Energy & Sustainability Statement

111 Manor Road, Witney, OX28 3UF

PR11012

Date: 27/02/2024

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Notice

Document History

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Contents

Executive summary

ERS Consultants Ltd has been appointed to prepare an Energy & Sustainability Statement for the property proposed for **111 Manor Road, Witney, OX28 3UF**.

The proposal is for the construction of a new 1-bedroom dwelling. This report will be focusing on implementing careful design and sustainable measures. This is so that the project creates and attractive new residential unit, addressing current housing needs within the local area.

Proposed schedules of accommodation are as follows:

- 1x 1-bedroom dwelling

Total combined floor area for habitable dwelling: 58.88m²

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:

- West Oxfordshire District Council (WODC) sustainability standards
- The National Planning Policy Framework (NPPF) July 2021

In line with WODCs sustainability targets, the dwelling would need to have a primary energy usage (DPER) of less than 35.00kWh/m²/year, without any reliance on fossil fuel/gas boilers. The DPER metric will be calculated using Elmhurst's Design SAP 10.2, which is approved software for assessing Part L 2021 compliance. This uses Primary Energy Factors determined in the latest 2021 Building Regulations.

The primary energy metric in SAP 10.2 is new for the 2021 regulations, and is a measure of the energy demand in the property. This energy statement will demonstrate the measures taken in order to ensure that energy demand has been minimalized in the residential development.

The methodology used to determine and reduce the energy demand follows the GLA guidance for energy statements, which uses a Be Lean, Be Clean, Be Green approach. While this approach is not specified for use by WODC, it is the most effective strategy for reducing energy demand in an appropriate manner and uses a holistic approach toward achieving this. The steps are outlined below:

Be Lean – Use less energy

At the be green stage, fabric first measures are emphasised when looking to reduce energy demand.

Emphasis will be put on the buildings fabric performance in order to reduce energy demand. This is because less energy 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 adopting enhanced construction details for the junctions, reducing thermal bridging. High levels of air tightness are also to be targets to reduce heat loss through the fabric further.

Be Clean – Supply energy efficiently

Once demand for energy has been minimised through fabric first measurements, all remaining energy should be supplied as cleanly as possible, using systems with a low primary energy factor and a high efficiency.

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

Be Green – Use renewable energy

At this stage of the project, various low-zero carbon and renewable technologies were considered to further the reduction in energy demand. For this development, Solar Photovoltaic Panels are considered a suitable technology that reduces reliance on grid electricity. The main heating system is also to be electric panels with an instantaneous water heating system.

After implementing 3.70kWp of PV on the southeast roof area and 0.7kWp of PV on the northeast roof area with an additional 3.00kWh battery storage at the Be Green stage, **the primary energy demand reduces to 34.87kWh/m^2/yr,** thus meeting the sustainability targets set by West Oxfordshire District Council.

Specification Summary

Table 1: Proposed Fabric Specifications			
Fabric Construction and Insulation			
Element	**Type**	**U-Value**	
Ground Floor	Ground Floor - Solid	0.12	
External Wall	Cavity Wall	0.17	
Plane Roof	Pitched – insulated at joists	0.10	
Windows	Window	Double glazed, argon filled, 16mm unit with low-e coating; G-Value of 63%; Aluminium frame;	1.20
External Doors	Half Glazed Door	Double glazed, argon filled, 16mm unit with low-e coating; G-Value of 63%; Aluminium frame;	1.20

Table 2: Proposed System Specifications

Space Heating

Main Heating System	SAP Default; Electric panel heaters;
Heating Controls	Programmer and appliance thermostats
Secondary Heating	n/a;

Water Heating

Heat source	Independent; Electric instantaneous at point of use	**Cylinder Size**	N/A	**Insulation**	N/A
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)	Instantaneous electric shower	**Rated Power [kW]**	9.30		
Bath Count	1	Primary pipework fully insulated;			
Solar Thermal	n/a;				

Ventilation

Mechanical Ventilation System	Intermittent extract fans in wet rooms;
Cooling system	n/a;
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 used for masonry cavity wall construction and timber frame sections. These details are attached as an appendix to this report, and are to be followed during the construction process with photographic evidence to be supplied as per Appendix B of Part L 2021; **Building Alliance Recognised Construction Details; Masonry Cavity Wall Hybrid; 90mm / 0.019W/mK / 0.19W/mK**

Lighting	**No. Fittings**	20	**Power [W]**	2	**Efficacy [lm/W]**	75	**Capacity [lm]**	150

Tariff and Meters	Standard	**Smart Electricity Meter**	Yes	**Smart Gas Meter**	Not present	

PV/Renewables	**3.70kWp PV** mounted on the Southeast roof; angle of sloped roof; **0.70kWp PV** mounted on the Northeast roof; angle of sloped roof; **3.00kWh battery storage capacity; Total: 4.40kWp PV**

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 **111 Manor Road, Witney, OX28 3UF.**

Proposed development: Construction of 1x 1-bedroom house.

Sitewide Gross Internal Area for the proposed dwelling: 58.88m²

The approximate site location of the proposed development is shown on the site plan Fig.1:

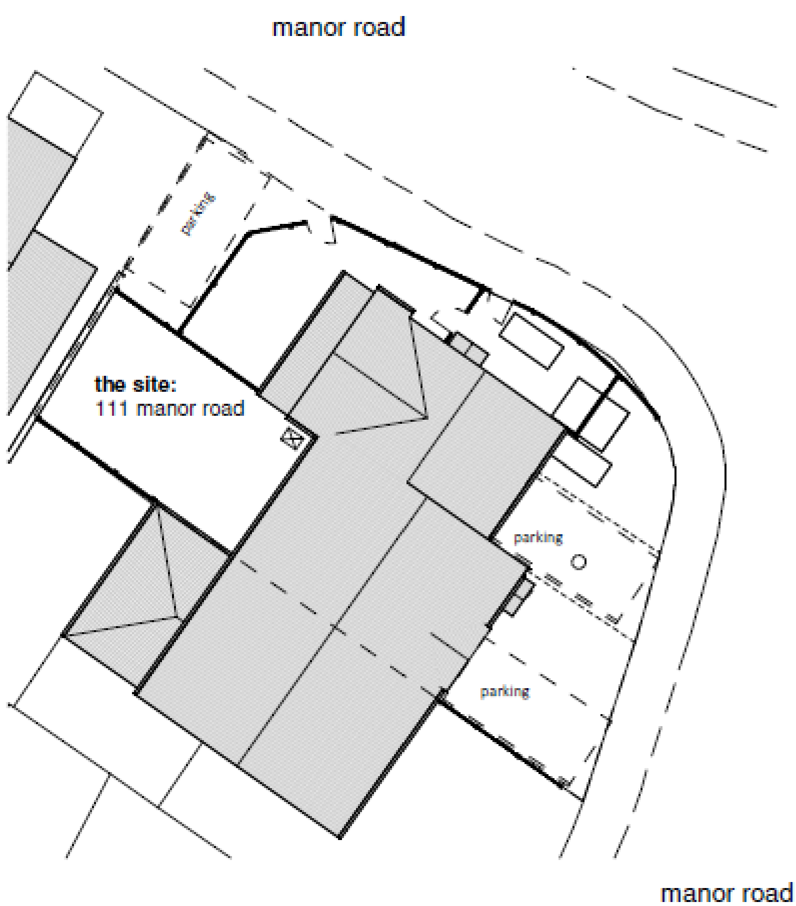


Fig.1 Site Plan

Policy context

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

- West Oxfordshire District Council (WODC) sustainability standards
- The National Planning Policy Framework (NPPF) July 2021

The WODC policy aims for a reduction in Energy Demand, so that the dwelling consumes less than 35.00 kWh/m^2/yr. It also stipulates that there is to be no fossil fuels (i.e., gas boilers) in the property.

Calculation methodology

The sections below present the methodology followed in reducing the energy demand for the dwelling.

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

The energy demand is shown by the primary energy metric (DPER) in SAP 10, and is calculated using the primary energy factors in Part L 2021. SAP 10 is the approved compliance software for Part L developed by Elmhurst Energy Systems Ltd.

Baseline:

The buildings baseline uses the same heating system as the as designed counterpart; therefore, in this exercise the baseline models also use an Air Source Heat Pump. 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. Here, we consider the most highly efficient versions of the selected heating system.

Be Green: use renewable energy

Renewable and low-zero carbon technologies are incorporated to reduce the reliance on grid electricity for the dwelling. 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 primary energy 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 3 below.

Table 3 Carbon Emission Factors for selected fuel type	
Fuel	**Primary energy factor**
Mains Gas	1.130
Bulk/Bottled LPG	1.141
Biogas	1.286
Heating Oil	1.180
Wood Pellets	1.325
Grid Electricity	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. The following is a description of the sustainable design methods under the Be Lean umbrella.

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.
- 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.

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

Table 4 Proposed fabric U-Values		
Domestic (U-Values in W/m²k)		
Element	**Part L 2021 Building Regulation**	**Proposed**
Wall	0.26	0.17 (Cavity Wall)
Floor	0.18	0.12 (Ground Floor)
Roof	0.16	0.10 (Plane Roof)
Windows	1.60	1.20
Doors	1.60	1.20
These u-values are recommended but may change during the construction stage, to meet site constraints, any worsening of the u-values must ensure compliance and the required energy demand target.		

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 proposed unit**.

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 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

The sustainability targets require water efficiency in the 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.

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.

In this project, strategies to mitigate the risk of overheating have been incorporated into the design, meaning that when assessed in the post-planning stage, it is hoped that no further design considerations need to be made in order to comply with Part O 2021.

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.

- 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 Clean – Supply energy efficiently

The Be Clean stage considers clean energy supply to the building. The following describes the possible systems considered for use in this project. Under the latest GLA guidance, this asks developers to consider Combines heat & power (CHP) and other types of district heating. Neither of these were considered feasible for this project due to size, site constraints, and the overall cost of those systems.

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.

In this project there will be no CHP incorporated so therefore, the Be Clean scenario will not further reduce CO_2 emissions on site for the proposed Site, therefore meaning there are no changes to the carbon reduction to be implemented to the property.

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 not currently located within a local heat network, so therefore it is not feasible to use district heating in this project.

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.

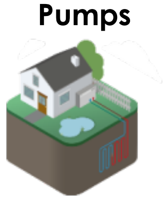
Keeping in mind that the space heating energy demand changes according to the season. While hot water energy demand will provide a significant base load throughout the year.

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 5. 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. These however aren't as beneficial to DPER.	20	High	High	2	☐
PV 	PV panels would generate significant energy savings, whilst having minimal impact on the appearance of the building. These are to be incorporated on the south facing roof.	25	Low	Med	10	■
Solar Thermal 	Solar thermal array mounted on the roof may contribute to energy reductions, but will reduce the amount of available roof space where Photo voltaic panels are proposed.	25	Low	Med	7	☐
Heat Pumps 	Ground loops requires space, additional time at the beginning of the construction process and very high capital costs. Air source heat pumps were not used for this project.	20	Med	Low	6	☐
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

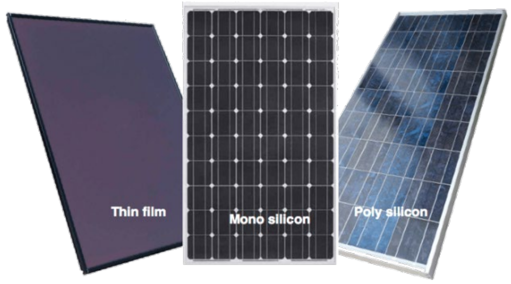


Fig 2. Photovoltaic Panels

Photovoltaic Panel is considered a suitable technology for this development as the development provides an extent of roof space for the installation of PV panels. In addition to this the PV arrays are relatively easy to install when compared to other renewable systems and provide a significant amount of energy savings.

The PV shall comprise of 4.40kWp of sloped roof mounted arrays on the dwelling in addition to 3.00kWh or more of battery storage. Table 6 summarizes the technical data for the proposed PV array. In total, the PV installation would reduce energy demand below the target threshold, to 34.87kWh/m²/yr.

Table 6. Proposed PV Specifications

Photovoltaic Panels	
Module Efficiency	15%
Tilt	Sloped roof angle
Array Area (approximately)	~20.00m²
Total power to be installed	4.40kWp
Total battery storage to be installed	3.00kWh
Primary Energy Savings	**56.76 kWh/m²/yr**

Be Green CO_2 emissions & savings

After the Be Green Stage, with the electric panels, the high-performance fabric and the PV panels, the energy demand of the building now meets the sustainability targets set by WODC. This means the energy demand is **34.87kWh/m²/yr,** and a total of **0.13 kWh/m²/yr** below the target of 35.00 kWh/m²/yr.

Conclusion

Following the implementation of the three-step Energy Hierarchy, the regulated energy demand of the property is **34.87kWh/m²/yr** according to a SAP 10 calculation against Part L standards, using the Primary Energy metric.

Overall, the proposed development at **111 Manor Road, Witney, OX28 3UF**, has been designed to meet energy policies set out by local and national planning requirements. This demonstrates that the development is committed to reducing energy demand using sustainable design measures and clean energy systems.

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 also be carefully designed to ensure the most economical operation of all equipment.

Measures have also been incorporated into the design in order to mitigate the risk of overheating, however Part O compliance will be assessed in the post planning stage. The passive measures incorporated include external shading devices on areas of large glazing.

To achieve the required energy demand target, electric panels to be provided for the as-built stage. In addition to this, levels of insulation mean the U-Values fall below the minimum notional standards of Part L reduce heat loss and therefore energy demand. After these measures, PV and battery storage is added to achieve the remaining reduction needed for the target.

As per the West Oxfordshire District Councils sustainability targets, residential developments are required to have an energy demand below 35.00 kWh/m²/yr. This development, after Be Lean, Be Clean and Be Green measures are implemented, consumes **34.87kWh/m²/yr,** thus meeting the sustainability targets.

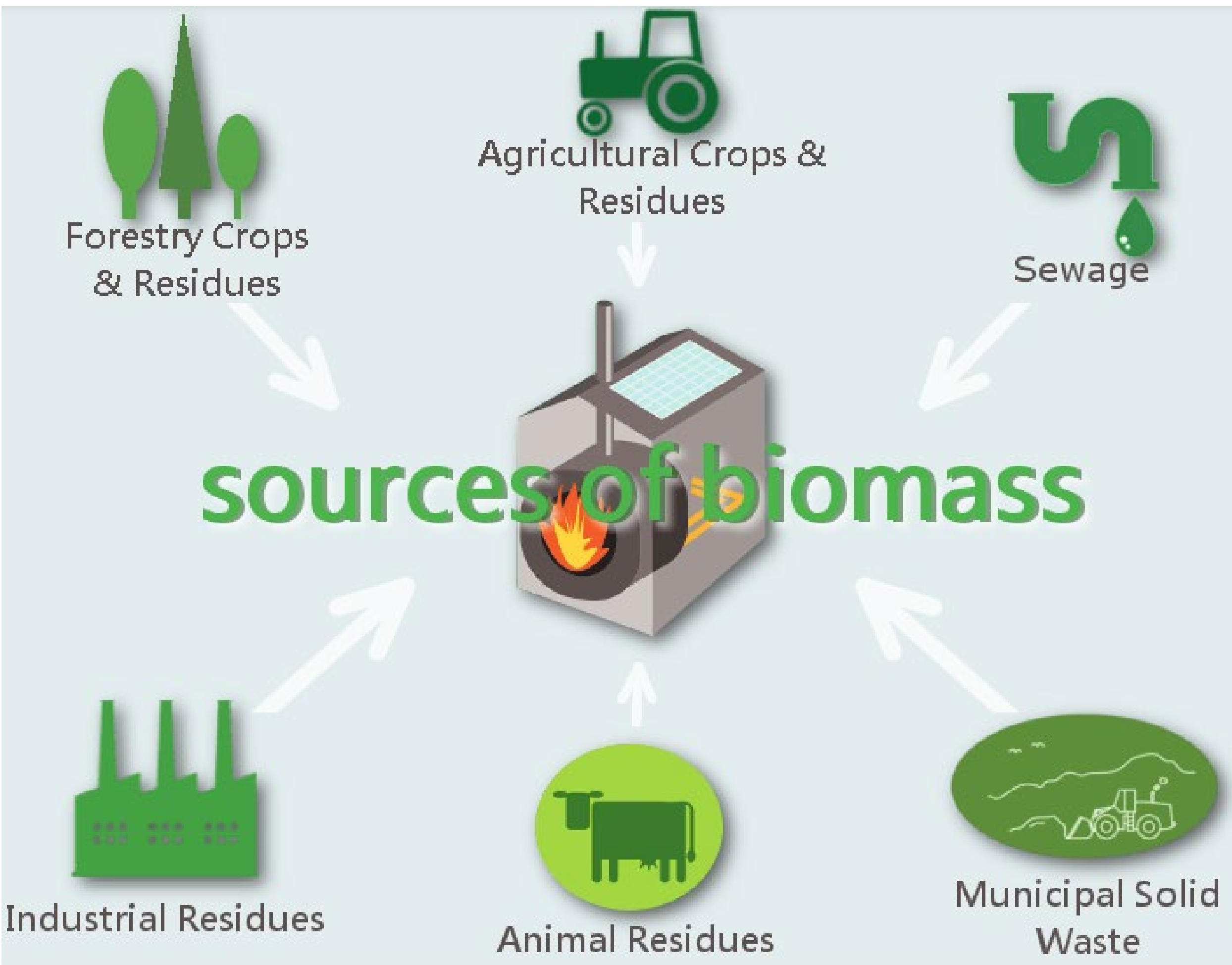
Post construction each building/dwelling is to have suitable testing to be provided to ensure the dwellings satisfy the requirements of this document and building regulation standards at the time of completion. These reports are to be provided as As-Built SAP worksheets, EPC and Air testing, for all 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 CO_2 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.



