Energy Assessment
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Executive summary

About the Scheme
The proposal comprises demolition of the existing building and construction of a three storey dwelling with associated parking and landscaping. The development is located in the London Borough of Haringey with a total GIA of approximately 2739 sqm.

Planning policy
The scheme has been developed in accordance with the London Plan 2021 "The Spatial Development Strategy for Greater London, March 2021" and with the Sustainable, Design and Construction SPG. The assessment also considers the Haringey's Local Plan Strategic Policies 2013-2026 targeting development to meet zero carbon standards. According to the planning policies, the scheme should achieve:

- Zero carbon target
- A minimum on-site CO_2 reduction of at least 25% in comparison with total emissions from a building which complies with 2006 Building Regulations
-
- At least 20% CO_2 improvement through renewable technologies, 'Be Green' stage
- Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:
    - through a cash in lieu contribution to the borough's carbon offset fund, or
    - off-site provided that an alternative proposal is identified, and delivery is certain

Summary
The whole dwelling has been analysed. High energy efficiency performance building services have been used in order to achieve the required carbon emission targets.

The scheme complies with the 2021 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- New build CO_2 emissions – The actual CO_2 Dwelling Emissions Rate (DER) is no greater than the notional building CO_2 Target Emissions Rate (TER).
- New dwelling Fabric efficiency – The Dwelling Fabric Energy Efficiency (DFEE) is not greater than the Target Fabric Energy Efficiency (TFEE).
- New build Primary energy – The Dwelling Primary Energy Rate (DPER) is no greater than the Target Primary Energy Rate (TPER).

In addition, the CO_2 emissions of the scheme have been calculated using the SAP 10.2 carbon emission factors, and the scheme can achieve:

- An on-site CO_2 reduction of 66.2% beyond Building Regulations through energy efficiency measures and inclusion of renewable technologies (Ground Source Heat Pump and PV panels)
- The development achieves 9.0% CO_2 improvement through energy efficiency measures, 'Be Lean' stage
- A further improvement of 57.1% CO_2 has been achieved through renewable technologies 'Be Green' stage (Ground Source Heat Pumps and PV panels)
- Overall, the scheme achieves an improvement of 66.2% through measures on-site
- Zero-carbon target can be achieved through a cash in lieu contribution to the borough's carbon offset fund. The carbon offset payment cost has been calculated as £18,795.

However, it is worth noting that the SAP database, presents several limitations, such as underestimating the unregulated energy demand, lacking ventilation units in the SAP databased that are capable of serving more than seven wet rooms, limitation on the available capacity for the heat pump (the database's largest Ground Source Heat Pump (GSHP) is 22kW, which is significantly lower than the probable requirement of 130kW), and the maximum solar PV battery capacity being 15kW (which is a tenth of the likely need).
These constraints result in the inability to accurately capture the carbon reduction potential that the design has to offer.
Despite these limitations, the proposal under consideration is anticipated to outperform SAP results. However, this expectation necessitates verification through more advanced modelling software in subsequent stages, focusing on dynamic simulations like thermal comfort, Computational Fluid Dynamics, and operational energy, which are not equivalent to the SAP EPC conventions and will be explored during detailed design stages alongside a Net-Zero certification of the building.

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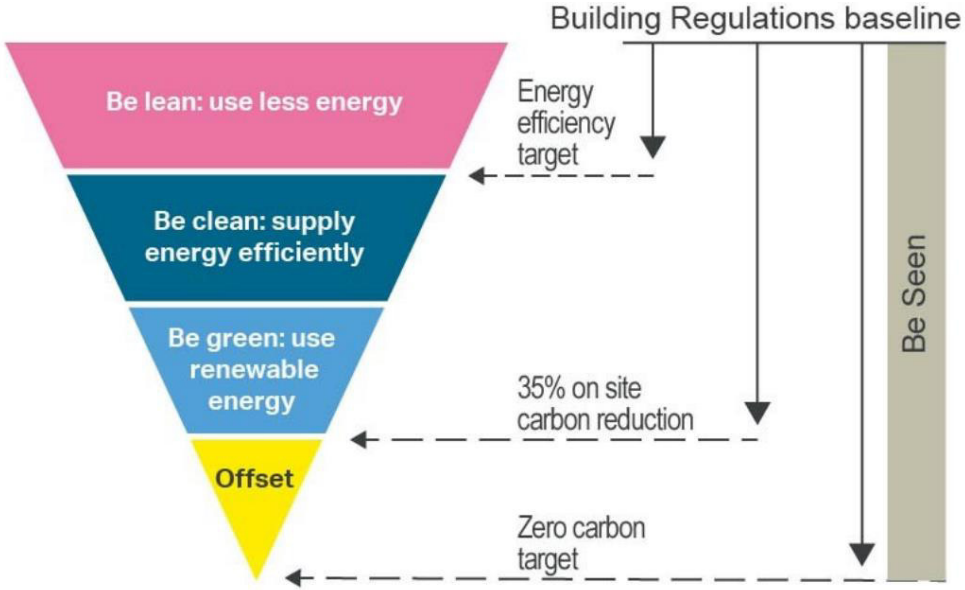
Energy hierarchy
The proposed scheme has followed the energy hierarchy that is illustrated below:



Source: Greater London Authority

Key measures
Key measures identified for each stage are shown below:

- Be Lean:
  - Low U-values for opaque elements and fenestration
  - Low g-value
  - Low air permeability
  - High efficiency lighting
  - Mechanical ventilation with heat recovery
  - Wastewater heat recovery
- Be Clean:
  - N/A
- Be Green:
  - Ground Source Heat Pump to provide space heating and hot water
  - Photovoltaic panels

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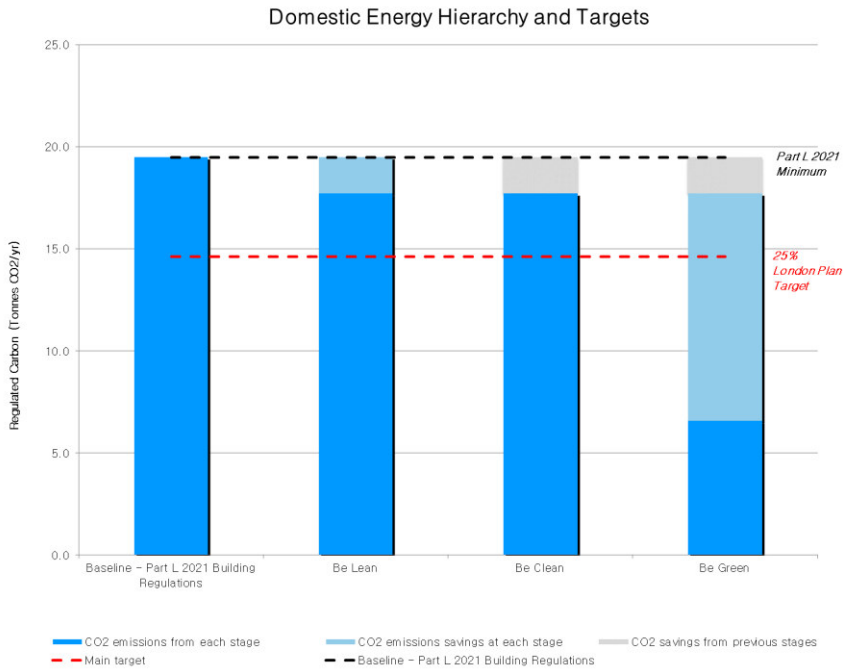
GLA's Energy Hierarchy: Regulated carbon emissions

The proposed scheme has followed the energy hierarchy. A graphical illustration of how the scheme performs in relation to Building Regulations and the Energy Hierarchy is shown below. Carbon dioxide emission factors for SAP 10.2 have been used for the calculation.

