	251.9865	225.7682	224.3355	208.2186	206.1734	214.0449	216.0128	228.5852	237.5841	262.0200	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	22.3595	17.9376	16.1508	11.8328	9.1400	7.4674	8.3378	10.8378	14.0772	18.4701	20.8619	22.9809	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-35.6400	-50.2256	-72.1743	-81.1360	-87.4873	-81.6640	-80.6509	-76.1325	-68.1673	-57.4149	-39.1729	-30.8149	(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	-20.2045	-42.4944	-84.4434	-126.8044	-167.6443	-168.4326	-166.4539	-140.9520	-103.3325	-60.7687	-26.9755	-15.9783	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	2728.3759	(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	2774.9474	(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)	180.4537	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1885.1651	(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	3884.6119	(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	2728.3759	0.2100	572.9589	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2774.9474	0.2100	582.7390	(264)
Space and water heating			1155.6979	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	180.4537	0.1443	26.0450	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-760.6805	0.1346	-102.3804	
PV Unit electricity exported	-1124.4846	0.1259	-141.5742	
Total			-243.9546	(269)
Total CO2, kg/year			949.7176	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			12.4500	(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	2728.3759	1.1300	3083.0647	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2774.9474	1.1300	3135.6906	(278)
Space and water heating			6218.7553	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	180.4537	1.5338	276.7858	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-760.6805	1.4974	-1139.0612	
PV Unit electricity exported	-1124.4846	0.4621	-519.6750	
Total			-1658.7363	(283)
Total Primary energy kWh/year			4966.9057	(286)
Target Primary Energy Rate (TPER)			65.1100	(287)

Predicted Energy Assessment

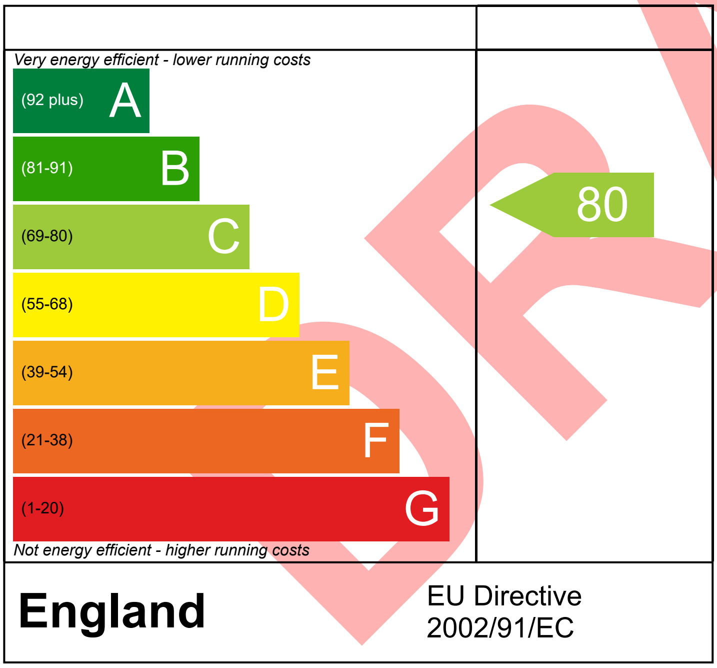
112, Hollow Way, Oxford, Oxfordshire, OX4 2NL

Dwelling type:	House, Detached
Date of assessment:	30/11/2023
Produced by:	Riley Dixon
Total floor area:	76.28 m²
DRRN:	

This document is a Predicted Energy Assessment for properties marketed when they are incomplete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, this rating will be updated and an official Energy Performance Certificate will be created for the property. This will include more detailed information about the energy performance of the completed property.

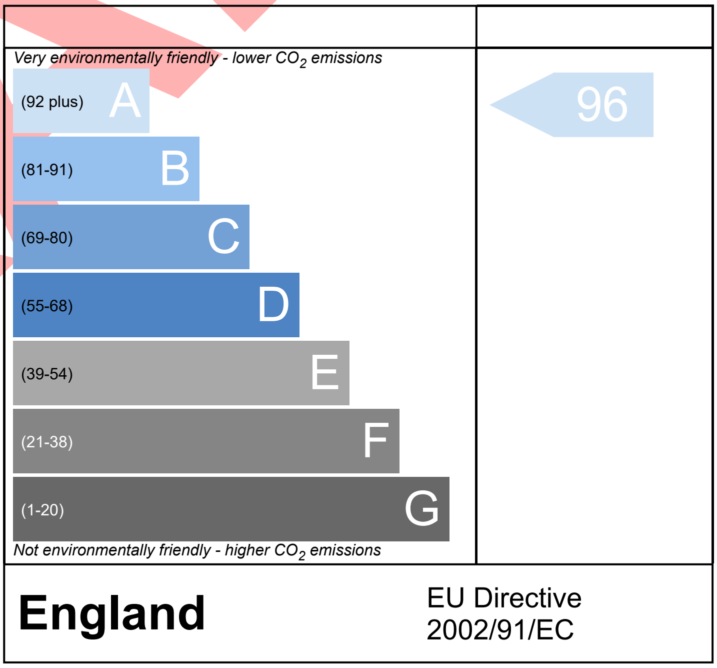
The energy performance has been assessed using the Government approved SAP 10 methodology and is rated in terms of the energy use per square meter of floor area; the energy efficiency is based on fuel costs and the environmental impact is based on carbon dioxide (CO2) emissions.