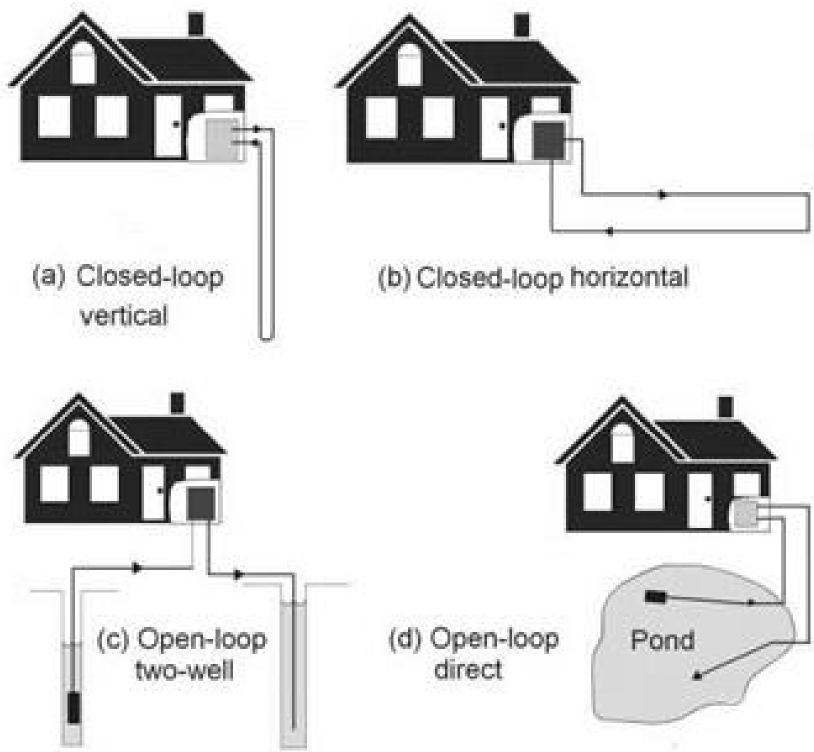
Geothermal Energy:

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

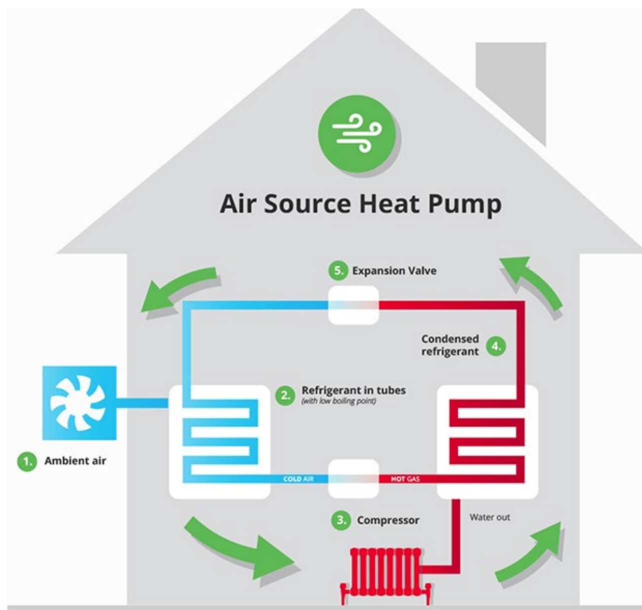
- good capacity
- low installation cost
- extensive ground excavation work

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.

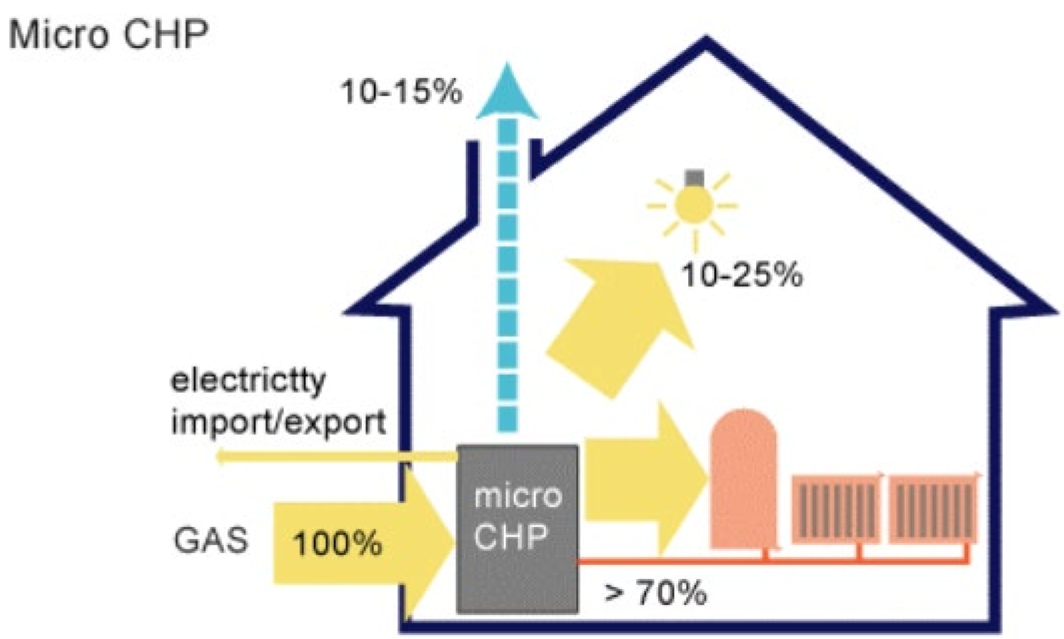
The heat produced by a heat pump is usually used to either provide space heating say to underfloor heating or radiators or the heat is used to generate domestic hot water via a storage vessel.



CHP

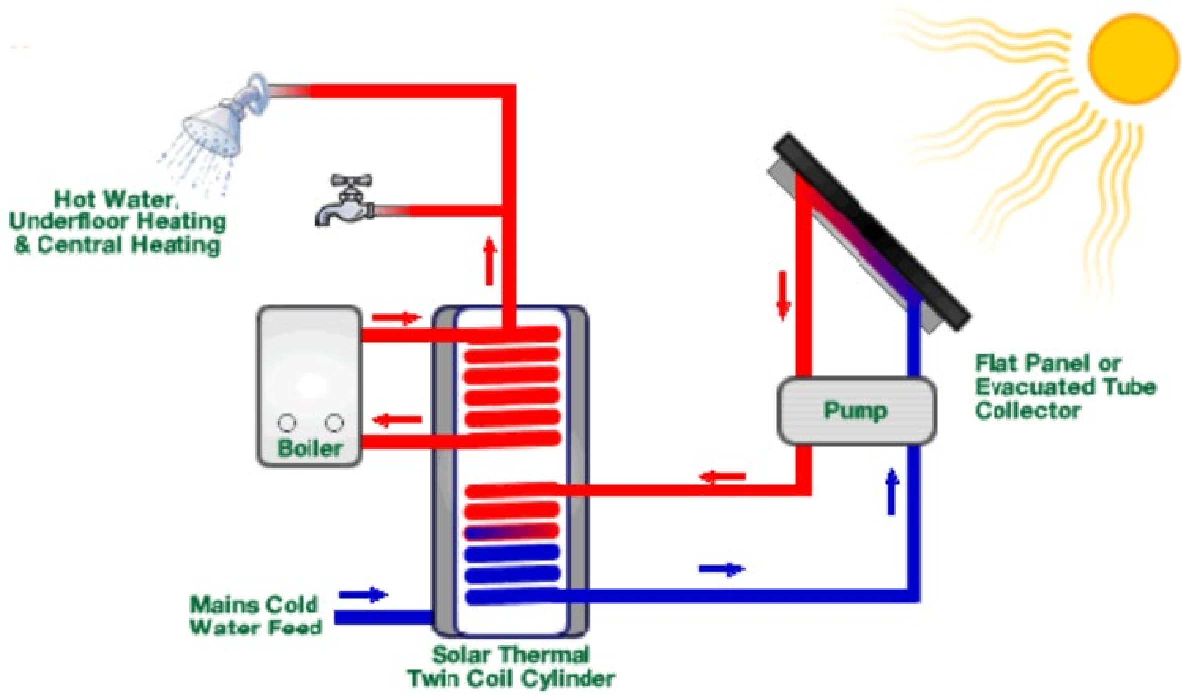
Combined heat and power (CHP) is a process involving simultaneous generation of heat and electricity, where the heat generated in the process in harnessed via heat recovery equipment. CHP at the large commercial size is now fairly common in premises which have a simultaneous demand for heating and electricity 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 approximately 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 flat roofs, in façades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles.

Currently, a PV system will cost between £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	16.49	0.136 (s)	1.5010t)	
	30				
7-hour tariff (high rate) (h)	7	19.60	0.136 (s)	1.5010t)	
	32				
7-hour tariff (low rate) (h)		9.40	0.136 (s)	1.501 (t)	
		31			
10-hour tariff (high rate) (">	21	20.54	0.136 (s)	1.501 (t)	
	34				
10-hour tariff (low rate) fib)		12.27	0.136 (a)	1.501 (0	
		33			
18-hour tariff (high rate) (">	26	17.41	0.136 (s)	1.501 (0	
	38				
18-hour tariff (low rate) 00		14.17	0.136 (s)	1.501 (t)	
		40			
24-hour heating tariff	26	14.04	0.136 (s)	1.501 0)	
	35				
electricity sold to grid, PV		5.59 (0	0.136 (s)	0.501 0)	
		60			
electricity sold to grid, other		5.59 ()	0.136 (s)	0.501 0)	
		36			
electricity, any tariff 0)		N/A	0.136 (s)	1.501 0t)	
		39			
Heat networks: (k)	92 0)				
heat from boilers - mains gas		4.44	0.210	1.130	
		51			
heat from boilers - LPG		4.44	0.241	1.141	
		52			
heat from boilers - oil (assumes 'gas oil')		4.44	0.335	1.180	
		53			
heat from boilers that can use mineral oil or biodiesel		4.44	0.335	1.180	
		56			
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

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

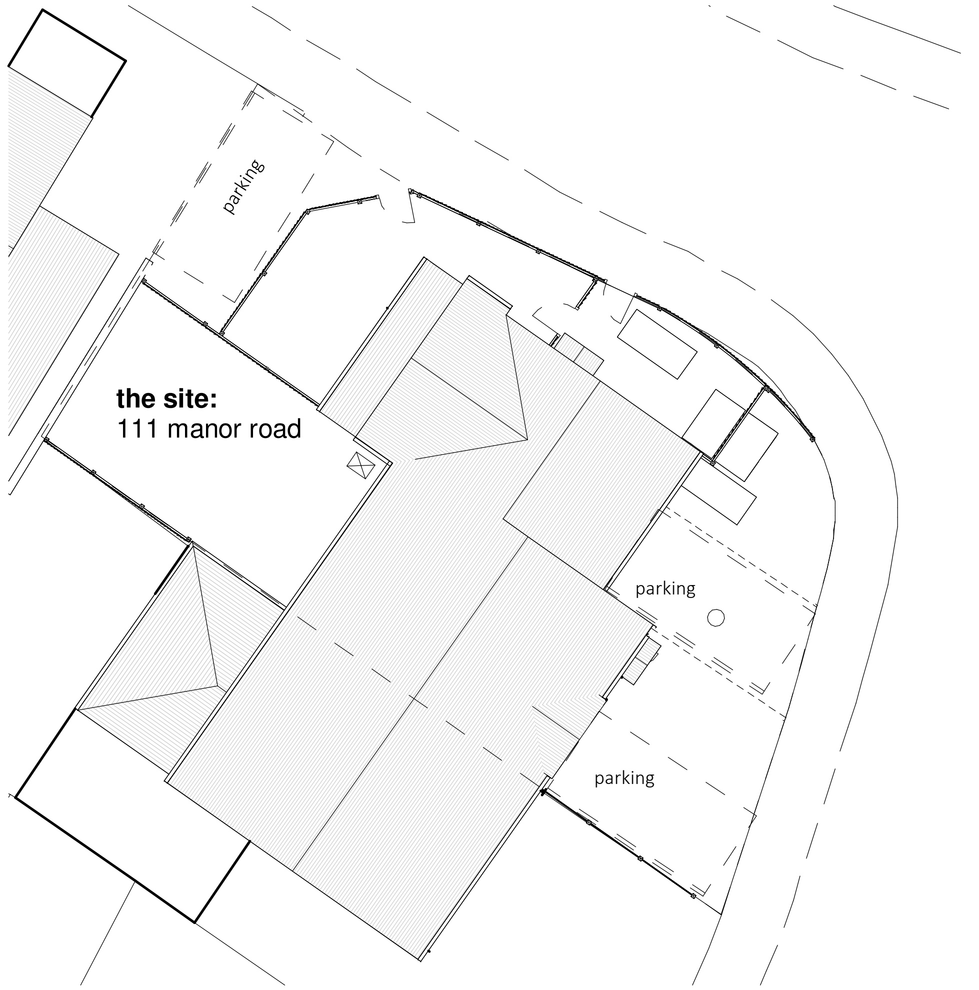
Appendix C – Plan, elevation and section drawings used for SAP Calculation

Appendix D – BREL Worksheets for As-Designed Dwelling (i.e., Be Green Specification)

Appendix E – Be Green SAP calculation reports for the As-Designed Dwelling

Appendix F – Be Green PEA showing potential EPC rating using provided specification

Appendix G – Sample Water calculation showing how to achieve consumption below 110/litres/person/day



1 p100B **00.1 Block Plan as proposed**
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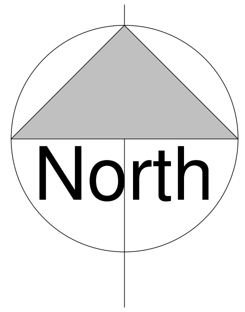
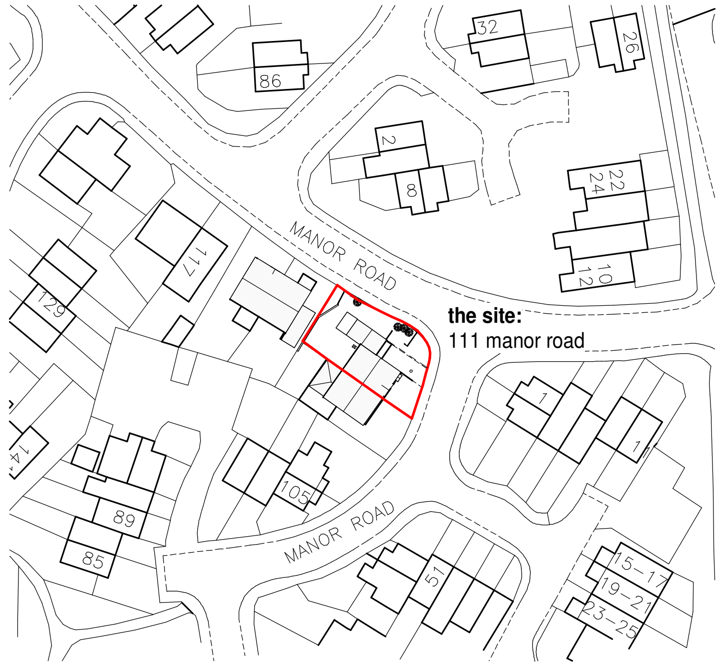
1:200 @ a3