As demonstrated in the figure the proposed scheme will reduce carbon emissions by 9.0% from the fabric energy efficiency measures described in the 'Be Lean' section and will reduce total carbon emissions by 66.2% over Building Regulations (using SAP 10.2 carbon dioxide emission factors) with the further inclusion of low and zero carbon technology (Ground source heat pump and photovoltaic panels).

Therefore, the scheme meets and exceeds the planning policy carbon reduction target and complies with London Plan 2021 Policy SI2 and Part L 2021.

The carbon offset payment to meet the zero-carbon target has been calculated as £18,795.



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Regulated CO_2 emissions

Residential				
GLA's Energy Hierarchy: Regulated CO_2 - Calculated using SAP 10.2 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	19.50	17.73	-	6.59
CO_2 emissions saving (tCO_2/yr)	-	1.76	-	11.14
Saving from each stage (%)	-	9.0	-	57.1
Total CO_2 emissions saving (tCO_2/yr)	12.90			
66.2% total CO_2 savings over 2021 Building Regulations Part L achieved				

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Establishing Carbon Emissions

Methodology

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the scheme's design and evolution.

The methodology followed in this report follows the guidance set out by the Greater London Authority (GLA) for developing energy strategies as detailed in the document. "Energy Assessment Guidance: Greater London Authority guidance on preparing energy assessments as part of planning applications (June 2022)". The scheme has been developed in accordance with the London Plan 2021.

This report has followed these documents and comprises the following components:

- Baseline: A calculation of the Part L 2021 Building Regulations compliant CO_2 emission baseline using approved software. The baseline assumes a gas boiler would provide heating and any active cooling would be electrically powered. Photovoltaic panels are included in the baseline in line with Part L 2021.
- Be Lean: A calculation of the impact of demand reduction measures. For example, passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading, and active design measures such as high efficacy lighting and efficient mechanical ventilation with heat recovery.
- Be Clean: In accordance with London Plan 2021 Policy SI3, this report has demonstrated how the scheme has selected heating, cooling and power systems to minimise carbon emissions. This comprises an evaluation of the feasibility of connecting to existing low carbon heat networks, planned networks, site-wide and communal heat networks, and CHP.
- Cooling Hierarchy: In accordance with London Plan 2021Policy SI4, measures that are proposed to reduce the demand for cooling have been set out such as minimisation of solar and internal gains and night cooling strategies.
- Be Green: In accordance with London Plan 2021 Policy SI2, this report has conducted a feasibility assessment of renewable energy technologies. This comprised a site-specific analysis of the technologies and, if applicable, how they would be integrated into the heating and cooling strategy for the scheme.

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Establishing CO_2 emissions

As required by the GLA both the regulated and unregulated emissions of the development must be quantified and demonstrated. The total emissions for the scheme are shown below.

CO_2 Emissions – Regulated and Unregulated (tonnes CO_2/yr) - SAP 10.2			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2021	19.50	1.61	21.11
Be Lean: Use less energy	17.73	1.61	19.34
Be Clean: Supply energy efficiently	-	-	-
Be Green: Use renewable energy	7.02	1.61	8.63

Carbon offsetting

London Plan 2021 Policy SI2, requires carbon dioxide reductions to be achieved as far as possible on-site and a cash in lieu contribution will be considered acceptable only in instances where it has been clearly demonstrated that no further savings can be achieved on-site. The remaining savings to reach zero carbon can be achieved either off-site or via a cash in lieu contribution.

The annual shortfall is determined by subtracting the overall regulated carbon dioxide savings from the target savings. The result is then multiplied by the assumed lifetime of the development's services (30 years) to give the cumulative shortfall. The cumulative shortfall is multiplied by the carbon dioxide offset price to determine the required cash-in-lieu contribution, as shown below. The cumulative savings for offset payment and the cash-in-lieu contribution have been anticipated and tabulated below, using SAP 10.2 carbon emission factors and an offset price of £95 per tonne.

Regulated carbon dioxide savings from each stage of the energy hierarchy – SAP 10.2		
	(tonnes CO_2/yr)	%
Be Lean: Savings from energy demand reduction	1.76	9.0%
Be Clean: Savings from heat networks	0.00	0.0%
Be Green: Savings from renewable energy	11.14	57.1%
Cumulative on-site savings	12.90	66.2%
Carbon shortfall	6.59	-
	(tonnes CO_2)	
Cumulative savings for offset	197.84	
Cash-in-lieu contribution	£ 18,795	

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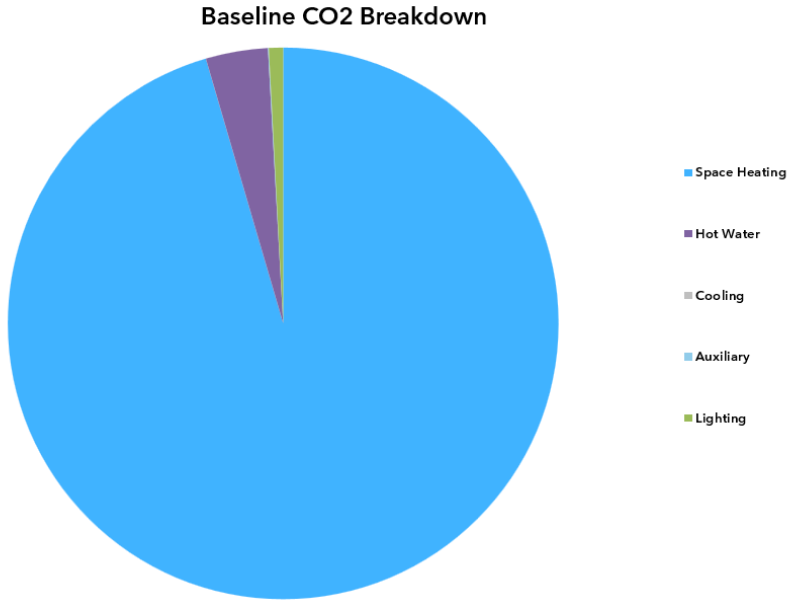
Baseline

Building regulations Part L 2021 minimum compliance

The total baseline carbon emissions for the whole scheme is 24.63 tonnes CO_2/yr (using SAP 10.2 carbon dioxide emission factors).