Energy Efficiency Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Building Regulations England Part L (BREL) Compliance Report

Approved Document L1 2021 Edition, England assessed by Array SAP 10 program, Array

Date: Thu 30 Nov 2023 09:04:31

Project Information			
Assessed By	Riley Dixon	Building Type	House, Detached
OCDEA Registration	EES/026759	Assessment Date	2023-11-30

Dwelling Details			
Assessment Type	As designed	Total Floor Area	76 m^2
Site Reference	PR11113 - 112 Hollow Way	Plot Reference	003-Be Green
Address	112 Hollow Way, Oxford, OX4 2NL		

Client Details	
Name	Mr Hugh Charles
Company	-
Address	2 Marshall Road, Oxford, OX4 2NR

This report covers items included within the SAP calculations. It is not a complete report of regulations compliance.

1a Target emission rate and dwelling emission rate		
Fuel for main heating system	Electricity	
Target carbon dioxide emission rate	*12.45 $kgCO_2/m^2$*	
Dwelling carbon dioxide emission rate	4.86 $kgCO_2/m^2$	OK
1b Target primary energy rate and dwelling primary energy		
Target primary energy	*65.11 kWh_{PE}/m^2*	
Dwelling primary energy	51.13 kWh_{PE}/m^2	OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency		
Target fabric energy efficiency	*40.7 kWh/m^2*	
Dwelling fabric energy efficiency	40.3 kWh/m^2	OK

2a Fabric U-values				
Element	***Maximum permitted average U-Value [W/m^2K]***	**Dwelling average U-Value [W/m^2K]**	**Element with highest individual U-Value**	
External walls	*0.26*	0.18	Walls (1) (0.18)	OK
Party walls	*0.2*	N/A	N/A	**N/A**
Curtain walls	*1.6*	N/A	N/A	**N/A**
Floors	*0.18*	0.12	Ground Floor (0.12)	OK
Roofs	*0.16*	0.13	Roof (1) (0.14)	OK
Windows, doors, and roof windows	*1.6*	1.3	SW EW Windows (1.3)	OK
Rooflights	*2.2*	N/A	N/A	**N/A**

2b Envelope elements (better than typically expected values are flagged with a subsequent (!))		
Name	**Net area [m^2]**	**U-Value [W/m^2K]**
Exposed wall: Walls (1)	99.881	0.18
Exposed wall: Walls (2)	0.94	0.18
Ground floor: Ground Floor, Ground Floor	38.14	0.12
Exposed roof: Roof (1)	16.5812	0.14
Exposed roof: Roof (2)	26.31	0.12
Exposed roof: Roof (3)	2.04	0.14

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	**Area [m^2]**	**Orientation**	**Frame factor**	**U-Value [W/m^2K]**
SW EW Windows, Window	1.89	South West	0.7	1.3
SW EW Windows, Window	2.304	South West	0.7	1.3
SW EW Windows, Window	1.86	South West	0.7	1.3
SW DW Windows, Window	1.5	South West	0.7	1.3
NW EW Windows, Window	0.504	North West	0.7	1.3
NW EW Door, Door	1.911	North West	N/A	1.3
NW SR Rooflights, Rooflights	0.468	North West	0.7	1.3
NE EW Windows, Window	3.78	North East	0.7	1.3
NE EW Windows, Window	1.86	North East	0.7	1.3
NE SR Rooflights, Rooflights	0.6308	North East	0.7	1.3

2d Thermal bridging (better than typically expected values are flagged with a subsequent (!))				
Building part **1 - Main Dwelling**: Thermal bridging calculated from linear thermal transmittances for each junction				
Main element	**Junction detail**	**Source**	**Psi value [W/mK]**	**Drawing / reference**
External wall	E2: Other lintels (including other steel lintels)	Government-approved scheme	0.019 **(!)**	MFF-150-E2-01
External wall	E3: Sill	Government-approved scheme	0.022 **(!)**	MFF-150-E3-01
External wall	E4: Jamb	Government-approved scheme	0.017 **(!)**	MFF-150-E4-01
External wall	E5: Ground floor (normal)	Government-approved scheme	0.061	MFF-150-E5-04
External wall	E6: Intermediate floor within a dwelling	Government-approved scheme	0.001 **(!)**	MFF-150-E6-01
Roof	R1: Head of roof window	SAP table default	0.24	
Roof	R2: Sill of roof window	SAP table default	0.24	
Roof	R3: Jamb of roof window	SAP table default	0.24	
External wall	E11: Eaves (insulation at rafter level)	Government-approved scheme	0.018 **(!)**	MFF-150-E11-01
External wall	E12: Gable (insulation at ceiling level)	Government-approved scheme	0.043	MFF-150-E12-01
External wall	E13: Gable (insulation at rafter level)	Government-approved scheme	0.043	MFF-150-E13-01
External wall	E16: Corner (normal)	Government-approved scheme	0.042	MFF-150-E16-01
Roof	R4: Ridge (vaulted ceiling)	SAP table default	0.12	
Roof	R5: Ridge (inverted)	SAP table default	0.12	
Roof	R7: Flat ceiling (inverted)	SAP table default	0.12	
Roof	R9: Roof to wall (flat ceiling)	SAP table default	0.32	

3 Air permeability (better than typically expected values are flagged with a subsequent (!))		
Maximum permitted air permeability at 50Pa	*8 m^3/hm^2*	
Dwelling air permeability at 50Pa	5 m^3/hm^2, Design value	OK
Air permeability test certificate reference		