2 p100B **00.0 Location Plan as existing**
1 : 1250

0 100m
1:1250 @ a3

Notes

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Rev	Date	Description
A	31jan	amenity space revised
B	23feb	amenity space consolidated

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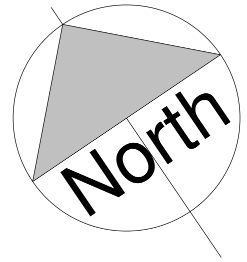
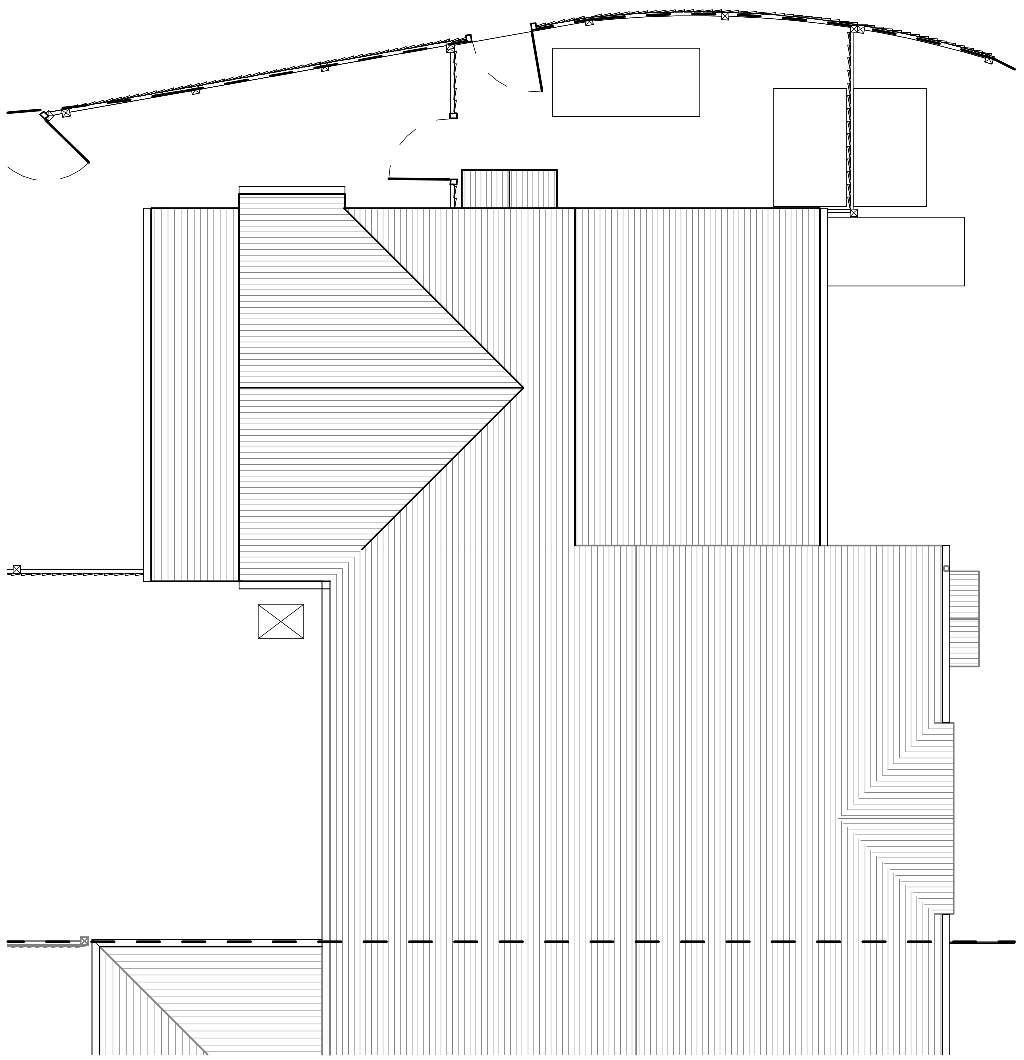
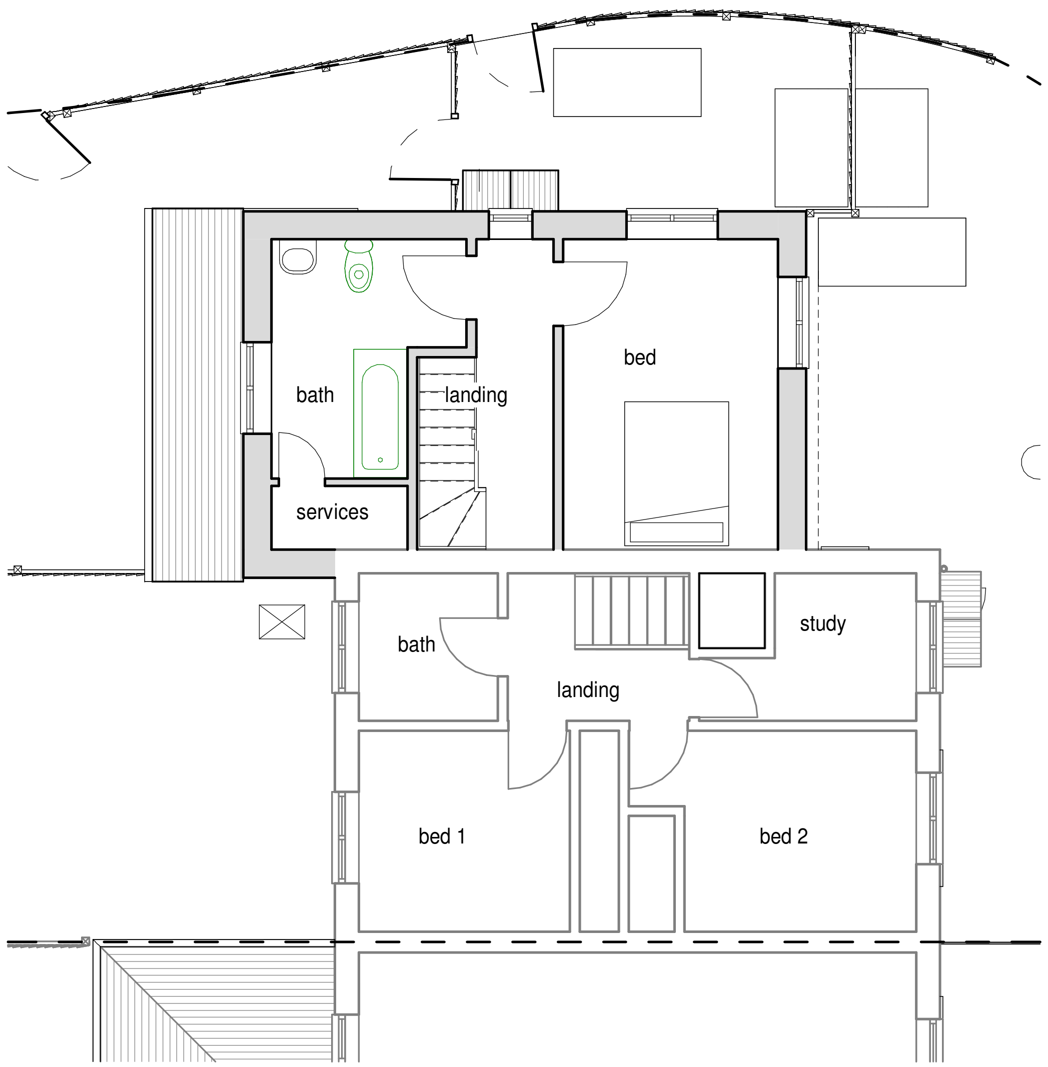
client:	Mr Jon Pickering
job:	Proposed development at 111 Manor Road, Witney, OX28 3UF
title:	Location & proposed block plan
status	planning issue
scale:	As indicated
date:	february 2024
no:	2243 p100B

23/02/2024 12:09:45





2 p111 **04.4 Roof Plan - as proposed**
1 : 100



1 p111 **02.4 First Floor plan - as proposed**
1 : 100

0 1 2 3 4 5m 1:100 @ a3

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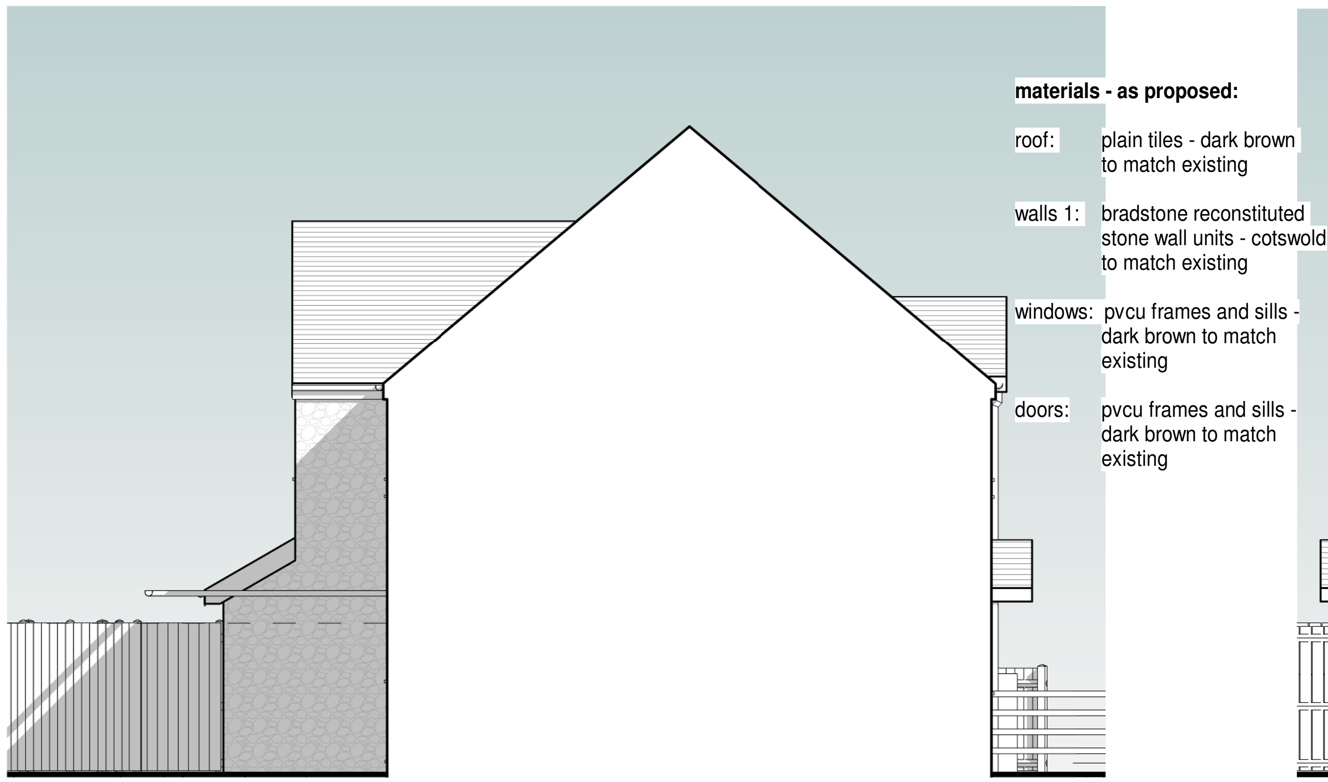
client:	Mr Jon Pickering
job:	Proposed development at 111 Manor Road, Witney, OX28 3UF
title:	First Floor and Roof plans - as proposed
status	planning issue
scale:	1 : 100
date:	february 2024
no:	2243 p111

23/02/2024 12:17:42

1 p112 **05.4 east elevation - as proposed**
1 : 100

2 p112 **06.4 north elevation - as proposed**
1 : 100



3 p112 **07.4 south elevation - as proposed**
1 : 100

4 p112 **08.4 west elevation - as proposed**
1 : 100

0 1 2 3 4 5m
1:100 @ a3

Notes

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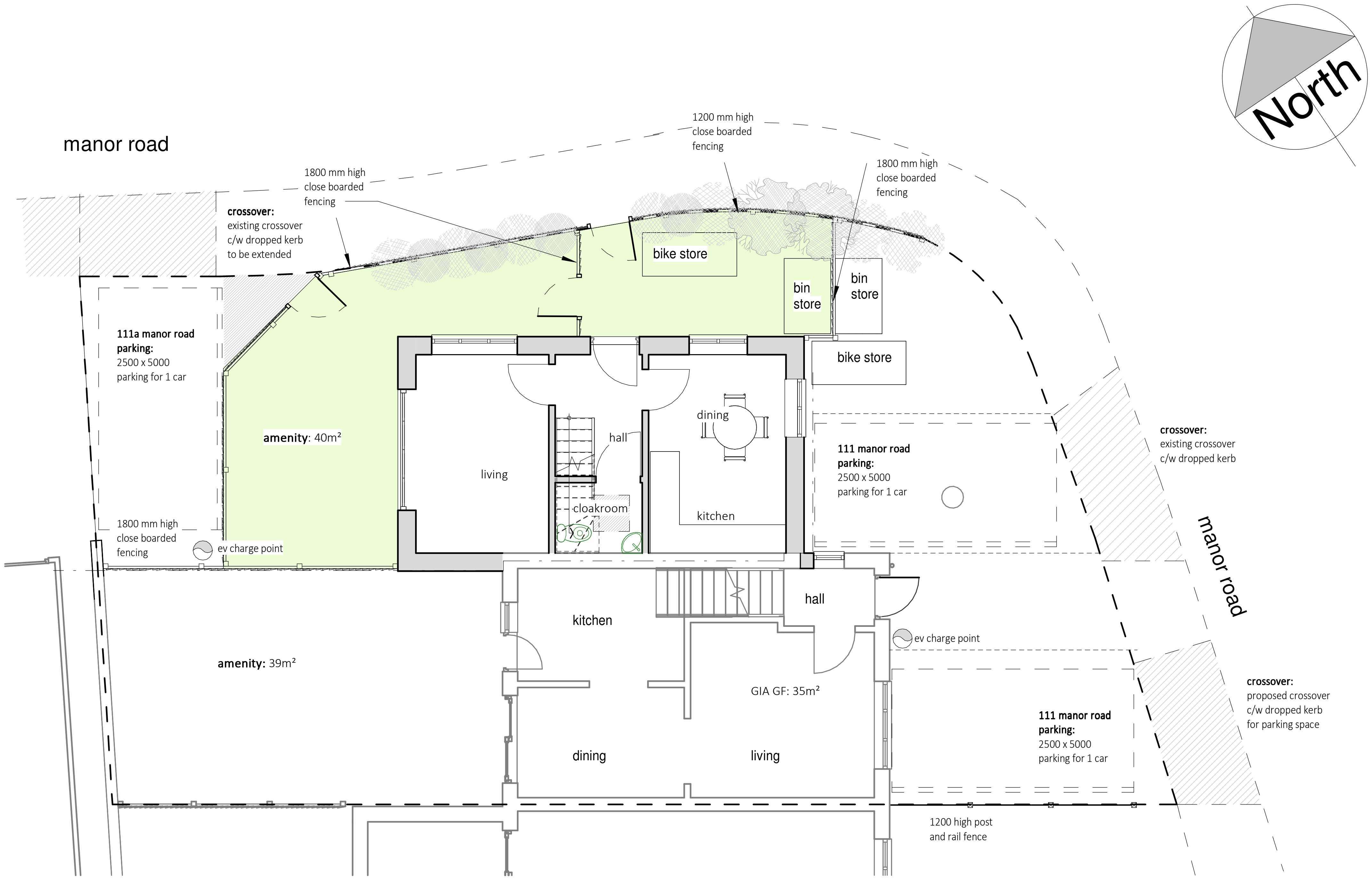
client:	Mr Jon Pickering
job:	Proposed development at 111 Manor Road, Witney, OX28 3UF
title:	Elevations - as proposed
status	planning issue
scale:	1 : 100
date:	february 2024
no:	2243 p112

23/02/2024 12:18:24



1 p110 **01.4 Ground floor plan - as proposed**

1 : 100

0 1 2 3 4 5m 1:100 @ a3

Notes

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Rev	Date	Description

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t **01865 874112**
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client:	Mr Jon Pickering
job:	Proposed development at 111 Manor Road, Witney, OX28 3UF
title:	Ground floor plan - as proposed
status	planning issue
scale:	1 : 100
date:	february 2024
no:	2243 p110

26/02/2024 13:36:49

Building Regulations England Part L (BREL) Compliance Report

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

Date: Tue 27 Feb 2024 12:33:42

Project Information			
Assessed By	Iraj Maghounaki	Building Type	House, End-terrace
OCDEA Registration	EES/015723	Assessment Date	2024-02-27