The pie chart provides a breakdown of the specific carbon emissions by system over the course of one year. The chart shows that space heating is the primary source of carbon dioxide emissions, and hot water is the second largest.

Carbon Emissions in tonnes CO_2/yr.				
Heating	Hot Water	Cooling	Auxiliary	Lighting
23.51	0.90	0.00	0.01	0.21



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Demand Reduction

Be Lean: summary

Demand reduction measures have reduced the scheme's carbon emissions by 9.0% (using SAP 10.2 figures) over the minimum Part L 2021 Building Regulations baseline.

U-values

Element	Minimum 2021 Building Regulations U-value W/m^{2}K	Proposed U-value W/m^{2}K
Flat roof	0.16	0.11
Pitched roof	0.16	0.11
Wall	0.26	0.12
Ground floor	0.18	0.11
Exposed floors	0.18	0.11
Windows	1.60 (g-value 0.63)	1.20(g-value 0.5)
Rooflights	2.20 (g-value 0.63)	1.40 (g-value 0.5)
Doors	1.60	1.40

Air permeability

A reduced air permeability has been targeted as per the table below:

Air permeability (m^3/hm^2 @50 Pa)	Minimum 2021 Building Regulations	Proposed
Dwelling	8	1.5

This will require careful attention to two key areas:

- Structural leakage
- Services leakage

Structural leakage occurs at joints in the building fabric and around window and door openings, loft hatches and access openings. There will also be some diffusion through materials such and cracks in masonry walls typically caused by poor perpends in the blockwork or brickwork. Structural leakage is hard to remedy retrospectively therefore good detailing at the design stage is essential.

Services leakage occurs at penetrations from pipes and cables entering the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be telecommunication cables. Attention, therefore, needs to be paid to sealing all penetrations during construction.

Thermal Bridging:

The scheme will be designed in line with best practise guidance and will target to reduce heat losses through thermal bridging. A detailed thermal bridging analysis will be required at the technical design stage to ensure that the following psi-values can be achieved.

Junctions	Psi-value (W/mK)
Lintels (E1)	0.5
Sill (E3)	0.04
Jambs (E4)	0.05
Ground floor (E5)	0.16
Intermediate Floor within a dwelling (E6)	0.07
Eaves (E24) (insulation at ceiling level - inverted)	0.24
Eaves (E11) (insulation at rafter level)	0.04
Corners (E16)	0.09
Corner (inverted) (E17)	-0.09

The default psi-value has been used for the remaining junctions.

Thermal Mass:

Thermal mass of the scheme has been indicatively modelled as 250 kJ/m^{2}K (medium).

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Heating
For the 'Be Lean' scenario, the scheme has been modelled with a gas boiler with an efficiency of 89.5% (as required by the GLA). For the 'Be Green' final scenario, a ground source heat pump with a minimum COP of 3.0 will be proposed as the main heating system. Heat will be provided via radiators and underfloor heating and will be controlled via time and temperature zone control by arrangement.

Hot Water
For the 'Be Lean', the hot water will be provided by the main gas heating system (gas boilers with an efficiency of 89.5%). For the 'Be Green' final scenario, hot water will be provided by the ground source heat pump, with a minimum COP of 3.0. A hot water cylinder of 180L and a heat loss factor of 1.2 has been specified.

A waste water heat recovery with a utilisation factor of 0.975 has been specified.

Ventilation
Balanced ventilation with heat recovery has been specified for the dwelling with a SFP of 1.05 and a heat recovery efficiency of 91% (Vent Axia Sentinel Kinetic Plus BS or similar).

Cooling
No cooling has been specified for the dwelling.

Lighting
High efficiency lighting has been specified for the development with a minimum efficacy of 80 lumens/W. 440 luminaires of 10W have been assumed for this stage.

Energy demand following energy efficiency measures (MWh/year)

	Space Heating	Hot water	Lighting	Auxiliary	Cooling	Unregulated gas	Unregulated electricity
Dwelling	42.9	0.9	1.4	12.6	0.0	0.0	11.8

Fabric energy efficiency

	Target Fabric Energy Efficiency (MWh/year)	Design Fabric Energy Efficiency (MWh/year)	Improvement (%)
Dwelling	106.95	105.82	1.1%

Primary Energy

	Target Primary Energy Rate (MWh/year)	Dwelling Primary Energy Rate (MWh/year)	Improvement (%)
Dwelling	107.03	67.03	37.4%

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Cooling and Overheating

Overheating and cooling

The aim of this section is to reduce the impact of the urban heat island effect in London and encourage the design of spaces to avoid overheating and excessive heat generation, and to mitigate overheating due to the impact of climate change.

Where design measures and the use of natural and/or mechanical ventilation are not enough to guarantee the occupant's comfort, in line with the cooling hierarchy the development's cooling strategy must include details of the active cooling plant being proposed, including efficiencies, and the ability to take advantage of free cooling and/or renewable cooling sources.

Where appropriate, the cooling strategy should investigate the opportunities to improve cooling efficiencies through the use of locally available sources such as ground cooling and river/dock water-cooling.

The Cooling Hierarchy in Policy SI4

Developments should reduce potential overheating and reliance on air conditioning systems and demonstrate this with the Cooling Hierarchy:

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

Avoiding overheating: measures taken

The following measures have been taken in accordance with the cooling hierarchy to reduce overheating and the need for cooling:

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
    - Solar control – all methods controlling solar gain to within tolerable limits have been considered. The location, size, design and type of window openings and glazing have been optimised and reduced solar gain factors from low emissivity windows have been specified.
    - Solar shading devices such as fenster markisen have been specified to limit solar gain. The shading has also been optimised to avoid substantially reducing daylighting or increasing the requirement for electric lighting.
    - Insulation levels have been maximised and the resulting U-values are lower than required by Building Regulations. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target U-values.
    - A reduced air permeability rate has been targeted to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.
2. Minimise internal heat generation through energy efficient design
    - Internal heat gains have been minimised where possible. Energy efficient appliances will help reduce internal heat gain and reduce the cooling requirement.
    - Energy efficient lighting will also be specified as per the 'Be Lean' section.