4 Space heating	
Main heating system 1: Heat pump with radiators or underfloor heating - Electricity	
Efficiency	293.5%
Emitter type	Both radiators and underfloor
Flow temperature	45°C
System type	Heat Pump
Manufacturer	Mitsubishi Electric Europe B.V.
Model	Ecodan 6.0 kW
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water	
Cylinder/store - type: Cylinder	
Capacity	180 litres
Declared heat loss	1.86 kWh/day
Primary pipework insulated	Yes
Manufacturer	
Model	
Commissioning	
Waste water heat recovery system 1 - type: N/A	
Efficiency	
Manufacturer	
Model	

6 Controls	
Main heating 1 - type: Time and temperature zone control by arrangement of plumbing and electrical services	
Function	
Ecodesign class	
Manufacturer	
Model	

Water heating - type: Cylinder thermostat and HW separately timed		
Manufacturer		
Model		

7 Lighting		
Minimum permitted light source efficacy	*75 lm/W*	
Lowest light source efficacy	75 lm/W	OK
External lights control	N/A	

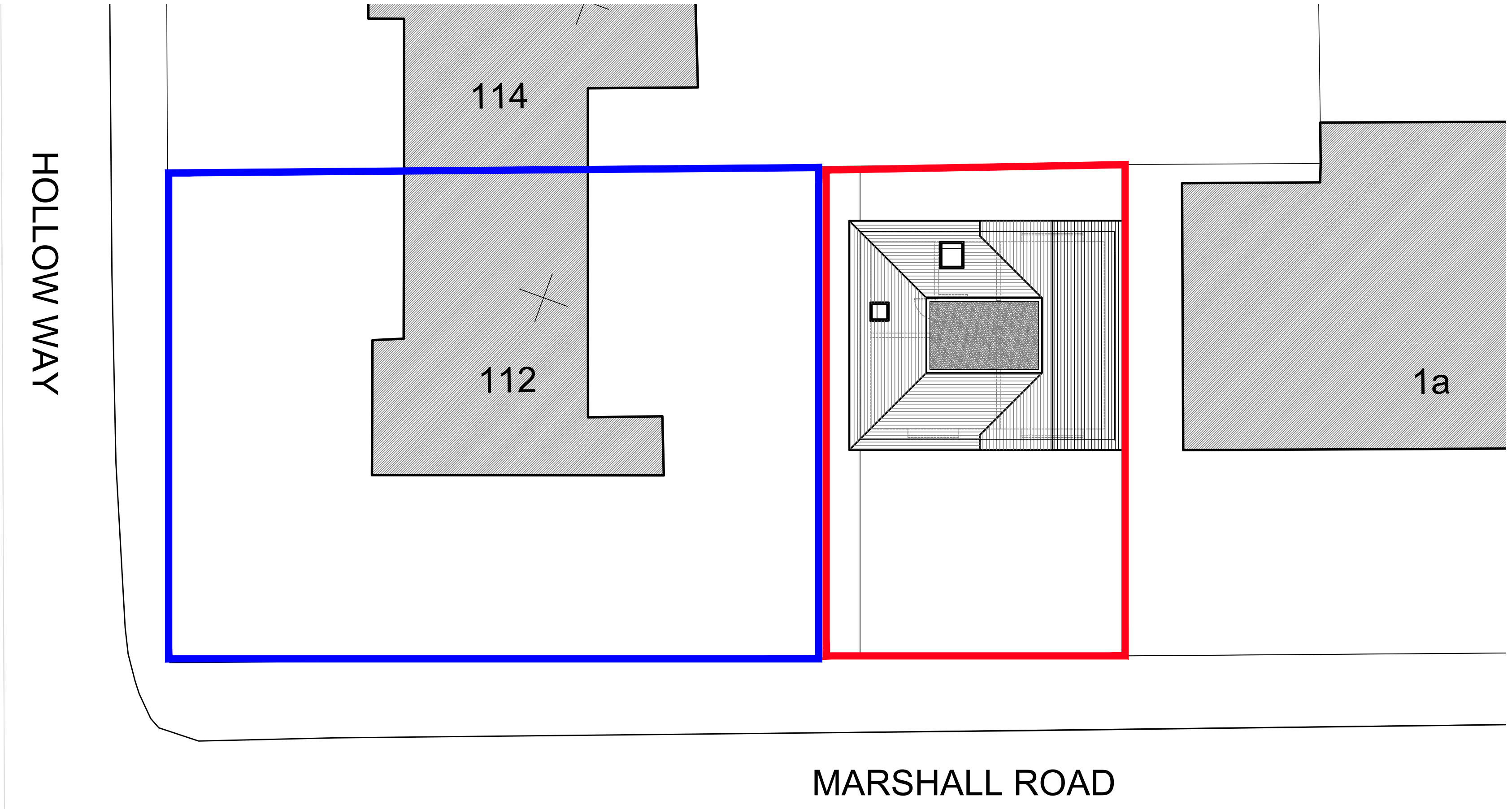
8 Mechanical ventilation		
System type: N/A		
Maximum permitted specific fan power	*N/A*	
Specific fan power	N/A	**N/A**
Minimum permitted heat recovery efficiency	*N/A*	
Heat recovery efficiency	N/A	**N/A**
Manufacturer/Model		
Commissioning		