Dwelling Details			
Assessment Type	As designed	Total Floor Area	59 m^2
Site Reference	PR11012 - 111 Manor Road	Plot Reference	001 - Be Green
Address	111 Manor Road, Witney, OX28 3UF		

Client Details	
Name	Ifor Rhys
Company	Ifor Rhys Ltd
Address	Lower Barn, 4 Blenheim Road, Horspath, Oxford, OX33 1RY

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	*13.73 $kgCO_2/m^2$*	
Dwelling carbon dioxide emission rate	1.56 $kgCO_2/m^2$	OK
1b Target primary energy rate and dwelling primary energy		
Target primary energy	*72.03 kWh_{PE}/m^2*	
Dwelling primary energy	34.87 kWh_{PE}/m^2	OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency		
Target fabric energy efficiency	*42.4 kWh/m^2*	
Dwelling fabric energy efficiency	36.8 kWh/m^2	OK

2a Fabric U-values				
Element	***Maximum permitted average U-Value [W/m²K]***	**Dwelling average U-Value [W/m²K]**	**Element with highest individual U-Value**	
External walls	*0.26*	0.17	Walls (1) (0.17)	OK
Party walls	*0.2*	0	Party Wall (1) (0)	**N/A**
Curtain walls	*1.6*	0	N/A	**N/A**
Floors	*0.18*	0.12	Heat Loss Floor 1 (0.12)	OK
Roofs	*0.16*	0.1	Roof (1) (0.1)	OK
Windows, doors, and roof windows	*1.6*	1.2	Windows (1.2)	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 [m²]**	**U-Value [W/m²K]**
Exposed wall: Walls (1)	69.1827	0.17
Party wall: Party Wall (1)	27.72	0 **(!)**
Ground floor: Heat Loss Floor 1, Heat Loss Floor 1	31.38	0.12
Exposed roof: Roof (1)	31.41	0.1 **(!)**

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	**Area [m²]**	**Orientation**	**Frame factor**	**U-Value [W/m²K]**
Windows, Windows	0.852	South East	0.8	1.2
Windows, Windows	1.392	South East	0.8	1.2
Door, HG Door	2.07	North East	N/A	1.2
Windows, Windows	1.2	North East	0.8	1.2
Windows, Windows	1.1495	North East	0.8	1.2
Windows, Windows	0.551	North East	0.8	1.2
Windows, Windows	2.1004	North East	0.8	1.2
Windows, Windows	5.225	North West	0.8	1.2
Windows, Windows	1.1374	North West	0.8	1.2

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)	Calculated by person with suitable expertise	0.019 **(!)**	MHF-100-E2-01
External wall	E3: Sill	Calculated by person with suitable expertise	0.021 **(!)**	MHF-100-E3-01
External wall	E4: Jamb	Calculated by person with suitable expertise	0.016 **(!)**	MHF-100-E4-01
External wall	E5: Ground floor (normal)	Calculated by person with suitable expertise	0.059	MHF-100-E5-12
External wall	E6: Intermediate floor within a dwelling	Calculated by person with suitable expertise	0.001 **(!)**	MHF-100-E6-01
External wall	E10: Eaves (insulation at ceiling level)	Calculated by person with suitable expertise	0.063	MHF-100-E10-01
External wall	E12: Gable (insulation at ceiling level)	Calculated by person with suitable expertise	0.041	MHF-100-E12-01
External wall	E16: Corner (normal)	Calculated by person with suitable expertise	0.037 **(!)**	MHF-100-E16-01
External wall	E25: Staggered party wall between dwellings	Calculated by person with suitable expertise	0.041	MHF-100-E25-02
Party wall	P1: Ground floor	Calculated by person with suitable expertise	0.043	MPW-P1-12
Party wall	P2: Intermediate floor within a dwelling	SAP table default	0 **(!)**	
Party wall	P4: Roof (insulation at ceiling level)	Calculated by person with suitable expertise	0.04	MPW-P4-01

3 Air permeability (better than typically expected values are flagged with a subsequent (!))		
Maximum permitted air permeability at 50Pa	*8 m³/hm²*	
Dwelling air permeability at 50Pa	5 m³/hm², Design value	OK
Air permeability test certificate reference		

4 Space heating	
Main heating system 1: Room heaters - Electricity	
Efficiency	100.0%
Emitter type	
Flow temperature	
System type	Panel, convector or radiant heaters
Manufacturer	
Model	
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

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

6 Controls	
Main heating 1 - type: Programmer and appliance thermostats	
Function	
Ecodesign class	
Manufacturer	
Model	

Water heating - type: N/A		
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	
Technology type: **Photovoltaic system (1)**	
Peak power	3.7 kWp
Orientation	South East
Pitch	45°
Overshading	None or very little
Manufacturer	
MCS certificate	
Technology type: **Photovoltaic system (2)**	
Peak power	0.7 kWp
Orientation	North East
Pitch	45°
Overshading	None or very little
Manufacturer	
MCS certificate	

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:	Assessor ID:
Name:	Date:
b. Client Declaration	
N/A	

Full SAP Calculation Printout

elmhurst energy

Property Reference	PR11012 - 111 Manor Road	Issued on Date	27/02/2024
Assessment Reference	002 - Be Lean	Prop Type Ref	
Property	111, Manor Road, Witney, Oxfordshire, OX28 3UF		

SAP Rating	70 C	DER	8.83	TER	13.73
Environmental	94 A	% DER < TER			35.69
CO_2 Emissions (t/year)	0.46	DFEE	36.81	TFEE	42.39
Compliance Check	See BREL	% DFEE < TFEE			13.18
% DPER < TPER	-27.21	DPER	91.63	TPER	72.03

Assessor Details	Mr. Iraj Maghounaki	Assessor ID	V571-0001
Client	-, Ifor Rhys		

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)			Volume (m3)	
Ground floor	31.3800 (1b)	x	2.4000 (2b)	=		75.3120 (1b) - (3b)	
First floor	27.5000 (1c)	x	2.6000 (2c)	=		71.5000 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 58.8800						(4)	
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=		146.8120 (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) =	0.2043	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4543	(18)
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180	(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	0.4055	0.3976	0.3896	0.3498	0.3419	0.3021	0.3021	0.2942	0.3180	0.3419	0.3578	0.3737	(22b)
Effective ac	0.5822	0.5790	0.5759	0.5612	0.5584	0.5456	0.5456	0.5433	0.5506	0.5584	0.5640	0.5698	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16035.6500	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		272.3446	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758

E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 4.2451 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.9705 (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	28.2072	28.0525	27.9009	27.1888	27.0555	26.4353	26.4353	26.3205	26.6742	27.0555	27.3251	27.6068	(38)
Heat transfer coeff	69.1777	69.0230	68.8714	68.1593	68.0261	67.4059	67.4059	67.2910	67.6448	68.0261	68.2956	68.5774	(39)
Average = Sum(39)m / 12 =												68.1587	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1749	1.1723	1.1697	1.1576	1.1553	1.1448	1.1448	1.1429	1.1489	1.1553	1.1599	1.1647	(40)
HLP (average)												1.1576	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.9498 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)
Average daily hot water use (litres/day)												54.2578	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)
Energy content (annual)										Total = Sum(45)m =		901.1065	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)

Total per year (kWh/year) = Sum(64)m = 765.9405 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 518.4290 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	11.2829	0.6300	0.8000	0.7700	19.7041	(75)
Southeast	2.2400	36.7938	0.6300	0.8000	0.7700	28.7864	(77)
Northwest	6.3600	11.2829	0.6300	0.8000	0.7700	25.0636	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	73.5540	140.1597	231.2701	352.7585	455.5466	478.8324	450.5841	369.8360	272.7002	165.5559	90.8087	61.1947	(83)
Total gains	484.4290	549.5640	627.8808	727.4061	806.5804	809.2988	769.5914	690.4910	605.9034	519.9415	469.7445	461.2824	(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	64.3899	64.5342	64.6763	65.3520	65.4800	66.0825	66.0825	66.1953	65.8491	65.4800	65.2216	64.9536	
alpha	5.2927	5.3023	5.3118	5.3568	5.3653	5.4055	5.4055	5.4130	5.3899	5.3653	5.3481	5.3302	
util living area	0.9941	0.9878	0.9667	0.8905	0.7260	0.5246	0.3840	0.4451	0.7169	0.9409	0.9881	0.9954	(86)
MIT	19.8593	20.0371	20.3362	20.6994	20.9200	20.9884	20.9982	20.9962	20.9449	20.6292	20.1764	19.8246	(87)
Th 2	19.9401	19.9423	19.9443	19.9541	19.9559	19.9644	19.9644	19.9660	19.9611	19.9559	19.9522	19.9483	(88)
util rest of house	0.9921	0.9836	0.9553	0.8571	0.6626	0.4436	0.2944	0.3468	0.6297	0.9145	0.9833	0.9938	(89)
MIT 2	18.6335	18.8603	19.2351	19.6709	19.8967	19.9588	19.9639	19.9649	19.9286	19.6050	19.0463	18.5955	(90)

Living area fraction fLA = Living area / (4) = 0.1914 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(92)

Temperature adjustment 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9891	0.9789	0.9484	0.8540	0.6714	0.4589	0.3116	0.3656	0.6443	0.9097	0.9788	0.9914	(94)
Useful gains	479.1664	537.9806	595.5066	621.1810	541.5335	371.3503	239.7887	252.4641	390.3610	472.9845	459.7979	457.2931	(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	1007.7907	979.1293	891.5968	747.5529	570.9114	374.4963	240.0933	253.1672	407.4309	625.9130	830.6542	1003.3406	(97)
Space heating kWh	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98a)

Space heating requirement - total per year (kWh/year) 1809.9392

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating kWh	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 1809.9392

Space heating per m2 (98c) / (4) = 30.7395 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 100.0000 (206)

Efficiency of main space heating system 2 (in %) 0.0000 (207)

Efficiency of secondary/supplementary heating system, % 0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(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 1809.9392 (211)

Space heating fuel - main system 2 0.0000 (213)

Space heating fuel - secondary 0.0000 (215)

Efficiency of water heater 100.0000

Water heating fuel used 765.9405 (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) 192.4129 (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	3286.7217	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1809.9392	16.4900	298.4590	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	16.4900	126.3036	(247)
Energy for instantaneous electric shower(s)	518.4290	16.4900	85.4889	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Energy for lighting	192.4129	16.4900	31.7289	(250)
Additional standing charges			0.0000	(251)
Total energy cost			541.9804	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600	(256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.8783	(257)
SAP value		69.5535	
SAP rating (Section 12)		70	(258)
SAP band		C	

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	1809.9392	0.1564	283.1543	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	765.9405	0.1416	108.4396	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			391.5939	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Total CO2, kg/year			491.4900	(272)
CO2 emissions per m2			8.3500	(273)
EI value			93.6600	
EI rating			94	(274)
EI band			A	

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY

1. Overall dwelling characteristics

		Area (m2)			Storey height (m)			Volume (m3)	
Ground floor		31.3800	(1b)	x	2.4000	(2b)	=	75.3120	(1b) - (3b)
First floor		27.5000	(1c)	x	2.6000	(2c)	=	71.5000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	58.8800								(4)
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =			146.8120	(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) =	0.2043	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			5.0000	(17)
Infiltration rate			0.4543	(18)
Number of sides sheltered			4	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.3180	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.0000	4.1000	3.8000	3.7000	3.2000	3.1000	3.1000	3.3000	3.5000	3.4000	3.8000	(22)
Wind factor	1.0750	1.0000	1.0250	0.9500	0.9250	0.8000	0.7750	0.7750	0.8250	0.8750	0.8500	0.9500	(22a)
Adj infilt rate													

	0.3419	0.3180	0.3260	0.3021	0.2942	0.2544	0.2465	0.2465	0.2624	0.2783	0.2703	0.3021	(22b)
Effective ac	0.5584	0.5506	0.5531	0.5456	0.5433	0.5324	0.5304	0.5304	0.5344	0.5387	0.5365	0.5456	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 16035.6500 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 272.3446 (35)
List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758
E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 4.2451 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.9705 (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	27.0555	26.6742	26.7983	26.4353	26.3205	25.7921	25.6957	25.6957	25.8917	26.0999	25.9943	26.4353	(38)
Heat transfer coeff													
	68.0261	67.6448	67.7688	67.4059	67.2910	66.7627	66.6662	66.6662	66.8622	67.0705	66.9648	67.4059	(39)
Average = Sum(39)m / 12 =												67.2113	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1553	1.1489	1.1510	1.1448	1.1429	1.1339	1.1322	1.1322	1.1356	1.1391	1.1373	1.1448	(40)
HLP (average)												1.1415	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.9498 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses													
	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)
Average daily hot water use (litres/day)												54.2578	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)
Energy content (annual)										Total = Sum(45)m =		901.1065	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss:													
Total storage loss													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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													
	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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													
	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)
								Total per year (kWh/year) = Sum(64)m =				765.9405	(64)
Electric shower(s)													
	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							518.4290	(64a)
Heat gains from water heating, kWh/month													
	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	13.7947	0.6300	0.8000	0.7700	24.0906	(75)
Southeast	2.2400	43.3860	0.6300	0.8000	0.7700	33.9439	(77)
Northwest	6.3600	13.7947	0.6300	0.8000	0.7700	30.6432	(81)

Solar gains	88.6777	153.4036	244.0691	381.0722	473.7274	536.0524	488.1841	410.6421	302.4448	183.4207	107.9860	74.1111	(83)
Total gains	499.5526	562.8079	640.6799	755.7197	824.7612	866.5188	807.1914	731.2971	635.6480	537.8063	486.9218	474.1988	(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	65.4800	65.8491	65.7286	66.0825	66.1953	66.7191	66.8157	66.8157	66.6198	66.4129	66.5177	66.0825	
alpha	5.3653	5.3899	5.3819	5.4055	5.4130	5.4479	5.4544	5.4544	5.4413	5.4275	5.4345	5.4055	
util living area	0.9927	0.9852	0.9584	0.8613	0.6736	0.4364	0.3135	0.3547	0.6455	0.9212	0.9842	0.9944	(86)
MIT	19.9356	20.1138	20.4194	20.7656	20.9491	20.9959	20.9995	20.9990	20.9700	20.7014	20.2647	19.8982	(87)
Th 2	19.9559	19.9611	19.9594	19.9644	19.9660	19.9733	19.9746	19.9746	19.9719	19.9690	19.9705	19.9644	(88)
util rest of house	0.9902	0.9802	0.9444	0.8220	0.6060	0.3592	0.2291	0.2619	0.5538	0.8876	0.9778	0.9925	(89)
MIT 2	18.7422	18.9712	19.3487	19.7512	19.9310	19.9716	19.9745	19.9744	19.9562	19.6975	19.1709	18.7010	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9869	0.9752	0.9376	0.8212	0.6169	0.3739	0.2453	0.2797	0.5704	0.8845	0.9728	0.9897	(94)
Useful gains	493.0017	548.8520	600.7199	620.6110	508.8233	324.0039	197.9736	204.5564	362.5744	475.6763	473.7009	469.3022	(95)
Ext temp.	4.5000	5.1000	6.9000	9.3000	12.3000	15.3000	17.2000	17.1000	14.6000	11.0000	7.4000	4.4000	(96)
Heat loss rate W	984.3811	953.1061	857.5201	717.5602	526.6100	324.9768	198.0438	204.6985	371.1012	596.2331	802.2557	979.4167	(97)
Space heating kWh	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98a)
Space heating requirement - total per year (kWh/year)												1617.1201	
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	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1617.1201	
Space heating per m2											(98c) / (4) =	27.4647	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(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	1617.1201	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	100.0000	
Water heating fuel used	765.9405	(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)	192.4129	(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	3093.9026	(238)

10a. Fuel costs - using BEDF prices (536)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1617.1201	25.1600	406.8674	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	25.1600	192.7106	(247)
Energy for instantaneous electric shower(s)	518.4290	25.1600	130.4367	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Energy for lighting	192.4129	25.1600	48.4111	(250)
Additional standing charges			0.0000	(251)
Total energy cost			778.4259	(255)

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	1617.1201	0.1569	253.7982	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	765.9405	0.1416	108.4396	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			362.2378	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Total CO2, kg/year			462.1339	(272)

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	1617.1201	1.5810	2556.6981	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	1.5235	1166.9355	(278)
Energy for instantaneous electric shower(s)	518.4290	1.5143	785.0748	(278a)
Space and water heating			3723.6336	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	192.4129	1.5338	295.1294	(282)
Total Primary energy kWh/year			4803.8378	(286)

SAP 10 EPC IMPROVEMENTS

002 - Be Lean

Current energy efficiency rating: C 70
Current environmental impact rating: A 94

N Solar water heating	Recommended
U Solar photovoltaic panels	Recommended
V2 Wind turbine	Not applicable