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3. Manage the heat within the building through exposed internal thermal mass and high ceilings
    - High thermal mass – Interseasonal Underground Thermal Energy Storage "UTES" has been designed. This system acts as 'thermal batteries'; it absorbs heat gains during the day when the building is occupied and 'store' it for an extended period, thereby helping to stabilise daytime temperatures. At night this heat can be dissipated, which 'resets' the heating cycle. Ventilation will also be used at night to purge the stored heat within the structure.
    - Room heights – high ceilings are traditionally used in hot climates to allow thermal stratification so that occupants can inhabit the lower cooler space, and to decrease the transfer of heat gain through the roof. The proposed building has floor to ceiling heights of more than 2.5m. As the roof will be well insulated to below building regulations, there will be minimal penetration of heat through the roof.
4. Provide passive ventilation
    - Openable windows are specified on all facades of the building.
    - Dual aspect has been specified to allow for cross ventilation. Cross ventilation will be achieved by opening windows on two facades and ensuring there is a clear path for airflow.
    - The scheme has been design to enable 'stack-effect' ventilation.
    - Wind towers have been design to cool and ventilate in summer and will replace traditional chimneys
    - Night time cooling will also be utilised. This will work in tandem with high thermal mass materials specified. The larger temperature differential that exists between internal and external temperatures at night will allow effective stack ventilation and purging of heat accumulated within the structure during the day.
5. Provide mechanical ventilation
    - Mechanical ventilation with summer by-pass will make use of 'free cooling' where the outside air temperature is below that in the building during summer months.
    - The mechanical systems will comply with the Domestic Building Services Compliance Guide as it is demonstrated in the 'Be Lean' section.

Overheating risk

According to the GLA guidance on preparing energy assessments (June 2022) Section 8, a dynamic modelling in line with CIBSE TM59 should be carried out to assess the risk of overheating. The dynamic overheating analysis has been carried out by Eight Versa in September 2023, confirms that the scheme meets the CIBSE TM59 requirements and comply with the new Part O Overheating Mitigation.

Active cooling

Air conditioning has not been specified for the scheme, since the overheating analysis demonstrates that there is no significant risk of overheating and the passive design measured are enough to guarantee the occupant's comfort.

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Heating Infrastructure

Heating infrastructure including CHP

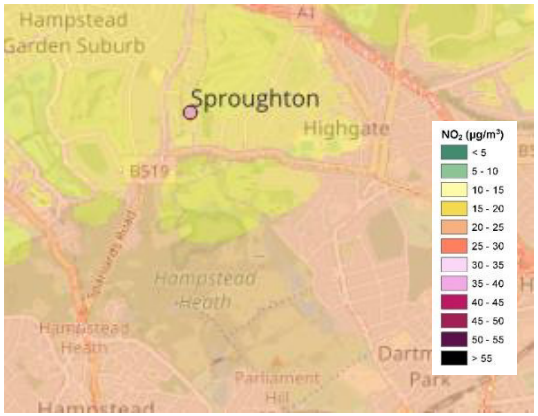
Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy SI3 of London Plan 2021. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

To comply with London Plan 2021 Policy SI 3, developments in Heat Network Priority Areas (HNPAs) should have a communal low-temperature heating system and should select a heat source in accordance with the following heating hierarchy:

- connect to local existing or planned heat networks
- use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
- use low-emission combined heat and power (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
- use ultra-low NOx gas boilers

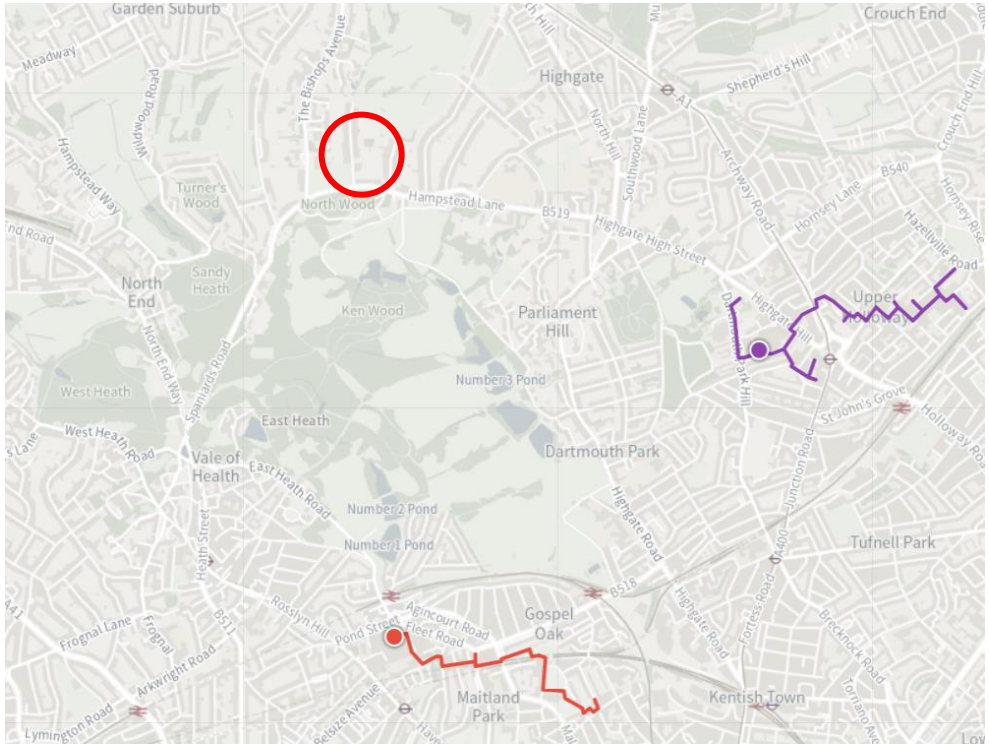
Air quality

Average annual NO_2 concentration in 2025 is estimated to be 15-20mg/m^3 based on LAEI 2025 projection model, therefore achieving NAQOs. It can be concluded that air quality impacts are 'not significant'.



Connect to local existing or planned heat network

The illustration below shows the London heat map. Red lines are existing heat networks and purple lines are proposed heat networks. The red circle shows the location of the proposed scheme.



A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. Therefore, a connection is not possible.

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Use zero-emission and/or local secondary heat sources

According to the GLA and London Plan 2021 Policy SI3, the exploitation of local energy opportunities to maximise the use of locally available energy sources whilst minimising primary energy demand and carbon emissions is encouraged. Secondary heat includes environmental sources such as air, water and ground; and waste sources such as heat from the sewerage system, sewage treatment plants, the tube network, data centres and chiller systems.

There are no local available waste heat sources for the scheme. The possibilities of capturing waste heat from nearby sources has been undertaken, however the amount of heat available is likely a fraction of the scheme's demand which makes its collection trivial within the context of the scheme.

Use low-emission combined heat and power (CHP)

In accordance with section 9 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion, or the development is of such a scale that it could be the catalyst for an area wide heat network, applicants should evaluate the feasibility of on-site CHP.