9 Local generation
N/A

10 Heat networks
N/A

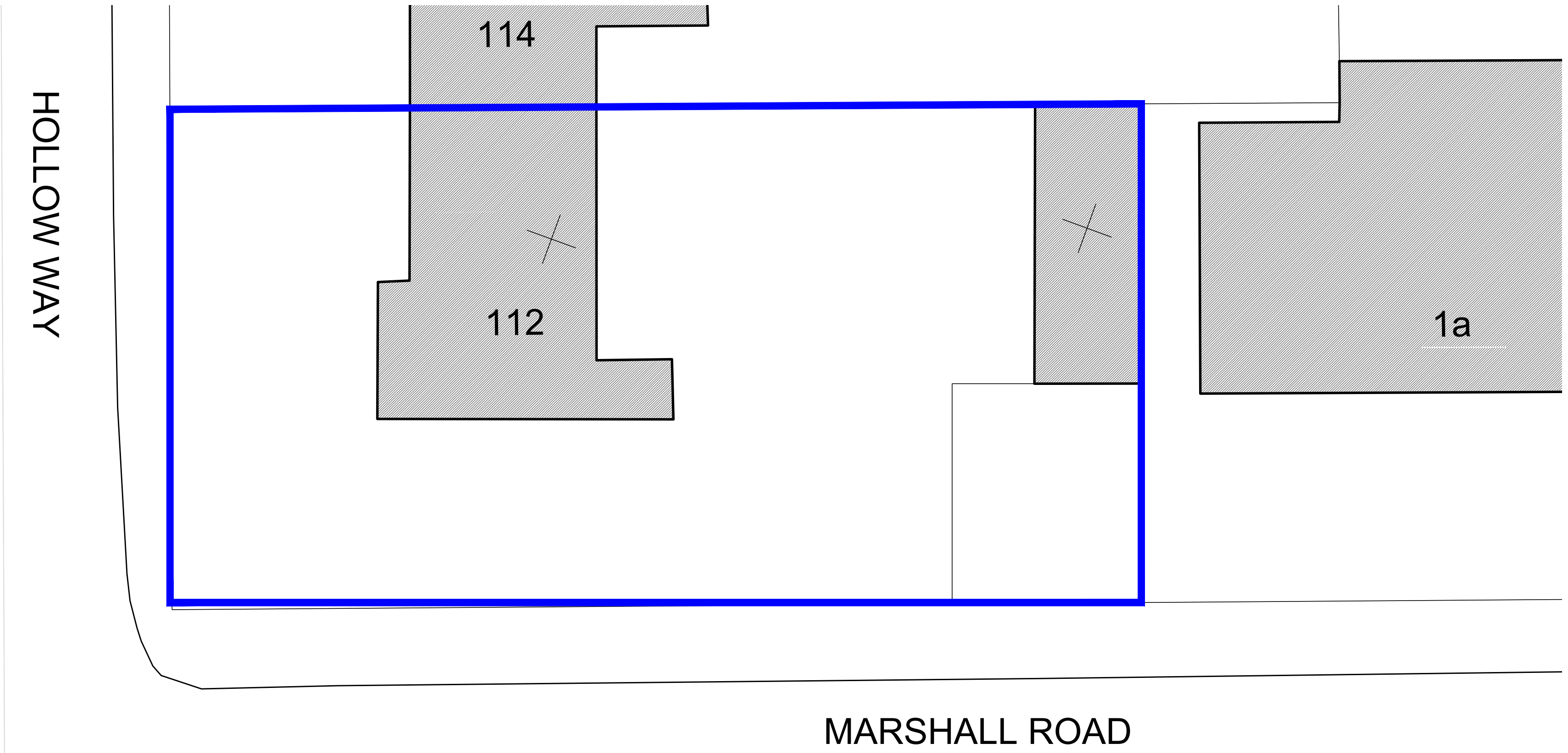
11 Supporting documentary evidence
N/A

12 Declarations	
a. Assessor Declaration	
This declaration by the assessor is confirmation that the contents of this BREL Compliance Report are a true and accurate reflection based upon the design information submitted for this dwelling for the purpose of carrying out the "As designed" assessment, and that the supporting documentary evidence (SAP Conventions, Appendix 1 (documentary evidence) schedules the minimum documentary evidence required) has been reviewed in the course of preparing this BREL Compliance Report.	
Signed: Name:	Assessor ID: Date:
b. Client Declaration	
N/A	