Recommended measures:	SAP change	Cost change	CO2 change
N Solar water heating	+ 2.8	-£ 84	-43 kg (9.3%)
U Solar photovoltaic panels	+ 10.3	-£ 271	-241 kg (57.5%)

Recommended measures	Typical annual savings		Energy efficiency	Environmental impact
Solar water heating	£84	0.73 kg/m²	C 72	A 94

Solar photovoltaic panels		£271	4.09 kg/m²	B 83	A 97
	Total Savings	£355	4.82 kg/m²		

Potential energy efficiency rating: B 83
Potential environmental impact rating: A 97

Fuel prices for cost data on this page from database revision number 536 TEST (31 Jan 2024)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, Thames Valley):

	Current	Potential	Saving
Electricity	£778	£694	£84
Space heating	£407	£427	-£20
Water heating	£323	£219	£104
Lighting	£48	£48	£0
Generated (PV)	-£0	-£271	£271
Total cost of fuels	£778	£423	£355
Total cost of uses	£778	£423	£355
Delivered energy	53 kWh/m²	15 kWh/m²	37 kWh/m²
Carbon dioxide emissions	0.5 tonnes	0.2 tonnes	0.3 tonnes
CO2 emissions per m²	8 kg/m²	3 kg/m²	5 kg/m²
Primary energy	82 kWh/m²	44 kWh/m²	38 kWh/m²

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	31.3800 (1b)	x	2.4000 (2b)	=	75.3120	(1b) - (3b)
First floor	27.5000 (1c)	x	2.6000 (2c)	=	71.5000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 58.8800						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	146.8120	(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) =	0.2043	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4543	(18)
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180	(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	0.4055	0.3976	0.3896	0.3498	0.3419	0.3021	0.3021	0.2942	0.3180	0.3419	0.3578	0.3737	(22b)
Effective ac	0.5822	0.5790	0.5759	0.5612	0.5584	0.5456	0.5456	0.5433	0.5506	0.5584	0.5640	0.5698	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 16035.6500 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 272.3446 (35)
List of Thermal Bridges

K1 Element	Length	Psi-value	Total

E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257	
E3 Sill	8.3700	0.0210	0.1758	
E4 Jamb	22.1000	0.0160	0.3536	
E5 Ground floor (normal)	17.9500	0.0590	1.0590	
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161	
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231	
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526	
E16 Corner (normal)	15.0000	0.0370	0.5550	
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100	
P1 Party wall - Ground floor	5.5500	0.0430	0.2386	
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000	
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				4.2451 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	40.9705 (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	28.2072	28.0525	27.9009	27.1888	27.0555	26.4353	26.4353	26.3205	26.6742	27.0555	27.3251	27.6068	(38)
Heat transfer coeff	69.1777	69.0230	68.8714	68.1593	68.0261	67.4059	67.4059	67.2910	67.6448	68.0261	68.2956	68.5774	(39)
Average = Sum(39)m / 12 =												68.1587	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1749	1.1723	1.1697	1.1576	1.1553	1.1448	1.1448	1.1429	1.1489	1.1553	1.1599	1.1647	(40)
HLP (average)												1.1576	
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												1.9498	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)
Average daily hot water use (litres/day)												54.2578	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)
Energy content (annual)										Total = Sum(45)m =		901.1065	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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)
Aperture area of solar collector												3.0000	(H1)
Zero-loss collector efficiency												0.8000	(H2)
Collector linear heat loss coefficient												1.8000	(H3)
Collector 2nd order heat loss coefficient												0.0000	(H4)
Collector loop efficiency												0.9000	(H5)
Incidence angle modifier												1.0000	(H6)
Overshading factor												0.8000	(H8)
Overall heat loss coefficient of system												6.5000	(H10)
Heat loss coefficient of collector loop												3.9667	(H11)
Dedicated solar storage volume												75.0000	(H12)
Effective solar volume												75.0000	(H14)
Reference volume												225.0000	(H15)
Storage tank correction coefficient												1.3161	(H16)
Heat delivered to hot water												381.3293	(H24)
Heat delivered to space heating												0.0000	(H29)
Solar input												381.3293	
Solar input	-0.0000	-17.2539	-43.7094	-49.9045	-54.3327	-48.4954	-47.9586	-47.0973	-40.3020	-27.7755	-4.5001	-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	79.6876	52.4299	29.1872	12.4559	4.7387	3.3226	2.5707	6.4968	14.9726	35.4757	64.6022	78.6714	(64)
								Total per year (kWh/year) = Sum(64)m =				384.6112	(64)
Electric shower(s)	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							518.4290	(64a)
Heat gains from water heating, kWh/month	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	11.2829	0.6300	0.8000	0.7700	19.7041	(75)
Southeast	2.2400	36.7938	0.6300	0.8000	0.7700	28.7864	(77)
Northwest	6.3600	11.2829	0.6300	0.8000	0.7700	25.0636	(81)

Solar gains	73.5540	140.1597	231.2701	352.7585	455.5466	478.8324	450.5841	369.8360	272.7002	165.5559	90.8087	61.1947	(83)
Total gains	484.4290	549.5640	627.8808	727.4061	806.5804	809.2988	769.5914	690.4910	605.9034	519.9415	469.7445	461.2824	(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	64.3899	64.5342	64.6763	65.3520	65.4800	66.0825	66.0825	66.1953	65.8491	65.4800	65.2216	64.9536	
alpha	5.2927	5.3023	5.3118	5.3568	5.3653	5.4055	5.4055	5.4130	5.3899	5.3653	5.3481	5.3302	
util living area	0.9941	0.9878	0.9667	0.8905	0.7260	0.5246	0.3840	0.4451	0.7169	0.9409	0.9881	0.9954	(86)
MIT	19.8593	20.0371	20.3362	20.6994	20.9200	20.9884	20.9982	20.9962	20.9449	20.6292	20.1764	19.8246	(87)
Th 2	19.9401	19.9423	19.9443	19.9541	19.9559	19.9644	19.9644	19.9660	19.9611	19.9559	19.9522	19.9483	(88)
util rest of house	0.9921	0.9836	0.9553	0.8571	0.6626	0.4436	0.2944	0.3468	0.6297	0.9145	0.9833	0.9938	(89)
MIT 2	18.6335	18.8603	19.2351	19.6709	19.8967	19.9588	19.9639	19.9649	19.9286	19.6050	19.0463	18.5955	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9891	0.9789	0.9484	0.8540	0.6714	0.4589	0.3116	0.3656	0.6443	0.9097	0.9788	0.9914	(94)
Useful gains	479.1664	537.9806	595.5066	621.1810	541.5335	371.3503	239.7887	252.4641	390.3610	472.9845	459.7979	457.2931	(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	1007.7907	979.1293	891.5968	747.5529	570.9114	374.4963	240.0933	253.1672	407.4309	625.9130	830.6542	1003.3406	(97)
Space heating kWh	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98a)
Space heating requirement - total per year (kWh/year)												1809.9392	
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	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1809.9392	
Space heating per m2										(98c) / (4) =		30.7395	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(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	79.6876	52.4299	29.1872	12.4559	4.7387	3.3226	2.5707	6.4968	14.9726	35.4757	64.6022	78.6714	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	79.6876	52.4299	29.1872	12.4559	4.7387	3.3226	2.5707	6.4968	14.9726	35.4757	64.6022	78.6714	(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	6.7945	6.1370	6.7945	6.5753	6.7945	6.5753	6.7945	6.7945	6.5753	6.7945	6.5753	6.7945	(231)
Lighting	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-38.7399	-57.4700	-83.8057	-89.8691	-89.5272	-80.6280	-79.8957	-75.7654	-67.8455	-62.9424	-43.1437	-33.1738	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity) (233b)m	-11.3466	-26.1099	-58.5406	-100.9030	-146.1556	-151.0857	-148.7558	-124.0086	-88.6176	-43.9035	-16.2661	-8.7401	(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                                                                                                          1809.9392 (211)
Space heating fuel - main system 2                                                                                                             0.0000 (213)
Space heating fuel - secondary                                                                                                                 0.0000 (215)
Efficiency of water heater                                                                                                                   100.0000
Water heating fuel used                                                                                                                      384.6112 (219)
Space cooling fuel                                                                                                                             0.0000 (221)

Electricity for pumps and fans:
   pump for solar water heating                                                                                                               80.0000 (230g)
Total electricity for the above, kWh/year                                                                                                     80.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                          192.4129 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                              -1727.2394 (233)
Wind generation                                                                                                                                0.0000 (234)
Hydro-electric generation (Appendix N)                                                                                                         0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                                                                 0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                                                     -0.0000 (236)
Energy used                                                                                                                                    0.0000 (237)
Total delivered energy for all uses                                                                                                         1258.1530 (238)


----------------------------------------------------------------------------------------------------
10a. Fuel costs - using Table 12 prices
----------------------------------------------------------------------------------------------------
                                                                                          Fuel          Fuel price          Fuel cost
                                                                                      kWh/year               p/kWh             £/year
Space heating - main system 1                                                        1809.9392             16.4900           298.4590 (240)
Total CO2 associated with community systems                                                                                    0.0000 (473)
Water heating (other fuel)                                                            384.6112             16.4900            63.4224 (247)
Energy for instantaneous electric shower(s)                                           518.4290             16.4900            85.4889 (247a)
Pumps, fans and electric keep-hot                                                       0.0000              0.0000             0.0000 (249)
Pump for solar water heating                                                           80.0000             16.4900            13.1920 (249)
Energy for lighting                                                                   192.4129             16.4900            31.7289 (250)
Additional standing charges                                                                                                    0.0000 (251)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                 -802.8063             16.4900          -132.3828
PV Unit electricity exported                                                         -924.4331              5.5900           -51.6758
Total                                                                                                                       -184.0586 (252)
Total energy cost                                                                                                            308.2326 (255)


----------------------------------------------------------------------------------------------------
11a. SAP rating - Individual heating systems
----------------------------------------------------------------------------------------------------
Energy cost deflator (Table 12):                                                                                               0.3600 (256)
Energy cost factor (ECF)                                                     [(255) x (256)] / [(4) + 45.0] =                  1.0682 (257)
SAP value                                                                                                                     82.6846
SAP rating (Section 12)                                                                                                           83 (258)
SAP band                                                                                                                           B


----------------------------------------------------------------------------------------------------
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                                                        1809.9392              0.1564           283.1543 (261)
Total CO2 associated with community systems                                                                                    0.0000 (373)
Water heating (other fuel)                                                            384.6112              0.1531            58.8916 (264)
Energy for instantaneous electric shower(s)                                           518.4290              0.1391            72.1249 (264a)
Space and water heating                                                                                                      342.0459 (265)
Pumps, fans and electric keep-hot                                                      80.0000              0.1387            11.0970 (267)
Energy for lighting                                                                   192.4129              0.1443            27.7711 (268)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                 -802.8063              0.1355          -108.7898
PV Unit electricity exported                                                         -924.4331              0.1225          -113.2324
Total                                                                                                                       -222.0222 (269)
Total CO2, kg/year                                                                                                           231.0167 (272)
CO2 emissions per m2                                                                                                           3.9200 (273)
EI value                                                                                                                      97.0200
EI rating                                                                                                                         97 (274)
EI band                                                                                                                            A

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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING
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----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
----------------------------------------------------------------------------------------------------
                                                                                          Area       Storey height             Volume
                                                                                          (m2)                 (m)               (m3)
Ground floor                                                                       31.3800 (1b)     x       2.4000 (2b)    =      75.3120 (1b) - (3b)
First floor                                                                        27.5000 (1c)     x       2.6000 (2c)    =      71.5000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)                 58.8800                                                    (4)
Dwelling volume                                                                             (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    146.8120 (5)


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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) =	0.2043	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4543	(18)
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.0000	4.1000	3.8000	3.7000	3.2000	3.1000	3.1000	3.3000	3.5000	3.4000	3.8000	(22)
Wind factor	1.0750	1.0000	1.0250	0.9500	0.9250	0.8000	0.7750	0.7750	0.8250	0.8750	0.8500	0.9500	(22a)
Adj infilt rate	0.3419	0.3180	0.3260	0.3021	0.2942	0.2544	0.2465	0.2465	0.2624	0.2783	0.2703	0.3021	(22b)
Effective ac	0.5584	0.5506	0.5531	0.5456	0.5433	0.5324	0.5304	0.5304	0.5344	0.5387	0.5365	0.5456	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16035.6500	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		272.3446	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758
E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		4.2451	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	40.9705	(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	27.0555	26.6742	26.7983	26.4353	26.3205	25.7921	25.6957	25.6957	25.8917	26.0999	25.9943	26.4353	(38)
Heat transfer coeff	68.0261	67.6448	67.7688	67.4059	67.2910	66.7627	66.6662	66.6662	66.8622	67.0705	66.9648	67.4059	(39)
Average = Sum(39)m / 12 =												67.2113	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1553	1.1489	1.1510	1.1448	1.1429	1.1339	1.1322	1.1322	1.1356	1.1391	1.1373	1.1448	(40)
HLP (average)												1.1415	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												1.9498	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)
Average daily hot water use (litres/day)												54.2578	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)
Energy content (annual)											Total = Sum(45)m =	901.1065	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)

If cylinder contains dedicated solar storage

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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													
	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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)
Aperture area of solar collector												3.0000	(H1)
Zero-loss collector efficiency												0.8000	(H2)
Collector linear heat loss coefficient												1.8000	(H3)
Collector 2nd order heat loss coefficient												0.0000	(H4)
Collector loop efficiency												0.9000	(H5)
Incidence angle modifier												1.0000	(H6)
Overshading factor												0.8000	(H8)
Overall heat loss coefficient of system												6.5000	(H10)
Heat loss coefficient of collector loop												3.9667	(H11)
Dedicated solar storage volume												75.0000	(H12)
Effective solar volume												75.0000	(H14)
Reference volume												225.0000	(H15)
Storage tank correction coefficient												1.3161	(H16)
Heat delivered to hot water												413.6494	(H24)
Heat delivered to space heating												0.0000	(H29)
Solar input												413.6494	
Solar input	-5.6002	-20.6577	-45.9094	-52.1103	-55.0764	-50.4873	-49.2184	-49.1179	-43.1568	-31.7314	-10.5836	-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													
	74.0874	49.0260	26.9873	10.2501	3.9950	1.3307	1.3108	4.4762	12.1178	31.5198	58.5186	78.6714	(64)
								Total per year (kWh/year) = Sum(64)m =				352.2911	(64)
Electric shower(s)													
	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							518.4290	(64a)
Heat gains from water heating, kWh/month													
	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)													
	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)													
	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains													
	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	13.7947	0.6300	0.8000	0.7700	24.0906	(75)
Southeast	2.2400	43.3860	0.6300	0.8000	0.7700	33.9439	(77)
Northwest	6.3600	13.7947	0.6300	0.8000	0.7700	30.6432	(81)