GLA guidance stipulates that small, or purely residential developments of less than 350 dwellings will not be expected to include on-site CHP. CHP systems are best utilised where there is a consistent and high demand for heat. Because of the small electricity supplies and demand of this scheme, a CHP installed to meet the base heat load would typically require the export of electricity to the grid. The administrative burden of managing CHP electricity sales at a small scale without an active energy service companies (ESCOs) is prohibitive for smaller operators of residential developments.

The heat demand profile of this residential scheme is not suitable to CHP. The implemented fabric improvements from the 'Be Lean' scenario have also reduced the energy demand from space heating to hot water. For CHP systems to be economically viable they need to run for at least 5,000 hours per year. Therefore, a CHP system would most likely be oversized, and as a result less efficient and economic.

Use ultra-low NOx gas boilers

Where it is clearly demonstrated that the above heating options (District heating, local secondary heat source and CHP) have been fully investigated and ruled out, then a site-wide heating strategy led by ultra-low NOx gas boilers can be considered.

Site wide heating network is not applicable as there is only one dwelling on site. A ground source heat pumo will be specified to meet the heating and hot water demand for the dwelling.

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Renewable Energy

Renewable Energy Feasibility:
In line with Policy SI2 of the London Plan 2021 the feasibility of renewable energy technologies has been considered. A detailed site-specific analysis and associated carbon saving calculations has also been provided for renewable energy technologies considered feasible.

Each technology has been assessed under 3 broader categories. There are key criteria for each category on which the technology is evaluated. The key criteria have been given a weighting based on a tick-system, a graphical representation of this is shown below:

The weighting of each of the criteria within the categories is shown below:

- Local, site-specific impact: (Maximum score of 5)
  - Local planning criteria = ✓
  - Land used by all components = ✓
  - Noise impact from operation = ✓
  - Interaction on the current building design = ✓
  - Buildability of installation = ✓

- Economic viability: (Maximum score of 5)
  - Capital cost of all components = ✓
  - Grants and funding available = ✓
  - Payback periods (years) 3-5, 5-10, 10-15 = ✓
  - Servicing requirements (low or high) = ✓
  - Maintenance costs (low or high) = ✓

- CO_2 and sustainability: (Maximum score of 10)
  - Carbon saving per year = ✓✓✓✓
  - Impact of future grid decarbonisation (gas vs. electric) = ✓✓
  - Local air quality/pollution = ✓✓
  - Resource use of installation = ✓✓

Key comments on each of the criteria and the corresponding score will be provided in a table for each of the technologies. The score for each of the criteria will be summed and each of the technologies will then be ranked. The assessment of each technology is undertaken on the following pages.

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Biomass & Biofuel - Rejected

Biomass is normally considered a carbon 'neutral' fuel, as the carbon dioxide emitted on burning has been recently absorbed from the atmosphere by photosynthesis. Although some form of fossil fuel derived inputs are required in the production and transportation of the fuel.

Wood is seen as a by-product of other industries and the small quantity of energy for drying, sawing, pelleting and delivery are typically discounted. Biomass from coppicing is likely to have external energy inputs from fertiliser, cutting, drying etc. and these may need to be considered. In this toolkit, all biomass fuels are considered to have zero net carbon emissions.

Biomass can be burnt directly to provide heat in buildings. Wood from forests, urban tree pruning, farmed coppices or farm and factory waste, is the most common fuel and is used commercially in the form of wood chips or pellets. Biomass boilers can also be designed to burn smokeless to comply with the Clean Air Acts.

Boilers can be fed automatically by screw drives from fuel hoppers. This typically involves daily addition of bagged fuels.

A biomass boiler could be installed on site for supplementary LTHW heating; however, a major factor influencing the suitability of a biomass boiler is the availability of the biomass fuel. A local and reliable fuel source would be essential for the biomass boiler to be an efficient replacement for a conventional boiler system. Therefore, a very comprehensive feasibility assessment needs to be undertaken to understand the practicalities of such a system.

It is estimated that the heating and hot water demand of the site is too large to meet the required CO_2 emissions reduction if a biomass boiler was a standalone system. Therefore, a biomass boiler would need to be combined with energy demand reduction measures and/or CHP. The likely installed cost would be circa £100,000. The additional cost of providing and storing the bio-fuel also needs to be accounted for. The site is likely to be unsuitable for biomass boilers due to site constraints such as limited transport/access issues, and storage of the biomass fuel. A detailed feasibility study will be required to investigate the suitability.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓	✓✓✓	✓✓✓✓✓
Local air quality impacts, increased transport usage, increased plant space, slightly increased buildability issues.	Increased capital costs of installation, typical payback of 8 years, Increased maintenance relative to gas boiler, resource use not significantly increased if well serviced.	Very low carbon intensity of feedstock if properly procured. Decarbonisation impact not applicable, air quality issues.

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Photovoltaic Panels (PV) - Accepted

Photovoltaic systems convert energy from the sun into electricity through semi-conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn the direct current (DC) output into alternating current (AC) electricity for use in buildings.

Photovoltaic panels supply electricity to the building and are attached to electricity gird or to any other electrical load. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

The cost of PV cells is heavily dependent on the size of the array. There are significant cost reductions available for larger installations.

The most suitable location for mounting photovoltaic panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a potential useable roof area of approximately 191 m^2 and is orientated south.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓✓ No local air quality impacts, use of unutilised roof space, no noise issues, good orientation, and slightly increased buildability issues for wiring and metering.	✓✓ Increased capital costs of installation, typical payback of 10-15 years, Feed in Tariff available, limited servicing and maintenance i.e. 1 visit per year, inverter will require replacement.	✓✓✓✓✓ ✓✓✓ High carbon saving from electricity, uses minimal grid electricity, no local air impact, high embodied energy of panels.

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Solar Thermal – Rejected

Solar water heating systems use the energy from the sun to heat water for domestic hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or a twin coil hot water cylinder inside the building. The systems work very successfully in all parts of the UK, as they can work in diffuse light conditions.

Like photovoltaic panels the most suitable location for mounting solar hot water panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a potential useable roof area of approximately 191 m^2 and is orientated south.

It is estimated that the CO_2 emissions reduction that would be produced by solar hot water as a standalone system would not be adequate to achieve the required CO_2 emissions reduction target. Therefore, a solar hot water system would need to be combined with more energy efficiency strategies, a CHP, or additional renewable technologies to achieve the carbon reduction target.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓✓ No local air quality impacts, use of unutilised roof space, no noise issues, slightly increased buildability issues for piping and cylinders.	✓✓✓ Increased capital costs of installation, typical payback of 8-10 years, Heat Incentive available, limited servicing and maintenance i.e. 1 visit per year, heat transfer fluid requires replacing every 10 years.	✓✓✓✓✓ ✓ Lower carbon saving as primarily displacing gas, uses minimal grid electricity, no local air impact, medium embodied energy of panels.