PROPOSED SITE PLAN/ ROOF PLAN
1:100 @A1 , 1:200@A3

LOCATION PLAN
1:1250@A3



EXISTING SITE PLAN/ ROOF PLAN
1:100 @A1 , 1:200@A3

1:1250@A3

0 10m 20m 30m 50m 75m
SCALE

1:100@A1, 1:200@A3

0 1m 2m 3m 5m 7.5m
SCALE

2351-03-PL-100	PLANNING	1:100@A1, 1:200@A3 1:1250@A3	OCTOBER 2023

PROPOSED SITE, GF, FF FLOOR PLANS

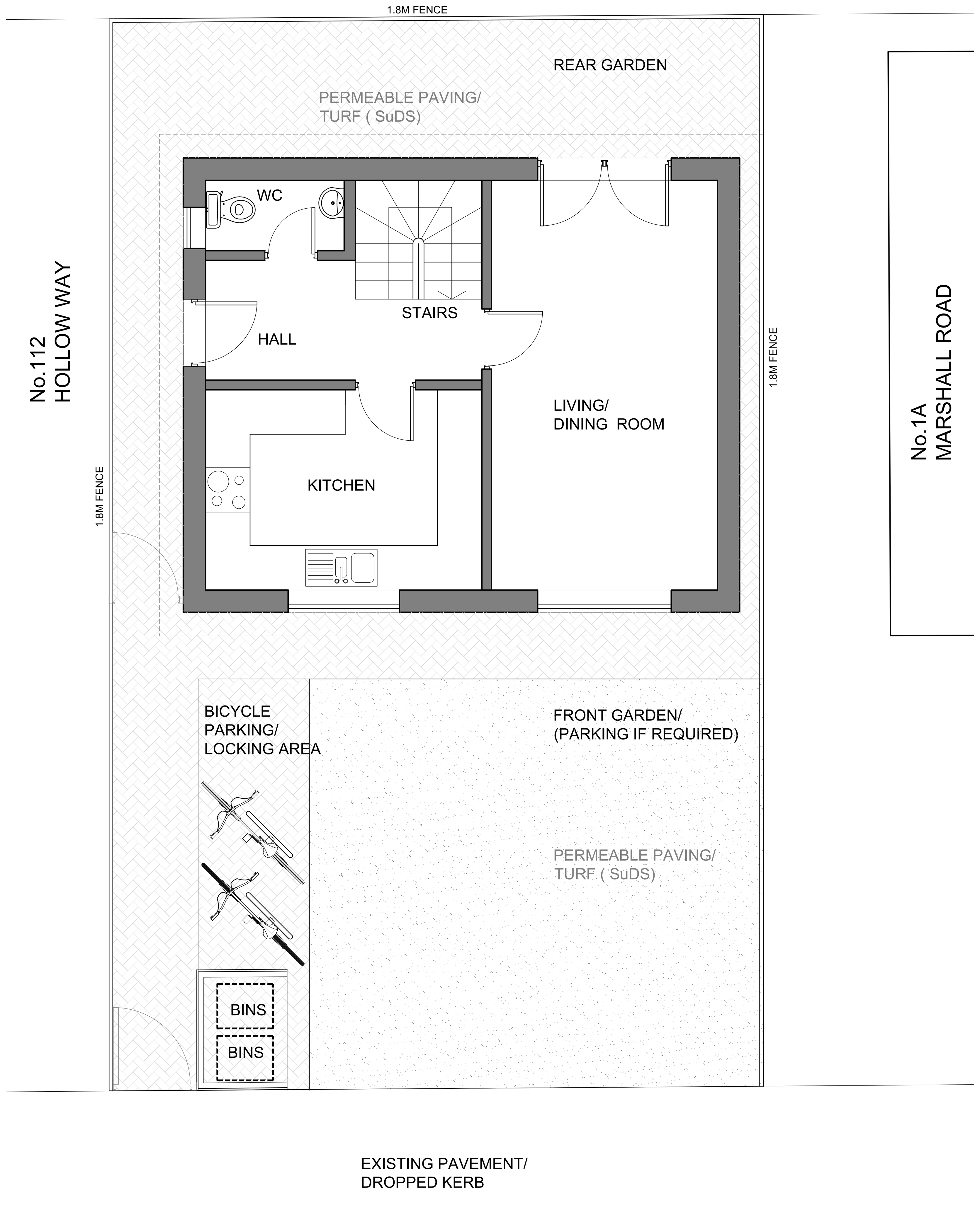
NEW DWELLING

MARSHALL ROAD, COWLEY
OXFORD
OX4 2NR

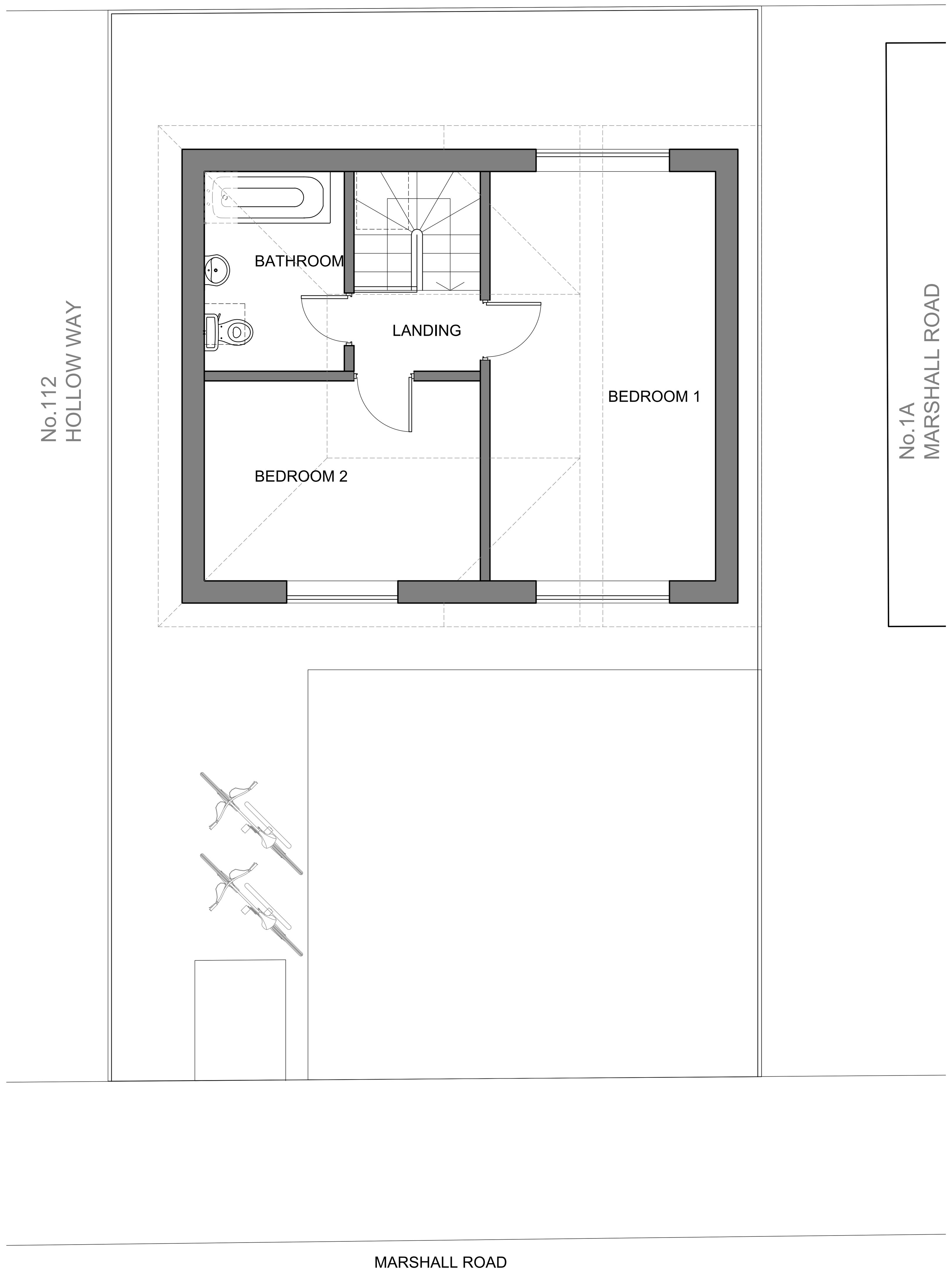
3 Kings Meadow
Osney mead
Oxford OX2 0DP