Solar gains	88.6777	153.4036	244.0691	381.0722	473.7274	536.0524	488.1841	410.6421	302.4448	183.4207	107.9860	74.1111	(83)
Total gains	499.5526	562.8079	640.6799	755.7197	824.7612	866.5188	807.1914	731.2971	635.6480	537.8063	486.9218	474.1988	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	65.4800	65.8491	65.7286	66.0825	66.1953	66.7191	66.8157	66.8157	66.6198	66.4129	66.5177	66.0825	
alpha	5.3653	5.3899	5.3819	5.4055	5.4130	5.4479	5.4544	5.4544	5.4413	5.4275	5.4345	5.4055	
util living area													
	0.9927	0.9852	0.9584	0.8613	0.6736	0.4364	0.3135	0.3547	0.6455	0.9212	0.9842	0.9944	(86)
MIT	19.9356	20.1138	20.4194	20.7656	20.9491	20.9959	20.9995	20.9990	20.9700	20.7014	20.2647	19.8982	(87)
Th 2	19.9559	19.9611	19.9594	19.9644	19.9660	19.9733	19.9746	19.9746	19.9719	19.9690	19.9705	19.9644	(88)
util rest of house													
	0.9902	0.9802	0.9444	0.8220	0.6060	0.3592	0.2291	0.2619	0.5538	0.8876	0.9778	0.9925	(89)
MIT 2	18.7422	18.9712	19.3487	19.7512	19.9310	19.9716	19.9745	19.9744	19.9562	19.6975	19.1709	18.7010	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9869	0.9752	0.9376	0.8212	0.6169	0.3739	0.2453	0.2797	0.5704	0.8845	0.9728	0.9897	(94)
Useful gains	493.0017	548.8520	600.7199	620.6110	508.8233	324.0039	197.9736	204.5564	362.5744	475.6763	473.7009	469.3022	(95)
Ext temp.	4.5000	5.1000	6.9000	9.3000	12.3000	15.3000	17.2000	17.1000	14.6000	11.0000	7.4000	4.4000	(96)
Heat loss rate W													
	984.3811	953.1061	857.5201	717.5602	526.6100	324.9768	198.0438	204.6985	371.1012	596.2331	802.2557	979.4167	(97)
Space heating kWh													
	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98a)
Space heating requirement - total per year (kWh/year)												1617.1201	

```
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
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                            1617.1201
Space heating per m2                                                                                                  (98c) / (4) =         27.4647 (99)



----------------------------------------------------------------------------------------------------
9a. Energy requirements - Individual heating systems, including micro-CHP
----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                                        0.0000 (201)
Fraction of space heat from main system(s)                                                                                                   1.0000 (202)
Efficiency of main space heating system 1 (in %)                                                                                           100.0000 (206)
Efficiency of main space heating system 2 (in %)                                                                                             0.0000 (207)
Efficiency of secondary/supplementary heating system, %                                                                                      0.0000 (208)

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (98)
Space heating efficiency (main heating system 1)
               100.0000   100.0000   100.0000   100.0000   100.0000     0.0000     0.0000     0.0000     0.0000   100.0000   100.0000   100.0000 (210)
Space heating fuel (main heating system)
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (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
                74.0874    49.0260    26.9873    10.2501     3.9950     1.3307     1.3108     4.4762    12.1178    31.5198    58.5186    78.6714 (64)
Efficiency of water heater                                                                                                                 100.0000 (216)
(217)m         100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000 (217)
Fuel for water heating, kWh/month
                74.0874    49.0260    26.9873    10.2501     3.9950     1.3307     1.3108     4.4762    12.1178    31.5198    58.5186    78.6714 (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     6.7945     6.1370     6.7945     6.5753     6.7945     6.5753     6.7945     6.7945     6.5753     6.7945     6.5753     6.7945 (231)
Lighting        23.8413    19.1264    17.2212    12.6170     9.7457     7.9623     8.8904    11.5560    15.0101    19.6941    22.2445    24.5039 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m        -45.0179   -60.7683   -84.8234   -90.7794   -89.0375   -83.8822   -82.0935   -78.8316   -70.9524   -65.8330   -48.9737   -38.8940 (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        -15.0531   -29.9000   -63.4380  -112.2692  -152.6982  -172.2593  -162.3919  -139.7660  -100.1209   -51.2849   -21.2319   -11.6553 (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                                                                                                        1617.1201 (211)
Space heating fuel - main system 2                                                                                                           0.0000 (213)
Space heating fuel - secondary                                                                                                               0.0000 (215)
Efficiency of water heater                                                                                                                 100.0000
Water heating fuel used                                                                                                                    352.2911 (219)
Space cooling fuel                                                                                                                           0.0000 (221)

Electricity for pumps and fans:
   pump for solar water heating                                                                                                             80.0000 (230g)
Total electricity for the above, kWh/year                                                                                                   80.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                        192.4129 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                            -1871.9557 (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                                                                                                        888.2974 (238)



----------------------------------------------------------------------------------------------------
10a. Fuel costs - using BEDF prices (536)
----------------------------------------------------------------------------------------------------
                                                                                              Fuel          Fuel price             Fuel cost
                                                                                          kWh/year               p/kWh               £/year
Space heating - main system 1                                                            1617.1201             25.1600             406.8674 (240)
Total CO2 associated with community systems                                                                                          0.0000 (473)
Water heating (other fuel)                                                                352.2911             25.1600              88.6364 (247)
Energy for instantaneous electric shower(s)                                               518.4290             25.1600             130.4367 (247a)
Pumps, fans and electric keep-hot                                                           0.0000              0.0000               0.0000 (249)
Pump for solar water heating                                                               80.0000             25.1600              20.1280 (249)
Energy for lighting                                                                       192.4129             25.1600              48.4111 (250)
Additional standing charges                                                                                                          0.0000 (251)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                     -839.8869             25.1600            -211.3156
PV Unit electricity exported                                                            -1032.0687              5.8100             -59.9632
Total                                                                                                                              -271.2787 (252)
Total energy cost                                                                                                                  423.2009 (255)



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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	1617.1201	0.1569	253.7982	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	352.2911	0.1541	54.2739	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			308.0721	(265)
Pumps, fans and electric keep-hot	80.0000	0.1387	11.0970	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-839.8869	0.1359	-114.1248	
PV Unit electricity exported	-1032.0687	0.1228	-126.7810	
Total			-240.9058	(269)
Total CO2, kg/year			178.1594	(272)

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	1617.1201	1.5810	2556.6981	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	352.2911	1.5701	553.1417	(278)
Energy for instantaneous electric shower(s)	518.4290	1.5143	785.0748	(278a)
Space and water heating			3109.8398	(279)
Pumps, fans and electric keep-hot	80.0000	1.5128	121.0240	(281)
Energy for lighting	192.4129	1.5338	295.1294	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-839.8869	1.5023	-1261.7420	
PV Unit electricity exported	-1032.0687	0.4507	-465.1808	
Total			-1726.9228	(283)
Total Primary energy kWh/year			2584.1452	(286)

Full SAP Calculation Printout

Property Reference	PR11012 - 111 Manor Road	Issued on Date	27/02/2024
Assessment Reference	001 - Be Green	Prop Type Ref	
Property	111, Manor Road, Witney, Oxfordshire, OX28 3UF		

SAP Rating	91 B	DER	1.56	TER	13.73
Environmental	99 A	% DER < TER			88.64
CO_2 Emissions (t/year)	0	DFEE	36.81	TFEE	42.39
Compliance Check	See BREL	% DFEE < TFEE			13.18
% DPER < TPER	51.59	DPER	34.87	TPER	72.03

Assessor Details	Mr. Iraj Maghounaki	Assessor ID	V571-0001
Client	-, Ifor Rhys		

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	31.3800 (1b)	x	2.4000 (2b)	=	75.3120 (1b) - (3b)
First floor	27.5000 (1c)	x	2.6000 (2c)	=	71.5000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	58.8800				(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	146.8120 (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) =	0.2043 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.4543 (18)
Number of sides sheltered		4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180 (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	0.4055	0.3976	0.3896	0.3498	0.3419	0.3021	0.3021	0.2942	0.3180	0.3419	0.3578	0.3737	(22b)
Effective ac	0.5822	0.5790	0.5759	0.5612	0.5584	0.5456	0.5456	0.5433	0.5506	0.5584	0.5640	0.5698	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16035.6500	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		272.3446	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758

E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 4.2451 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.9705 (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	28.2072	28.0525	27.9009	27.1888	27.0555	26.4353	26.4353	26.3205	26.6742	27.0555	27.3251	27.6068	(38)
Heat transfer coeff	69.1777	69.0230	68.8714	68.1593	68.0261	67.4059	67.4059	67.2910	67.6448	68.0261	68.2956	68.5774	(39)

Average = Sum(39)m / 12 = 68.1587

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1749	1.1723	1.1697	1.1576	1.1553	1.1448	1.1448	1.1429	1.1489	1.1553	1.1599	1.1647	(40)
HLP (average)												1.1576	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.9498 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)

Average daily hot water use (litres/day) 54.2578 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)

Energy content (annual) Total = Sum(45)m = 901.1065

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss: Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)

Total per year (kWh/year) = Sum(64)m = 765.9405 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 518.4290 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	11.2829	0.6300	0.8000	0.7700	19.7041	(75)
Southeast	2.2400	36.7938	0.6300	0.8000	0.7700	28.7864	(77)
Northwest	6.3600	11.2829	0.6300	0.8000	0.7700	25.0636	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	73.5540	140.1597	231.2701	352.7585	455.5466	478.8324	450.5841	369.8360	272.7002	165.5559	90.8087	61.1947	(83)
Total gains	484.4290	549.5640	627.8808	727.4061	806.5804	809.2988	769.5914	690.4910	605.9034	519.9415	469.7445	461.2824	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	64.3899	64.5342	64.6763	65.3520	65.4800	66.0825	66.0825	66.1953	65.8491	65.4800	65.2216	64.9536	
alpha	5.2927	5.3023	5.3118	5.3568	5.3653	5.4055	5.4055	5.4130	5.3899	5.3653	5.3481	5.3302	
util living area	0.9941	0.9878	0.9667	0.8905	0.7260	0.5246	0.3840	0.4451	0.7169	0.9409	0.9881	0.9954	(86)
MIT	19.8593	20.0371	20.3362	20.6994	20.9200	20.9884	20.9982	20.9962	20.9449	20.6292	20.1764	19.8246	(87)
Th 2	19.9401	19.9423	19.9443	19.9541	19.9559	19.9644	19.9644	19.9660	19.9611	19.9559	19.9522	19.9483	(88)
util rest of house	0.9921	0.9836	0.9553	0.8571	0.6626	0.4436	0.2944	0.3468	0.6297	0.9145	0.9833	0.9938	(89)
MIT 2	18.6335	18.8603	19.2351	19.6709	19.8967	19.9588	19.9639	19.9649	19.9286	19.6050	19.0463	18.5955	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9891	0.9789	0.9484	0.8540	0.6714	0.4589	0.3116	0.3656	0.6443	0.9097	0.9788	0.9914	(94)
Useful gains	479.1664	537.9806	595.5066	621.1810	541.5335	371.3503	239.7887	252.4641	390.3610	472.9845	459.7979	457.2931	(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	1007.7907	979.1293	891.5968	747.5529	570.9114	374.4963	240.0933	253.1672	407.4309	625.9130	830.6542	1003.3406	(97)
Space heating kWh	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98a)
Space heating requirement - total per year (kWh/year)												1809.9392	
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	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1809.9392	
Space heating per m2											(98c) / (4) =	30.7395	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-83.2624	-126.7107	-188.5780	-201.0752	-194.4106	-170.7798	-169.1682	-164.1651	-149.5497	-140.4084	-93.9751	-70.8440	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-11.5914	-32.1321	-84.2040	-169.0132	-267.6395	-285.7069	-280.3311	-225.1544	-151.6766	-63.1875	-18.6275	-8.4801	(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	1809.9392	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	100.0000	
Water heating fuel used	765.9405	(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)	192.4129	(232)

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

PV generation	-3350.6715	(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		-63.9498	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1809.9392	16.4900	298.4590	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	16.4900	126.3036	(247)
Energy for instantaneous electric shower(s)	518.4290	16.4900	85.4889	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Energy for lighting	192.4129	16.4900	31.7289	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1752.9272	16.4900	-289.0577	
PV Unit electricity exported	-1597.7443	5.5900	-89.3139	
Total			-378.3716	(252)
Total energy cost			163.6088	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600	(256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.5670	(257)
SAP value		90.8091	
SAP rating (Section 12)		91	(258)
SAP band		B	

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	1809.9392	0.1564	283.1543	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	765.9405	0.1416	108.4396	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			391.5939	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1752.9272	0.1357	-237.8500	
PV Unit electricity exported	-1597.7443	0.1194	-190.7349	
Total			-428.5849	(269)
Total CO2, kg/year			62.9050	(272)
CO2 emissions per m2			1.0700	(273)
EI value			99.1886	
EI rating			99	(274)
EI band			A	

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)			Volume (m3)	
Ground floor		31.3800 (1b)	x	2.4000 (2b)		=	75.3120	(1b) - (3b)
First floor		27.5000 (1c)	x	2.6000 (2c)		=	71.5000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	58.8800							(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	146.8120	(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) =	0.2043	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			5.0000	(17)
Infiltration rate			0.4543	(18)

Number of sides sheltered 4 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.7000 (20)
Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.3180 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.0000	4.1000	3.8000	3.7000	3.2000	3.1000	3.1000	3.3000	3.5000	3.4000	3.8000	(22)
Wind factor	1.0750	1.0000	1.0250	0.9500	0.9250	0.8000	0.7750	0.7750	0.8250	0.8750	0.8500	0.9500	(22a)
Adj infilt rate	0.3419	0.3180	0.3260	0.3021	0.2942	0.2544	0.2465	0.2465	0.2624	0.2783	0.2703	0.3021	(22b)
Effective ac	0.5584	0.5506	0.5531	0.5456	0.5433	0.5324	0.5304	0.5304	0.5344	0.5387	0.5365	0.5456	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 16035.6500 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 272.3446 (35)
List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758
E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 4.2451 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.9705 (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	27.0555	26.6742	26.7983	26.4353	26.3205	25.7921	25.6957	25.6957	25.8917	26.0999	25.9943	26.4353	(38)
Heat transfer coeff	68.0261	67.6448	67.7688	67.4059	67.2910	66.7627	66.6662	66.6662	66.8622	67.0705	66.9648	67.4059	(39)

Average = Sum(39)m / 12 = 67.2113

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1553	1.1489	1.1510	1.1448	1.1429	1.1339	1.1322	1.1322	1.1356	1.1391	1.1373	1.1448	(40)
HLP (average)												1.1415	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.9498 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)

Average daily hot water use (litres/day) 54.2578 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)

Energy content (annual) Total = Sum(45)m = 901.1065

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss: Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)

Total per year (kWh/year) = Sum(64)m = 765.9405 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	45.5764	40.6090	44.3434	42.3164	43.1104	41.1232	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 518.4290 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	13.7947	0.6300	0.8000	0.7700	24.0906	(75)
Southeast	2.2400	43.3860	0.6300	0.8000	0.7700	33.9439	(77)
Northwest	6.3600	13.7947	0.6300	0.8000	0.7700	30.6432	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	88.6777	153.4036	244.0691	381.0722	473.7274	536.0524	488.1841	410.6421	302.4448	183.4207	107.9860	74.1111	(83)
Total gains	499.5526	562.8079	640.6799	755.7197	824.7612	866.5188	807.1914	731.2971	635.6480	537.8063	486.9218	474.1988	(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	65.4800	65.8491	65.7286	66.0825	66.1953	66.7191	66.8157	66.8157	66.6198	66.4129	66.5177	66.0825	
alpha	5.3653	5.3899	5.3819	5.4055	5.4130	5.4479	5.4544	5.4544	5.4413	5.4275	5.4345	5.4055	
util living area	0.9927	0.9852	0.9584	0.8613	0.6736	0.4364	0.3135	0.3547	0.6455	0.9212	0.9842	0.9944	(86)
MIT	19.9356	20.1138	20.4194	20.7656	20.9491	20.9959	20.9995	20.9990	20.9700	20.7014	20.2647	19.8982	(87)
Th 2	19.9559	19.9611	19.9594	19.9644	19.9660	19.9733	19.9746	19.9746	19.9719	19.9690	19.9705	19.9644	(88)
util rest of house	0.9902	0.9802	0.9444	0.8220	0.6060	0.3592	0.2291	0.2619	0.5538	0.8876	0.9778	0.9925	(89)
MIT 2	18.7422	18.9712	19.3487	19.7512	19.9310	19.9716	19.9745	19.9744	19.9562	19.6975	19.1709	18.7010	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.9706	19.1899	19.5536	19.9454	20.1259	20.1676	20.1707	20.1705	20.1502	19.8896	19.3803	18.9301	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9869	0.9752	0.9376	0.8212	0.6169	0.3739	0.2453	0.2797	0.5704	0.8845	0.9728	0.9897	(94)
Useful gains	493.0017	548.8520	600.7199	620.6110	508.8233	324.0039	197.9736	204.5564	362.5744	475.6763	473.7009	469.3022	(95)
Ext temp.	4.5000	5.1000	6.9000	9.3000	12.3000	15.3000	17.2000	17.1000	14.6000	11.0000	7.4000	4.4000	(96)
Heat loss rate W	984.3811	953.1061	857.5201	717.5602	526.6100	324.9768	198.0438	204.6985	371.1012	596.2331	802.2557	979.4167	(97)
Space heating kWh	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98a)
Space heating requirement - total per year (kWh/year)												1617.1201	
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	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1617.1201	
Space heating per m2											(98c) / (4) =	27.4647	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	365.5863	271.6588	191.0594	69.8034	13.2333	0.0000	0.0000	0.0000	0.0000	89.6943	236.5595	379.5252	(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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(64)

Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-97.5399	-134.5214	-191.2178	-202.1662	-192.3996	-174.5076	-171.8260	-168.9201	-155.6764	-147.0856	-107.4504	-83.6782	(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	-16.2899	-37.9695	-93.3574	-192.5159	-282.4439	-331.0353	-309.7153	-257.9355	-174.2717	-76.3642	-25.7088	-12.0343	(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	1617.1201	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	100.0000	
Water heating fuel used	765.9405	(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)	192.4129	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-3636.6311	(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	-542.7285	(238)

10a. Fuel costs - using BEDF prices (536)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1617.1201	25.1600	406.8674	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	25.1600	192.7106	(247)
Energy for instantaneous electric shower(s)	518.4290	25.1600	130.4367	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Energy for lighting	192.4129	25.1600	48.4111	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1826.9894	25.1600	-459.6705	
PV Unit electricity exported	-1809.6416	5.8100	-105.1402	
Total			-564.8107	(252)
Total energy cost			213.6152	(255)

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	1617.1201	0.1569	253.7982	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	765.9405	0.1416	108.4396	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			362.2378	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1826.9894	0.1362	-248.7787	
PV Unit electricity exported	-1809.6416	0.1197	-216.6300	
Total			-465.4087	(269)
Total CO2, kg/year			-3.2747	(272)

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	1617.1201	1.5810	2556.6981	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	765.9405	1.5235	1166.9355	(278)
Energy for instantaneous electric shower(s)	518.4290	1.5143	785.0748	(278a)
Space and water heating			3723.6336	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	192.4129	1.5338	295.1294	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1826.9894	1.5034	-2746.6375	
PV Unit electricity exported	-1809.6416	0.4391	-794.5494	
Total			-3541.1869	(283)
Total Primary energy kWh/year			1262.6509	(286)

SAP 10 EPC IMPROVEMENTS

001 - Be Green

Current energy efficiency rating: B 91
Current environmental impact rating: A 99

N	Solar water heating	Recommended
U	Solar photovoltaic panels	Already installed
V2	Wind turbine	Not applicable

Recommended measures:	SAP change	Cost change	CO2 change
N Solar water heating	+ 2.1	-£ 59	-42 kg (1278.7%)

	Typical annual savings		Energy efficiency	Environmental impact
Recommended measures				
Solar water heating	£59	0.71 kg/m²	A 93	A 100
Total Savings	£59	0.71 kg/m²		

Potential energy efficiency rating: A 93
Potential environmental impact rating: A 100

Fuel prices for cost data on this page from database revision number 536 TEST (31 Jan 2024)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, Thames Valley):

	Current	Potential	Saving
Electricity	£778	£694	£84
Space heating	£407	£427	-£20
Water heating	£323	£219	£104
Lighting	£48	£48	£0
Generated (PV)	-£565	-£540	-£25
Total cost of fuels	£213	£154	£59
Total cost of uses	£213	£154	£59
Delivered energy	-9 kWh/m²	-15 kWh/m²	6 kWh/m²
Carbon dioxide emissions	-0.0 tonnes	-0.0 tonnes	0.0 tonnes
CO2 emissions per m²	-0 kg/m²	-1 kg/m²	1 kg/m²
Primary energy	21 kWh/m²	15 kWh/m²	6 kWh/m²

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	31.3800 (1b)	x	2.4000 (2b)	=	75.3120 (1b) - (3b)
First floor	27.5000 (1c)	x	2.6000 (2c)	=	71.5000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 58.8800					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	146.8120 (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) =	0.2043 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.4543 (18)
Number of sides sheltered		4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180 (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	0.4055	0.3976	0.3896	0.3498	0.3419	0.3021	0.3021	0.2942	0.3180	0.3419	0.3578	0.3737	(22b)
Effective ac	0.5822	0.5790	0.5759	0.5612	0.5584	0.5456	0.5456	0.5433	0.5506	0.5584	0.5640	0.5698	(25)