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Wind Energy – Rejected

Wind energy is a cost-effective method of renewable power generation. Wind turbines can produce electricity without carbon dioxide emissions in ranges from watts to megawatt outputs. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower.

The blades drive a generator either directly or via a gearbox to produce electricity. The electricity can either be linked to the grid or charge batteries. An inverter is required to convert the electricity from direct current (DC) to alternating current (AC) for feeding into the grid.

Modern quiet wind turbines are becoming viable in low density areas where ease of maintenance and immediate connection to the grid or direct use of the electricity in a building, may make them cost effective, despite lower wind speeds than open areas.

Wind turbines are generally less suited to dense urban areas as their output will be affected by potentially lower and more disrupted wind speeds, and their use of much more cost-effective machines may be prohibited by their proximity to some building types. Small turbines can be used in inner city areas mounted on buildings, although there are relatively few installations.

A detailed wind resource evaluation would be required for the site to fully understand the generation potential and payback period. Also, it is likely that planning restrictions and resistance from groups within the local community could also affect the viability of wind energy for the project.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓	✓✓✓✓	✓✓✓✓✓
No local air quality impacts, use of unutilised roof space, medium noise issues, relatively limited wind speeds in local area, increased buildability issues for wiring and metering.	Medium capital costs of installation, typical payback of 5 years, Feed in Tariff available, limited servicing and maintenance, costs of 2-3% typical.	High carbon saving from electricity, output limited from urban installation, consumes little grid electricity, no local air impact, low embodied energy of panels

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Ground Source Heat Pump (GSHP) – Accepted

Geo-thermal energy is essentially heat collected from the ground. Heat obtained from the ground may be considered it as a source of heating and cooling within the UK by the use of a geo-thermal heat pump or ground source heat pumps.

A ground source heat pump is a device for converting energy in the form of low-level heat to heat at a usable temperature. The heat pump consists of five main parts: ground collector loop/or boreholes, heat exchanger, compressor, condenser heat exchanger and expansion valve.

At approximately 1.2-1.5 metres down below ground level the temperature is a constant 10 to 12°C. Any boreholes would need to be sunk to an effective depth of 50 – 120m and a ground feasibility report would be required to ascertain if this method of heat source were viable.

From the boreholes pre-insulated pipework is laid in the ground to the heat exchanger device. The system is filled with water and antifreeze. The cooled water is pumped around the loop / borehole gathering energy as it circulates. The water that has been heated to 10-12°C is returned to the ground source heat exchanger where the energy is transferred to the refrigerant gas. For every 1kW of energy used to compress the refrigerant, the process 'gives up' 4 kW of energy for use in the system being used to heat the building.

The installation cost for a Ground Source Heat pump is typically high compared to a gas-boiler installation but carbon dioxide emission savings will typically be more than that of an air source heat pump.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓ No local air quality impacts, no visual impact, no noise issues, significant site area. Increased buildability issues for pipework and heating emitters internally.	✓ High capital costs of installation, typical payback >15 years where gas is displaced, Renewable Heat Incentive available, limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan. High Energy Efficiency	✓✓✓✓✓ ✓✓✓ Medium carbon saving from gas displacement, consumes some electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

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Air Source Heat Pump (ASHP) – Rejected

Air source heat pump systems work on the same principle as a ground source heat pump although they use the outside air as the heat source.

The coefficients of performance given by air source heat pump systems are inferior to that of ground source systems due to varying air temperatures. In the depth of winter, the energy efficiency of an air source system will be lower than that of a ground source system, and it is likely that more back-up heat will be required if an air source unit is fitted. This back-up heat often comes from a direct electric heater. They operate over a varying temperatures range of -15°C to +25°C, however, the performance will reduce to below the required 3 to 1 carbon saving ratio in winter, and they also require a defrosting mechanism to melt ice that forms on the air heat exchanger.

ASHPs are cheaper to install than ground source heat pumps but carbon dioxide emission savings will typically be less than that of a ground source heat pump.

Moreover, ASHP use is often associated with noise issues and given the site is located in a residential community, this will not be considered desirable.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓ No local air quality impacts, use of unutilised roof space, over visual impact, low noise issues, increased buildability issues for pipework and heating emitters internally.	✓✓ Medium- high capital costs of installation, typical payback >15 years where gas is displaced, Renewable Heat Incentive available Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	✓✓✓✓✓ ✓✓ Medium carbon saving from gas displacement, less efficient in winter, consumes electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

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Summary comparison matrix
An assessment of the feasibility of each of the technologies is shown below.

Renewable Technology	Comments	Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)	Total Score
Biomass Boiler	High air quality impact	✓	✓✓✓	✓✓✓✓✓	9
Photovoltaic	High CO_2 savings and low visual impact	✓✓✓✓	✓✓	✓✓✓✓✓ ✓✓✓	14
Solar Thermal	Low CO_2 savings compared to PV panels	✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓	13
Wind Energy	High visual and noise impact	✓	✓✓✓✓	✓✓✓✓✓	10
GSHP	High capital cost	✓✓✓	✓✓	✓✓✓✓✓ ✓✓✓	12
ASHP	Low capital cost but low CO_2 savings compared to GSHP	✓✓✓	✓	✓✓✓✓✓✓ ✓	12

Photovoltaic panels, solar thermal panels, ASHP and GSHP have scored the best.

Due to the limited roof space, photovoltaic panels and GSHP have been specified as they can provide higher CO_2 savings compared to the solar thermal panels and ASHPs.

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Ground Source Het Pump (GSHP) - Performance

The lifecycle of the proposed system is 25 years. To calculate the lifecycle cost of the GSHP, the maintenance of the system and cost of electricity to run the pumps will be included.

The GSHP has been estimated to have a minimum CoP of 3.0 and it will cover 100% of the space heating demand and 100% of the hot water demand. A thermal store will be specified to optimise the system's operations.

The following table summarise the reduction in carbon emissions and the life cycle cost of the GSHP system compared to a gas boiler.

	Gas Boiler	Ground Source Heat Pump
	Heating and hot water	Heating and hot water
Installation cost (£)	8,000	35,000
Maintenance and replacement cost (£)	6,000	10,000
Total (£)	14,000	45,000
Energy demand (kWh)	75,092	25,031
Cost of gas/electricity (p/kWh)	8.0	17.0
Annual operational cost (£)	6,007	4,255

It should be noted that the figures above are based on SAP modelling for CO_2 compliance. Compliance models are not well suited to investment appraisals because they do not accurately estimate energy consumption. It is estimated that the lifecycle saving for GSHP will be greater than boiler under 'real-life' operating conditions and consumption.

Moreover, the servicing strategy has been proposed based on sustainability aspirations and compliance with GLA requirements, which is intended to supersede simple economic payback appraisals for purposes of energy strategies.