T: 01865 818197
project51architecture.co.uk
office@project51architecture.co.uk

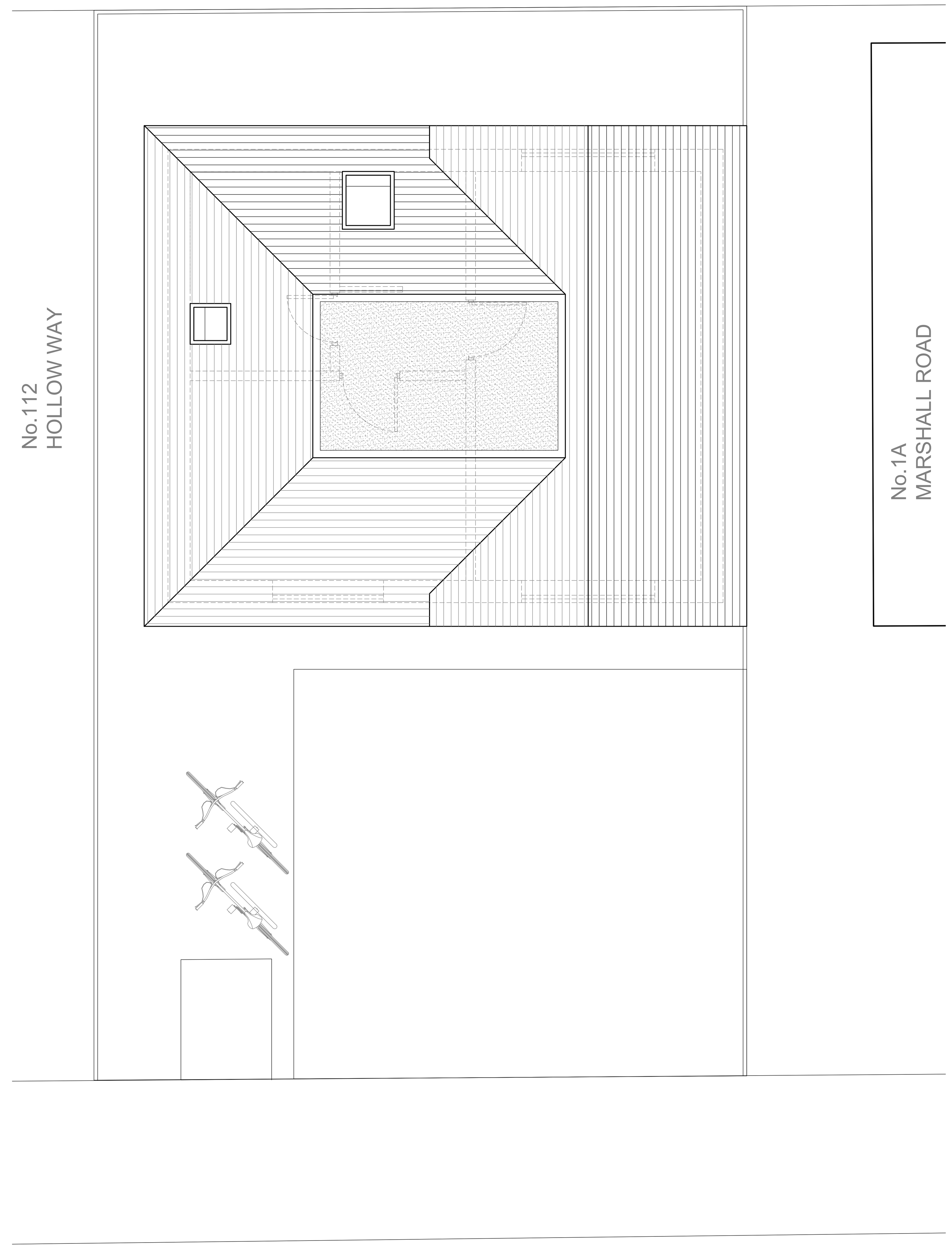
PROJECT 51 ARCHITECTURE



NEW DWELLING
PROPOSED GROUND FLOOR
1:50@A1, 1:100@A3



NEW DWELLING
PROPOSED FIRST FLOOR
1:50@A1, 1:100@A3



NEW DWELLING
ROOF PLAN
1:50@A1, 1:100@A3

1:50@A1, 1:100@A3

0 1m 2m 3m 5m 7.5m
SCALE