```
-------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-------------------------------------------------------------------------------------------------
Element                                         Gross       Openings        NetArea       U-value         A x U       K-value         A x K
                                                   m2             m2             m2         W/m2K           W/K        kJ/m2K          kJ/K
HG Door                                                                      2.0700        1.2000        2.4840                              (26a)
Windows (Uw = 1.20)                                                         13.6000        1.1450       15.5725                              (27)
Heat Loss Floor 1                                                           31.3800        0.1200        3.7656      110.0000     3451.8000 (28a)
External Walls                                84.8600        15.6700        69.1900        0.1700       11.7623      110.0000     7610.9000 (29a)
Plane Roof                                    31.4100                       31.4100        0.1000        3.1410        9.0000      282.6900 (30)
Total net area of external elements Aum(A, m2)                             147.6500                                                          (31)
Fabric heat loss, W/K = Sum (A x U)                                              (26)...(30) + (32) =  36.7254                               (33)
Party Walls                                                                 27.7200        0.0000        0.0000      110.0000     3049.2000 (32)
GF - Timber                                                                 48.0000                                    9.0000      432.0000 (32c)
FF - Timber                                                                 51.8400                                    9.0000      466.5600 (32c)
Internal Floor                                                              27.5000                                   18.0000      495.0000 (32d)
Internal Ceiling                                                            27.5000                                    9.0000      247.5000 (32e)

Heat capacity Cm = Sum(A x k)                                                         (28)...(30) + (32) + (32a)...(32e) =  16035.6500 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                          272.3446 (35)
List of Thermal Bridges
        K1 Element                                                                        Length       Psi-value         Total
        E2 Other lintels (including other steel lintels)                                 11.8800          0.0190        0.2257
        E3 Sill                                                                           8.3700          0.0210        0.1758
        E4 Jamb                                                                          22.1000          0.0160        0.3536
        E5 Ground floor (normal)                                                         17.9500          0.0590        1.0590
        E6 Intermediate floor within a dwelling                                          16.0700          0.0010        0.0161
        E10 Eaves (insulation at ceiling level)                                           9.8900          0.0630        0.6231
        E12 Gable (insulation at ceiling level)                                           8.6000          0.0410        0.3526
        E16 Corner (normal)                                                              15.0000          0.0370        0.5550
        E25 Staggered party wall between dwellings                                       10.0000          0.0410        0.4100
        P1 Party wall - Ground floor                                                      5.5500          0.0430        0.2386
        P2 Party wall - Intermediate floor within a dwelling                              5.8900          0.0000        0.0000
        P4 Party wall - Roof (insulation at ceiling level)                                5.8900          0.0400        0.2356
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                                   4.2451 (36)
Point Thermal bridges                                                                                         (36a) =        0.0000
Total fabric heat loss                                                                          (33) + (36) + (36a) =       40.9705 (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         28.2072    28.0525    27.9009    27.1888    27.0555    26.4353    26.4353    26.3205    26.6742    27.0555    27.3251    27.6068 (38)
Heat transfer coeff
              69.1777    69.0230    68.8714    68.1593    68.0261    67.4059    67.4059    67.2910    67.6448    68.0261    68.2956    68.5774 (39)
Average = Sum(39)m / 12 =                                                                                                     68.1587

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP            1.1749     1.1723     1.1697     1.1576     1.1553     1.1448     1.1448     1.1429     1.1489     1.1553     1.1599     1.1647 (40)
HLP (average)                                                                                                                 1.1576
Days in mont       31         28         31         30         31         30         31         31         30         31         30         31



-------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                             1.9498 (42)
Hot water usage for mixer showers
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
              24.5969    24.2316    23.7172    22.7687    22.0585    21.2710    20.8456    21.3564    21.9126    22.7553    23.7233    24.5138 (42b)
Hot water usage for other uses
              34.5979    33.3398    32.0817    30.8236    29.5654    28.3073    28.3073    29.5654    30.8236    32.0817    33.3398    34.5979 (42c)
Average daily hot water use (litres/day)                                                                                     54.2578 (43)

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
              59.1948    57.5714    55.7989    53.5923    51.6239    49.5783    49.1529    50.9219    52.7361    54.8369    57.0631    59.1116 (44)
Energy conte  93.7501    81.9809    85.7608    73.3651    69.4957    60.9623    59.4462    63.0519    65.0289    74.4132    81.2968    92.5545 (45)
Energy content (annual)                                                                                Total = Sum(45)m =    901.1065
Distribution loss  (46)m = 0.15 x (45)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 (46)
Water storage loss:
Total storage loss
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (56)
If cylinder contains dedicated solar storage
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (57)
Primary loss   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (59)
Combi loss     0.0000     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
              79.6876    69.6837    72.8967    62.3604    59.0714    51.8180    50.5293    53.5941    55.2746    63.2512    69.1023    78.6714 (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)
Aperture area of solar collector                                                                                              3.0000 (H1)
Zero-loss collector efficiency                                                                                                0.8000 (H2)
Collector linear heat loss coefficient                                                                                        1.8000 (H3)
Collector 2nd order heat loss coefficient                                                                                     0.0000 (H4)
Collector loop efficiency                                                                                                     0.9000 (H5)
Incidence angle modifier                                                                                                      1.0000 (H6)
Overshading factor                                                                                                            0.8000 (H8)
Overall heat loss coefficient of system                                                                                       6.5000 (H10)
Heat loss coefficient of collector loop                                                                                       3.9667 (H11)
Dedicated solar storage volume                                                                                               75.0000 (H12)
Effective solar volume                                                                                                       75.0000 (H14)
Reference volume                                                                                                            225.0000 (H15)
Storage tank correction coefficient                                                                                           1.3161 (H16)
Heat delivered to hot water                                                                                                 381.3293 (H24)
Heat delivered to space heating                                                                                               0.0000 (H29)
Solar input                                                                                                                 381.3293
Solar input   -0.0000   -17.2539   -43.7094   -49.9045   -54.3327   -48.4954   -47.9586   -47.0973   -40.3020   -27.7755    -4.5001    -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
              79.6876    52.4299    29.1872    12.4559     4.7387     3.3226     2.5707     6.4968    14.9726    35.4757    64.6022    78.6714 (64)
                                                                                Total per year (kWh/year) = Sum(64)m =   384.6112 (64)
Electric shower(s)
              45.5764    40.6090    44.3434    42.3164    43.1104    41.1232    42.4940    43.1104    42.3164    44.3434    43.5096    45.5764 (64a)
                                                  Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =   518.4290 (64a)
Heat gains from water heating, kWh/month
              31.3160    27.5732    29.3100    26.1692    25.5455    23.2353    23.2558    24.1761    24.3977    26.8987    28.1530    31.0619 (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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)													
	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)													
	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains													
	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	11.2829	0.6300	0.8000	0.7700	19.7041	(75)
Southeast	2.2400	36.7938	0.6300	0.8000	0.7700	28.7864	(77)
Northwest	6.3600	11.2829	0.6300	0.8000	0.7700	25.0636	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	73.5540	140.1597	231.2701	352.7585	455.5466	478.8324	450.5841	369.8360	272.7002	165.5559	90.8087	61.1947	(83)
Total gains	484.4290	549.5640	627.8808	727.4061	806.5804	809.2988	769.5914	690.4910	605.9034	519.9415	469.7445	461.2824	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	64.3899	64.5342	64.6763	65.3520	65.4800	66.0825	66.0825	66.1953	65.8491	65.4800	65.2216	64.9536	
alpha	5.2927	5.3023	5.3118	5.3568	5.3653	5.4055	5.4055	5.4130	5.3899	5.3653	5.3481	5.3302	
util living area													
	0.9941	0.9878	0.9667	0.8905	0.7260	0.5246	0.3840	0.4451	0.7169	0.9409	0.9881	0.9954	(86)
MIT	19.8593	20.0371	20.3362	20.6994	20.9200	20.9884	20.9982	20.9962	20.9449	20.6292	20.1764	19.8246	(87)
Th 2	19.9401	19.9423	19.9443	19.9541	19.9559	19.9644	19.9644	19.9660	19.9611	19.9559	19.9522	19.9483	(88)
util rest of house													
	0.9921	0.9836	0.9553	0.8571	0.6626	0.4436	0.2944	0.3468	0.6297	0.9145	0.9833	0.9938	(89)
MIT 2	18.6335	18.8603	19.2351	19.6709	19.8967	19.9588	19.9639	19.9649	19.9286	19.6050	19.0463	18.5955	(90)
Living area fraction									fLA = Living area / (4) =			0.1914	(91)
MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8681	19.0855	19.4458	19.8677	20.0925	20.1558	20.1619	20.1623	20.1231	19.8011	19.2626	18.8308	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9891	0.9789	0.9484	0.8540	0.6714	0.4589	0.3116	0.3656	0.6443	0.9097	0.9788	0.9914	(94)
Useful gains	479.1664	537.9806	595.5066	621.1810	541.5335	371.3503	239.7887	252.4641	390.3610	472.9845	459.7979	457.2931	(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													
	1007.7907	979.1293	891.5968	747.5529	570.9114	374.4963	240.0933	253.1672	407.4309	625.9130	830.6542	1003.3406	(97)
Space heating kWh													
	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98a)
Space heating requirement - total per year (kWh/year)												1809.9392	
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													
	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1809.9392	
Space heating per m2											(98c) / (4) =	30.7395	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(98)
Space heating efficiency (main heating system 1)													
	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)													
	393.2965	296.4519	220.2911	90.9878	21.8571	0.0000	0.0000	0.0000	0.0000	113.7788	267.0166	406.2593	(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

	79.6876	52.4299	29.1872	12.4559	4.7387	3.3226	2.5707	6.4968	14.9726	35.4757	64.6022	78.6714	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month													
	79.6876	52.4299	29.1872	12.4559	4.7387	3.3226	2.5707	6.4968	14.9726	35.4757	64.6022	78.6714	(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	6.7945	6.1370	6.7945	6.5753	6.7945	6.5753	6.7945	6.7945	6.5753	6.7945	6.5753	6.7945	(231)
Lighting	23.8413	19.1264	17.2212	12.6170	9.7457	7.9623	8.8904	11.5560	15.0101	19.6941	22.2445	24.5039	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-83.3379	-126.3045	-184.8373	-189.8696	-172.8546	-148.2168	-147.1995	-145.9481	-138.5405	-138.2812	-94.0218	-70.8994	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-11.5159	-32.5383	-87.9447	-180.2188	-289.1956	-308.2699	-302.2998	-243.3714	-162.6858	-65.3147	-18.5808	-8.4247	(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	1809.9392	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	100.0000	
Water heating fuel used	384.6112	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
pump for solar water heating	80.0000	(230g)
Total electricity for the above, kWh/year	80.0000	(231)
Electricity for lighting (calculated in Appendix L)	192.4129	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-3350.6715	(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	-365.2791	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	1809.9392	16.4900	298.4590	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	384.6112	16.4900	63.4224	(247)
Energy for instantaneous electric shower(s)	518.4290	16.4900	85.4889	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	80.0000	16.4900	13.1920	(249)
Energy for lighting	192.4129	16.4900	31.7289	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1640.3110	16.4900	-270.4873	
PV Unit electricity exported	-1710.3605	5.5900	-95.6092	
Total			-366.0964	(252)
Total energy cost			126.1948	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600	(256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.4373	(257)
SAP value		92.9108	
SAP rating (Section 12)		93	(258)
SAP band		A	

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	1809.9392	0.1564	283.1543	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	384.6112	0.1531	58.8916	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			342.0459	(265)
Pumps, fans and electric keep-hot	80.0000	0.1387	11.0970	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1640.3110	0.1365	-223.9745	
PV Unit electricity exported	-1710.3605	0.1190	-203.5399	
Total			-427.5143	(269)
Total CO2, kg/year			25.5246	(272)
CO2 emissions per m2			0.4300	(273)
EI value			99.6707	
EI rating			100	(274)
EI band			A	