Cost Performance Criteria	Value
Extra Cost Over Life Cycle (£)	31,000
Predicted Annual Savings (£)	1,752
Payback Period (years)	17.7
Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	50,061
Annual Carbon Emissions Reductions (kg CO_2/year) using SAP10.0 carbon factors	10,603
CO_2 Emissions Reduction (%) with SAP10.0	42.5%

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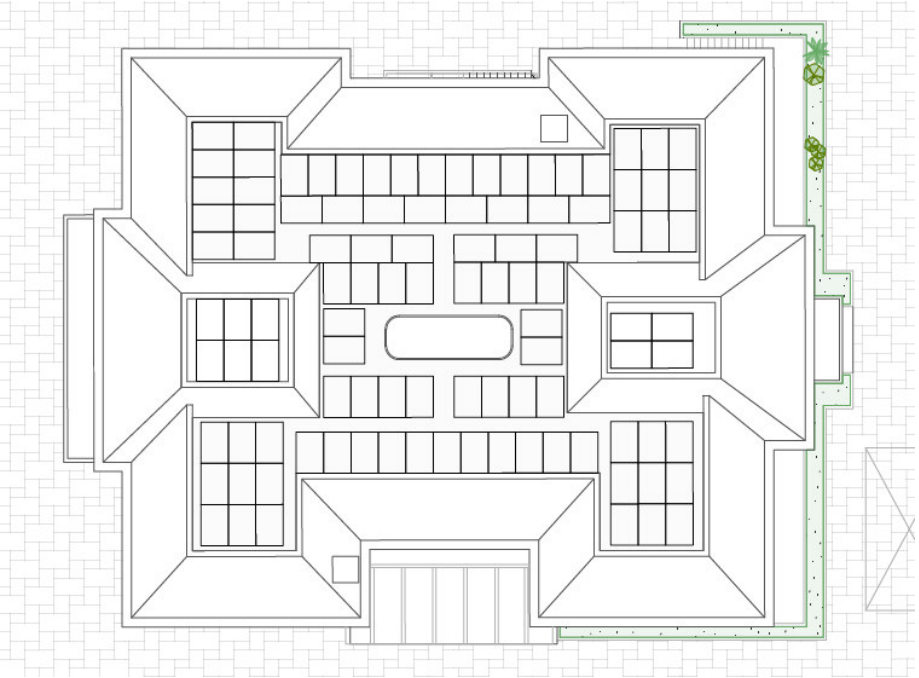
Photovoltaic panels (PV) - Performance

A photovoltaic panel system of 42.1 kWp (105 panels of 405W each) has been specified for the whole development, a detailed summary of the lifecycle cost, revenue and payback for the photovoltaic panels is presented in this section.

The following drawing shows that there are 190m^2 of available roof that could be used to install photovoltaic modules and lack of shading. PV panels will be placed with 30° tilt, oriented south, covering 160m^2 of the roof.



The lifecycle of the proposed high efficiency panels is 25 years. To calculate the lifecycle cost of the panels, the maintenance of the system and replacement cost will be included. The total costs for the proposed system's lifetime is shown in the table below.

Capital cost (£)	63,360
Maintenance cost (£)	1,820
Operational cost (£)	900
Total (£)	66,080
Cost of electricity (p/kWh)	17.0
Electricity generation (kWh/yr)	13,971
% of energy used on site	100%
Savings (£)	2,375
Summary	
Cost Performance Criteria	Value
Extra Cost Over Life Cycle (£)	66,080
Predicted Annual Savings (£)	2,375
Payback Period (years)	27.8
Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	13,971
Annual Carbon Emissions Reductions (kg CO_2/year) using SAP10.0 carbon factors	1,900
CO_2 Emissions Reduction (%) with SAP10.0	7.6%

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Appendix A

SAP files

The emission figures and details of the calculations and methodology used to determine the figures provided within the report can be found in the following pages:

- Baseline/Be Lean – TER from the TER SAP worksheet/DER from the Be Lean scenario DER SAP worksheet
- Be Green – DER from the Be Green scenario DER SAP worksheet

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Baseline/Be Lean- TER from the TER SAP worksheet/DER from the Be Lean scenario DER SAP worksheet

Full SAP Calculation Printout

Property Reference	LEAN	Issued on Date	04/08/2023
Assessment Reference	LEAN	Prop Type Ref	
Property	Sproughton, Courtenay Avenue, London, N6 4LR		

SAP Rating	86 B	DER	8.68	TER	9.54
Environmental	89 B	% DER < TER			9.01
CO_2 Emissions (t/year)	16.11	DFEE	51.77	TFEE	52.32
Compliance Check	See BREL	% DFEE < TFEE			1.05
% DPER < TPER	0.75	DPER	51.97	TPER	52.36

Assessor Details	Ms. Vanessa Vienna	Assessor ID	T798-0001
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200	(1a)	x 3.6000	(2a) =	2893.3920	(1a) -
Ground floor	427.1700	(1b)	x 3.9000	(2b) =	1665.9630	(1b) -
First floor	406.6100	(1c)	x 3.9000	(2c) =	1585.7790	(1c) -
Second floor	406.6100	(1d)	x 2.1700	(2d) =	882.3437	(1d) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(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		0 * 10 =	0.0000 (7a)
Number of passive vents		0 * 10 =	0.0000 (7b)
Number of flueless gas fires		0 * 40 =	0.0000 (7c)
			Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =		0.0000 / (5) =	0.0000 (8)
Pressure test			Yes
Pressure Test Method			Blower Door
Measured/design AP50			1.5000 (17)
Infiltration rate			0.0750 (18)
Number of sides sheltered			0 (19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.0750 (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	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881	(22b)

Balanced mechanical ventilation with heat recovery	
If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000 (23c)

Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241	(25)

---
3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K

window (Uw = 1.20)			200.5300	1.1450	229.6145	(27)
Door			4.9400	1.4000	6.9160	(26)
Rooflight			7.4700	1.3258	9.9034	(27a)
Exposed floor			638.5600	0.1100	70.2416	(28)
Ground floor			99.6500	0.1100	10.9615	(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124	(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472	(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612	(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140	(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868	(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313	(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052	(30)
Total net area of external elements Aum(A, m2)			3030.9800			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951	(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1	Element	Length	Psi-value	Total
E6	Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24	Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22	Basement floor	28.1060	0.2200	6.1833
E17	Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16	Corner (normal)	207.1440	0.0900	18.6430
E15	Flat roof with parapet	16.9100	0.3000	5.0730
E14	Flat roof	100.4770	0.1600	16.0763
E11	Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9	Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7	Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4	Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5	Ridge (inverted)	30.6370	0.1200	3.6764
E20	Exposed floor (normal)	104.0220	0.3200	33.2870
E1	Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
R6	Flat ceiling	82.1420	0.1200	9.8570
E5	Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 224.1321 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 795.1272 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1332.2813	1327.9330	1323.5848	1301.8435	1297.4952	1275.7540	1275.7540	1271.4057	1284.4505	1297.4952	1306.1917	1314.8882	(39)