2351-03-PL-101	PLANNING	1:50@A1, 1:100@A3	OCTOBER 2023

PROPOSED GROUND FLOOR, FIRST FLOOR, & ROOF PLANS

NEW DWELLING

MARSHALL ROAD, COWLEY
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3 Kings Meadow
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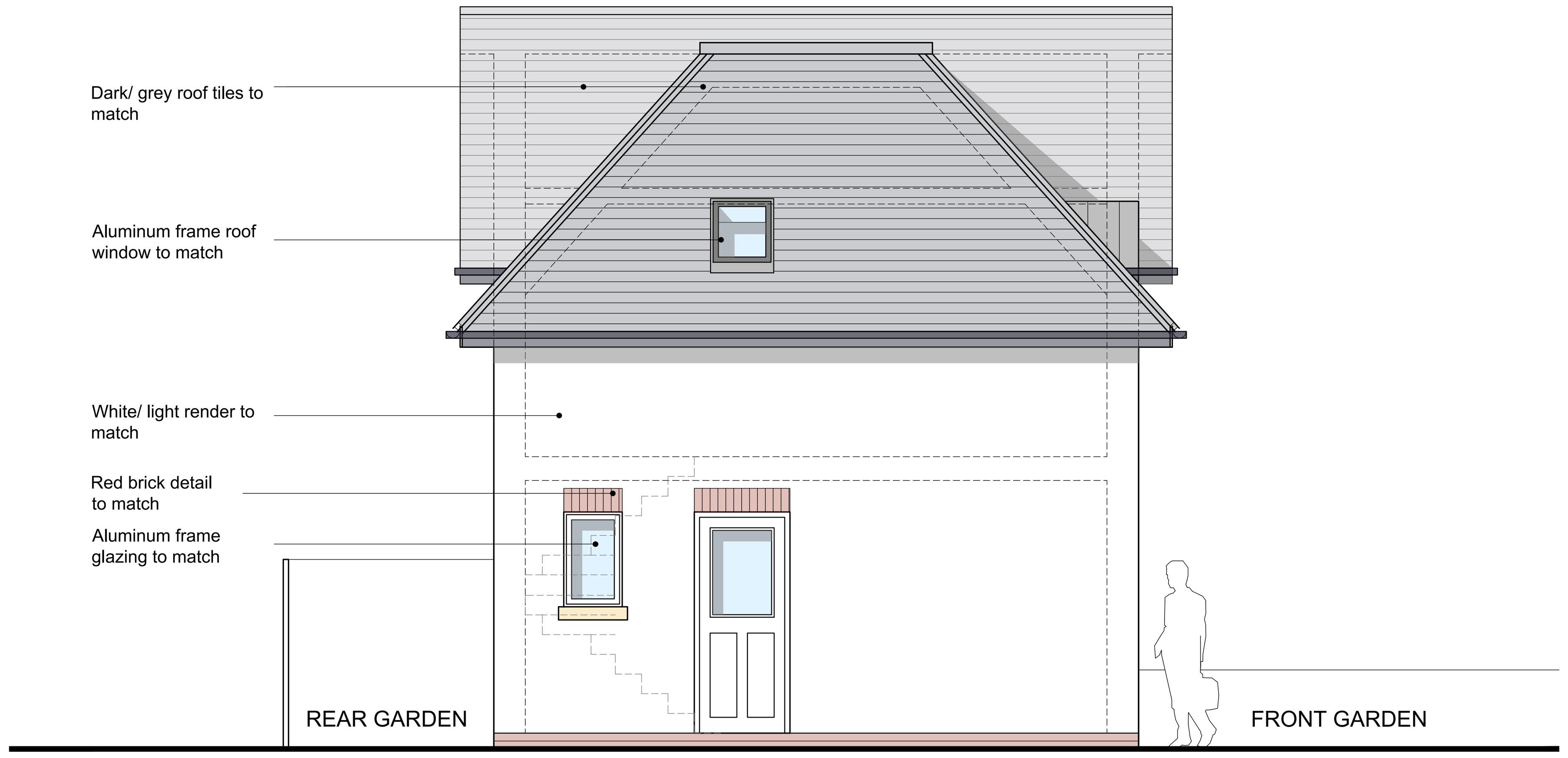
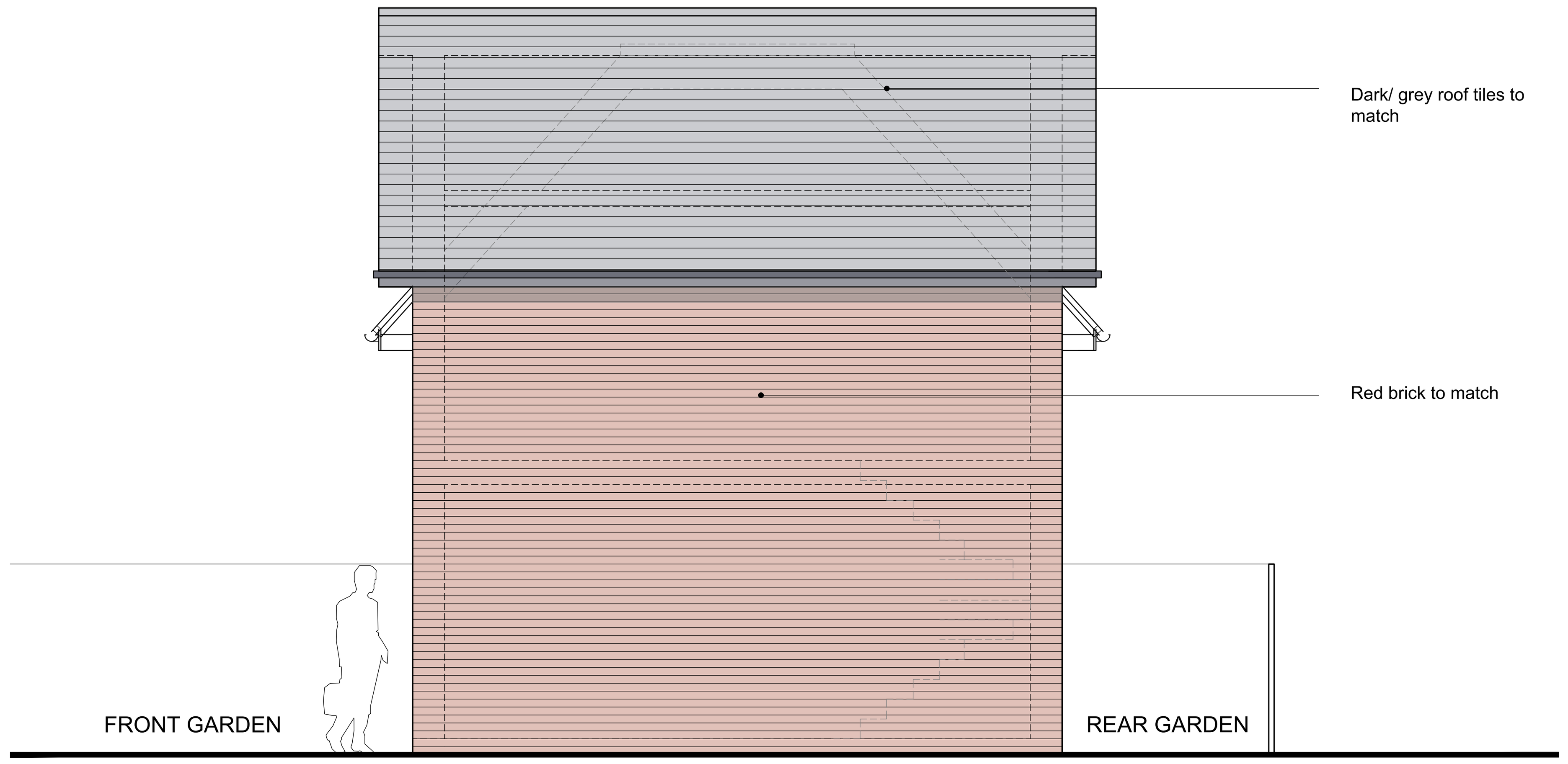
PROJECT 51 ARCHITECTURE