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)			Volume (m3)	
Ground floor	31.3800 (1b)	x	2.4000 (2b)	=	75.3120	(1b) - (3b)
First floor	27.5000 (1c)	x	2.6000 (2c)	=	71.5000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 58.8800						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	146.8120	(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) =	0.2043	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4543	(18)
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3180	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.3000	4.0000	4.1000	3.8000	3.7000	3.2000	3.1000	3.1000	3.3000	3.5000	3.4000	3.8000	(22)
Wind factor	1.0750	1.0000	1.0250	0.9500	0.9250	0.8000	0.7750	0.7750	0.8250	0.8750	0.8500	0.9500	(22a)
Adj infilt rate	0.3419	0.3180	0.3260	0.3021	0.2942	0.2544	0.2465	0.2465	0.2624	0.2783	0.2703	0.3021	(22b)
Effective ac	0.5584	0.5506	0.5531	0.5456	0.5433	0.5324	0.5304	0.5304	0.5344	0.5387	0.5365	0.5456	(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	
HG Door			2.0700	1.2000	2.4840			(26a)
Windows (Uw = 1.20)			13.6000	1.1450	15.5725			(27)
Heat Loss Floor 1			31.3800	0.1200	3.7656	110.0000	3451.8000	(28a)
External Walls	84.8600	15.6700	69.1900	0.1700	11.7623	110.0000	7610.9000	(29a)
Plane Roof	31.4100		31.4100	0.1000	3.1410	9.0000	282.6900	(30)
Total net area of external elements Aum(A, m2)			147.6500					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	36.7254			(33)
Party Walls			27.7200	0.0000	0.0000	110.0000	3049.2000	(32)
GF - Timber			48.0000			9.0000	432.0000	(32c)
FF - Timber			51.8400			9.0000	466.5600	(32c)
Internal Floor			27.5000			18.0000	495.0000	(32d)
Internal Ceiling			27.5000			9.0000	247.5000	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) =	16035.6500	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	272.3446	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	11.8800	0.0190	0.2257
E3 Sill	8.3700	0.0210	0.1758
E4 Jamb	22.1000	0.0160	0.3536
E5 Ground floor (normal)	17.9500	0.0590	1.0590
E6 Intermediate floor within a dwelling	16.0700	0.0010	0.0161
E10 Eaves (insulation at ceiling level)	9.8900	0.0630	0.6231
E12 Gable (insulation at ceiling level)	8.6000	0.0410	0.3526
E16 Corner (normal)	15.0000	0.0370	0.5550
E25 Staggered party wall between dwellings	10.0000	0.0410	0.4100
P1 Party wall - Ground floor	5.5500	0.0430	0.2386
P2 Party wall - Intermediate floor within a dwelling	5.8900	0.0000	0.0000
P4 Party wall - Roof (insulation at ceiling level)	5.8900	0.0400	0.2356

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		4.2451	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	40.9705	(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	27.0555	26.6742	26.7983	26.4353	26.3205	25.7921	25.6957	25.6957	25.8917	26.0999	25.9943	26.4353	(38)
Heat transfer coeff	68.0261	67.6448	67.7688	67.4059	67.2910	66.7627	66.6662	66.6662	66.8622	67.0705	66.9648	67.4059	(39)
Average = Sum(39)m / 12 =												67.2113	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1553	1.1489	1.1510	1.1448	1.1429	1.1339	1.1322	1.1322	1.1356	1.1391	1.1373	1.1448	(40)
HLP (average)												1.1415	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												1.9498	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	24.5969	24.2316	23.7172	22.7687	22.0585	21.2710	20.8456	21.3564	21.9126	22.7553	23.7233	24.5138	(42b)
Hot water usage for other uses	34.5979	33.3398	32.0817	30.8236	29.5654	28.3073	28.3073	29.5654	30.8236	32.0817	33.3398	34.5979	(42c)
Average daily hot water use (litres/day)												54.2578	(43)
Daily hot water use	59.1948	57.5714	55.7989	53.5923	51.6239	49.5783	49.1529	50.9219	52.7361	54.8369	57.0631	59.1116	(44)
Energy conte	93.7501	81.9809	85.7608	73.3651	69.4957	60.9623	59.4462	63.0519	65.0289	74.4132	81.2968	92.5545	(45)
Energy content (annual)											Total = Sum(45)m =	901.1065	
Distribution loss (46)m = 0.15 x (45)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	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	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	79.6876	69.6837	72.8967	62.3604	59.0714	51.8180	50.5293	53.5941	55.2746	63.2512	69.1023	78.6714	(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)
Aperture area of solar collector												3.0000	(H1)
Zero-loss collector efficiency												0.8000	(H2)
Collector linear heat loss coefficient												1.8000	(H3)
Collector 2nd order heat loss coefficient												0.0000	(H4)
Collector loop efficiency												0.9000	(H5)
Incidence angle modifier												1.0000	(H6)
Overshading factor												0.8000	(H8)
Overall heat loss coefficient of system												6.5000	(H10)
Heat loss coefficient of collector loop												3.9667	(H11)
Dedicated solar storage volume												75.0000	(H12)
Effective solar volume												75.0000	(H14)
Reference volume												225.0000	(H15)
Storage tank correction coefficient												1.3161	(H16)
Heat delivered to hot water												413.6494	(H24)
Heat delivered to space heating												0.0000	(H29)
Solar input												413.6494	
Solar input	-5.6002	-20.6577	-45.9094	-52.1103	-55.0764	-50.4873	-49.2184	-49.1179	-43.1568	-31.7314	-10.5836	-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	74.0874	49.0260	26.9873	10.2501	3.9950	1.3307	1.3108	4.4762	12.1178	31.5198	58.5186	78.6714	(64)
								Total per year (kWh/year) = Sum(64)m =				352.2911	(64)
Electric shower(s)	45.5764	40.6090	44.3434	42.3164	43.1104	41.2332	42.4940	43.1104	42.3164	44.3434	43.5096	45.5764	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							518.4290	(64a)
Heat gains from water heating, kWh/month	31.3160	27.5732	29.3100	26.1692	25.5455	23.2353	23.2558	24.1761	24.3977	26.8987	28.1530	31.0619	(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	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	116.9878	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.2380	24.1926	19.6747	14.8950	11.1342	9.4000	10.1570	13.2025	17.7203	22.5000	26.2608	27.9951	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	253.9010	256.5357	249.8963	235.7620	217.9198	201.1507	189.9479	187.3132	193.9526	208.0870	225.9291	242.6982	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	48.6486	(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)	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	-77.9919	(71)
Water heating gains (Table 5)	42.0914	41.0315	39.3952	36.3461	34.3353	32.2712	31.2578	32.4948	33.8858	36.1541	39.1013	41.7499	(72)
Total internal gains	410.8749	409.4043	396.6108	374.6476	351.0338	330.4664	319.0072	320.6550	333.2032	354.3856	378.9358	400.0877	(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	5.0000	13.7947	0.6300	0.8000	0.7700	24.0906	(75)
Southeast	2.2400	43.3860	0.6300	0.8000	0.7700	33.9439	(77)
Northwest	6.3600	13.7947	0.6300	0.8000	0.7700	30.6432	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	88.6777	153.4036	244.0691	381.0722	473.7274	536.0524	488.1841	410.6421	302.4448	183.4207	107.9860	74.1111	(83)
Total gains	499.5526	562.8079	640.6799	755.7197	824.7612	866.5188	807.1914	731.2971	635.6480	537.8063	486.9218	474.1988	(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	65.4800	65.8491	65.7286	66.0825	66.1953	66.7191	66.8157	66.8157	66.6198	66.4129	66.5177	66.0825	
alpha	5.3653	5.3899	5.3819	5.4055	5.4130	5.4479	5.4544	5.4544	5.4413	5.4275	5.4345	5.4055	
util living area	0.9927	0.9852	0.9584	0.8613	0.6736	0.4364	0.3135	0.3547	0.6455	0.9212	0.9842	0.9944	(86)
MIT	19.9356	20.1138	20.4194	20.7656	20.9491	20.9959	20.9995	20.9990	20.9700	20.7014	20.2647	19.8982	(87)
Th 2	19.9559	19.9611	19.9594	19.9644	19.9660	19.9733	19.9746	19.9746	19.9719	19.9690	19.9705	19.9644	(88)

```
util rest of house
                 0.9902     0.9802     0.9444     0.8220     0.6060     0.3592     0.2291     0.2619     0.5538     0.8876     0.9778     0.9925 (89)
MIT 2           18.7422    18.9712    19.3487    19.7512    19.9310    19.9716    19.9745    19.9744    19.9562    19.6975    19.1709    18.7010 (90)
Living area fraction                                                                                    fLA = Living area / (4) =      0.1914 (91)
MIT             18.9706    19.1899    19.5536    19.9454    20.1259    20.1676    20.1707    20.1705    20.1502    19.8896    19.3803    18.9301 (92)
Temperature adjustment                                                                                                                 0.0000
adjusted MIT    18.9706    19.1899    19.5536    19.9454    20.1259    20.1676    20.1707    20.1705    20.1502    19.8896    19.3803    18.9301 (93)


----------------------------------------------------------------------------------------------------
8. Space heating requirement
----------------------------------------------------------------------------------------------------

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9869     0.9752     0.9376     0.8212     0.6169     0.3739     0.2453     0.2797     0.5704     0.8845     0.9728     0.9897 (94)
Useful gains   493.0017   548.8520   600.7199   620.6110   508.8233   324.0039   197.9736   204.5564   362.5744   475.6763   473.7009   469.3022 (95)
Ext temp.        4.5000     5.1000     6.9000     9.3000    12.3000    15.3000    17.2000    17.1000    14.6000    11.0000     7.4000     4.4000 (96)
Heat loss rate W
               984.3811   953.1061   857.5201   717.5602   526.6100   324.9768   198.0438   204.6985   371.1012   596.2331   802.2557   979.4167 (97)
Space heating kWh
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (98a)
Space heating requirement - total per year (kWh/year)                                                                               1617.1201
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
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                      1617.1201
Space heating per m2                                                                                          (98c) / (4) =       27.4647 (99)


----------------------------------------------------------------------------------------------------
9a. Energy requirements - Individual heating systems, including micro-CHP
----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                                   0.0000 (201)
Fraction of space heat from main system(s)                                                                                              1.0000 (202)
Efficiency of main space heating system 1 (in %)                                                                                      100.0000 (206)
Efficiency of main space heating system 2 (in %)                                                                                        0.0000 (207)
Efficiency of secondary/supplementary heating system, %                                                                                 0.0000 (208)

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (98)
Space heating efficiency (main heating system 1)
               100.0000   100.0000   100.0000   100.0000   100.0000     0.0000     0.0000     0.0000     0.0000   100.0000   100.0000   100.0000 (210)
Space heating fuel (main heating system)
               365.5863   271.6588   191.0594    69.8034    13.2333     0.0000     0.0000     0.0000     0.0000    89.6943   236.5595   379.5252 (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
                74.0874    49.0260    26.9873    10.2501     3.9950     1.3307     1.3108     4.4762    12.1178    31.5198    58.5186    78.6714 (64)
Efficiency of water heater                                                                                                           100.0000 (216)
(217)m         100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000 (217)
Fuel for water heating, kWh/month
                74.0874    49.0260    26.9873    10.2501     3.9950     1.3307     1.3108     4.4762    12.1178    31.5198    58.5186    78.6714 (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     6.7945     6.1370     6.7945     6.5753     6.7945     6.5753     6.7945     6.7945     6.5753     6.7945     6.5753     6.7945 (231)
Lighting        23.8413    19.1264    17.2212    12.6170     9.7457     7.9623     8.8904    11.5560    15.0101    19.6941    22.2445    24.5039 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m        -97.5591  -133.8724  -186.6252  -188.3684  -169.1135  -148.4272  -147.6043  -147.7856  -142.2868  -143.8908  -107.3202   -83.7587 (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        -16.2706   -38.6186   -97.9501  -206.3137  -305.7301  -357.1157  -333.9371  -279.0699  -187.6614   -79.5590   -25.8391   -11.9537 (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                                                                                                   1617.1201 (211)
Space heating fuel - main system 2                                                                                                      0.0000 (213)
Space heating fuel - secondary                                                                                                          0.0000 (215)
Efficiency of water heater                                                                                                            100.0000
Water heating fuel used                                                                                                               352.2911 (219)
Space cooling fuel                                                                                                                      0.0000 (221)

Electricity for pumps and fans:
   pump for solar water heating                                                                                                        80.0000 (230g)
Total electricity for the above, kWh/year                                                                                              80.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                                   192.4129 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                       -3636.6311 (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                                                                                                  -876.3779 (238)


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10a. Fuel costs - using BEDF prices (536)
----------------------------------------------------------------------------------------------------
                                                                                                  Fuel           Fuel price           Fuel cost
```

	kWh/year	p/kWh	£/year	
Space heating - main system 1	1617.1201	25.1600	406.8674	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	352.2911	25.1600	88.6364	(247)
Energy for instantaneous electric shower(s)	518.4290	25.1600	130.4367	(247a)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(249)
Pump for solar water heating	80.0000	25.1600	20.1280	(249)
Energy for lighting	192.4129	25.1600	48.4111	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1696.6122	25.1600	-426.8676	
PV Unit electricity exported	-1940.0188	5.8100	-112.7151	
Total			-539.5827	(252)
Total energy cost			154.8969	(255)

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	1617.1201	0.1569	253.7982	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	352.2911	0.1541	54.2739	(264)
Energy for instantaneous electric shower(s)	518.4290	0.1391	72.1249	(264a)
Space and water heating			308.0721	(265)
Pumps, fans and electric keep-hot	80.0000	0.1387	11.0970	(267)
Energy for lighting	192.4129	0.1443	27.7711	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1696.6122	0.1371	-232.6685	
PV Unit electricity exported	-1940.0188	0.1194	-231.5466	
Total			-464.2151	(269)
Total CO2, kg/year			-45.1499	(272)

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	1617.1201	1.5810	2556.6981	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	352.2911	1.5701	553.1417	(278)
Energy for instantaneous electric shower(s)	518.4290	1.5143	785.0748	(278a)
Space and water heating			3109.8398	(279)
Pumps, fans and electric keep-hot	80.0000	1.5128	121.0240	(281)
Energy for lighting	192.4129	1.5338	295.1294	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1696.6122	1.5070	-2556.8181	
PV Unit electricity exported	-1940.0188	0.4377	-849.2291	
Total			-3406.0472	(283)
Total Primary energy kWh/year			905.0208	(286)

Predicted Energy Assessment

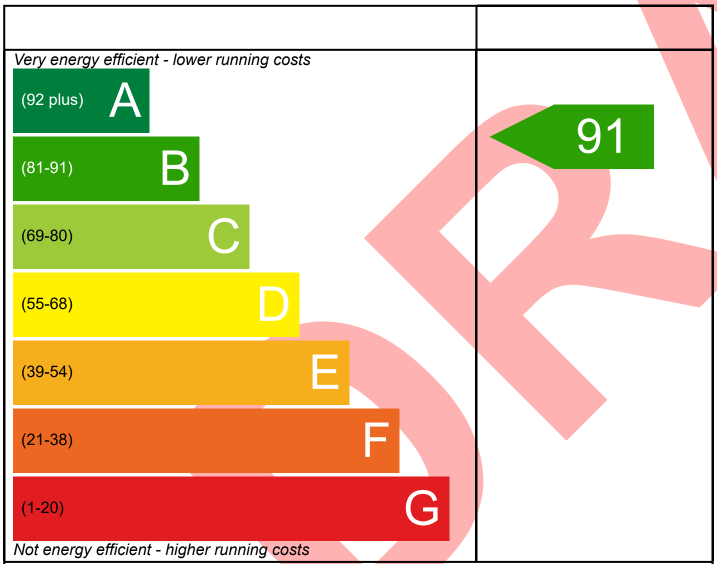
111, Manor Road, Witney, Oxfordshire, OX28 3UF

Dwelling type:	House, End-Terrace
Date of assessment:	27/02/2024
Produced by:	Iraj Maghounaki
Total floor area:	58.88 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.

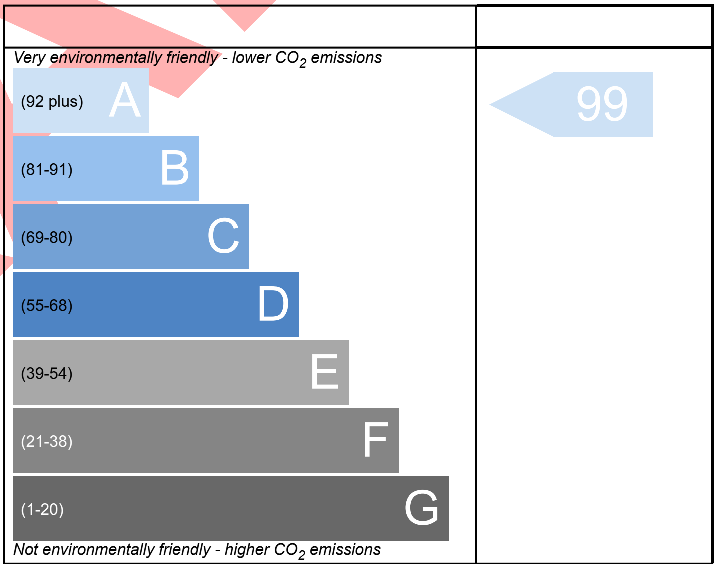
Energy Efficiency Rating



England EU Directive 2002/91/EC

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



England EU Directive 2002/91/EC

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.

breglobal

Job no:	PR11012
Date:	27/02/2024
Assessor name:	Iraj Maghounaki
Registration no:	BRE400012
Development name:	Appendix G

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 for 111 Manor Road																			
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	155	17.05		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)	6	13.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Has a washing machine been specified?		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		115.4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
	Normalisation factor		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91		0.91
Code for Sustainable Homes	Total Consumption		105.0		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		110.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
	17.K Compliance?		Yes		-		-		-		-		-		-		-		-		-