PROPOSED FRONT ELEVATION (SOUTH)
1:50@A1, 1:100@A3

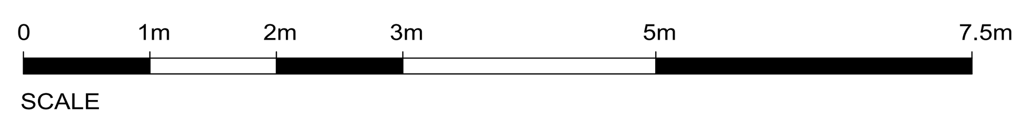


PROPOSED SIDE ELEVATION (EAST)
1:50@A1, 1:100@A3

PROPOSED REAR ELEVATION (NORTH)
1:50@A1, 1:100@A3



PROPOSED SIDE ELEVATION (WEST)
1:50@A1, 1:100@A3



2351-03-PL-102 PLANNING	1:50@A1, 1:100@A3	OCTOBER 2023

PROPOSED ELEVATIONS

NEW DWELLING

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office@project51architecture.co.uk

PROJECT 51 ARCHITECTURE

breglobal

Job no: PR11113
Date: 30/11/2023
Assessor name: Iraj Maghounaki
Registration no: BRE400012
Development name: 112 Hollow Way - SAMPLE

PRINTING: before printing please make sure that in "Page Setup" you have selected the page to be as "Landscape" and that the Scale has been set up to 70% (maximum)

WATER EFFICIENCY CALCULATOR FOR NEW DWELLINGS - (BASIC CALCULATOR)

	House Type:	Type 1		Type 2		Type 3		Type 4		Type 5		Type 6		Type 7		Type 8		Type 9		Type 10	
	Description:	SAMPLE																			
Installation Type	**Unit of measure**	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day
Is a dual or single flush WC specified?		Dual																			
WC	Full flush volume	6	8.76		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
	Part flush volume	3	8.88		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Taps (excluding kitchen and external taps)	Flow rate (litres / minute)	6	11.06		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Are both a Bath & Shower Present?		Bath & Shower																			
Bath	Capacity to overflow	150	16.50		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Shower	Flow rate (litres / minute)	8	34.96		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Kitchen sink taps	Flow rate (litres / minute)	5	12.56		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a washing machine been specified?		No																			
Washing Machine	Litres / kg	7	17.16		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a dishwasher been specified?		No																			
Dishwasher	Litres / place setting	0.9	4.50		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a waste disposal unit been specified?		No	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Water Softener	Litres / person / day		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Calculated Use			114.4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Normalisation factor			0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91
Code for Sustainable Homes	**Total Consumption**		**104.1**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**
	Mandatory level		**Level 3/4**		-		-		-		-		-		-		-		-		-
Building Regulations 17.K	External use		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0		5.0
	Total Consumption		**109.1**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**
	17.K Compliance?		**Yes**		-		-		-		-		-		-		-		-		-