Average = Sum(39)m / 12 = 1300.7564

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6518	0.6496	0.6475	0.6369	0.6347	0.6241	0.6241	0.6220	0.6284	0.6347	0.6390	0.6433	(40)
HLP (average)												0.6363	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

---

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3993 (42)

Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Total storage loss

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)

If cylinder contains dedicated solar storage

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss 50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)

Total heat required for water heating calculated for each month

421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
WWHRS -99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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

322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)

Total per year (kWh/year) = Sum(64)m = 3248.1149 (64)

12Total per year (kWh/year) 3248 (64)

Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

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

Heat gains from water heating, kWh/month

136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)
Total internal gains													
	2601.6832	2703.4614	2566.0808	2494.8122	2352.6232	2269.6593	2169.7070	2160.3838	2233.8071	2302.8486	2451.2848	2534.7903	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	3890.3697	5025.7029	6032.4759	7194.7311	7928.9260	7927.5059	7574.8914	6903.2824	6131.4014	4952.0453	4019.1661	3621.2541	(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	106.5481	106.8970	107.2482	109.0393	109.4047	111.2692	111.2692	111.6497	110.5158	109.4047	108.6763	107.9575	
alpha	8.1032	8.1265	8.1499	8.2693	8.2936	8.4179	8.4179	8.4433	8.3677	8.2936	8.2451	8.1972	
util living area													
	1.0000	1.0000	0.9999	0.9992	0.9892	0.9065	0.7247	0.8069	0.9854	0.9998	1.0000	1.0000	(86)
MIT	20.1674	20.2540	20.3921	20.5908	20.7792	20.9204	20.9576	20.9510	20.8402	20.5917	20.3491	20.1617	(87)
Th 2	20.3836	20.3855	20.3874	20.3969	20.3988	20.4083	20.4083	20.4103	20.4045	20.3988	20.3950	20.3912	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9988	0.9835	0.8613	0.6358	0.7227	0.9744	0.9998	1.0000	1.0000	(89)
MIT 2	19.3609	19.4735	19.6524	19.9154	20.1563	20.3284	20.3585	20.3568	20.2384	19.9183	19.6038	19.3601	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	19.5240	19.6314	19.8020	20.0520	20.2823	20.4481	20.4797	20.4770	20.3601	20.0545	19.7546	19.5222	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.3740	19.4814	19.6520	19.9020	20.1323	20.2981	20.3297	20.3270	20.2101	19.9045	19.6046	19.3722	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9983	0.9799	0.8512	0.6234	0.7096	0.9692	0.9996	1.0000	1.0000	(94)
Useful gains	3890.3644	5025.6383	6031.7764	7182.6516	7769.8514	6747.8690	4722.4013	4898.7651	5942.7261	4950.2428	4019.1373	3621.2516	(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													
	20082.8065	19363.0795	17407.7297	14322.8787	10940.8604	7269.3835	4758.1607	4992.7837	7848.1025	12072.4896	16333.3622	19949.7753	(97)
Space heating kWh													
	12047.1769	9634.7605	8463.7093	5140.9635	2359.2307	0.0000	0.0000	0.0000	0.0000	5298.9516	8866.2420	12148.4216	(98a)
Space heating requirement - total per year (kWh/year)												63959.4561	
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													
	12047.1769	9634.7605	8463.7093	5140.9635	2359.2307	0.0000	0.0000	0.0000	0.0000	5298.9516	8866.2420	12148.4216	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												63959.4561	
Space heating per m2											(98c) / (4) =	31.2896	(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 %) 89.5000 (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													
	12047.1769	9634.7605	8463.7093	5140.9635	2359.2307	0.0000	0.0000	0.0000	0.0000	5298.9516	8866.2420	12148.4216	(98)
Space heating efficiency (main heating system 1)													
	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)													
	13460.5329	10765.0955	9456.6584	5744.0933	2636.0119	0.0000	0.0000	0.0000	0.0000	5920.6163	9906.4156	13573.6554	(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													
	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
Efficiency of water heater													
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month													
	359.8208	317.4373	336.7669	296.6453	287.5504	259.2332	256.6713	267.2870	270.5318	301.3496	319.7705	356.1146	(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	1077.7026	973.4088	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(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 71463.0794 (211)
Space heating fuel - main system 2 0.0000 (213)
Space heating fuel - secondary 0.0000 (215)
Efficiency of water heater 89.5000
Water heating fuel used 3629.1787 (219)
Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)
mechanical ventilation fans (SFP = 1.4700) 12603.0785 (230a)
central heating pump 41.0000 (230c)
main heating flue fan 45.0000 (230e)
Total electricity for the above, kWh/year 12689.0785 (231)
Electricity for lighting (calculated in Appendix L) 1422.1609 (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 89203.4974 (238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	71463.0794	0.2100	15007.2467	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3629.1787	0.2100	762.1275	(264)
Space and water heating			15769.3742	(265)
Pumps, fans and electric keep-hot	12689.0785	0.1387	1760.1316	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Total CO2, kg/year			17734.7676	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			8.6800	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year

Space heating - main system 1	71463.0794	1.1300	80753.2797 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	3629.1787	1.1300	4100.9719 (278)
Space and water heating			84854.2516 (279)
Pumps, fans and electric keep-hot	12689.0785	1.5128	19196.0380 (281)
Energy for lighting	1422.1609	1.5338	2181.3578 (282)
Total Primary energy kWh/year			106231.6474 (286)
Dwelling Primary energy Rate (DPER)			51.9700 (287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777 (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	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(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	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			4.9400	1.0000	4.9400			(26)
TER Opening Type (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Rooflight			7.4700	2.0221	15.1048			(27a)
Exposed floor			638.5600	0.1300	83.0128			(28)
Ground floor			99.6500	0.1300	12.9545			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1800	129.4686			(29a)
Sloping wall	219.5600		219.5600	0.1800	39.5208			(29a)
Basement wall	368.0100		368.0100	0.1800	66.2418			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1800	14.5710			(29a)
Dormer wall	69.8900		69.8900	0.1800	12.5802			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		676.4455			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E6	Intermediate floor within a dwelling	212.1260	0.0000	0.0000
E24	Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	0.0200	0.2781
E22	Basement floor	28.1060	0.0700	1.9674
E17	Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16	Corner (normal)	207.1440	0.0900	18.6430
E15	Flat roof with parapet	16.9100	0.5600	9.4696
E14	Flat roof	100.4770	0.0800	8.0382
E11	Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9	Roof to wall (flat ceiling)	68.3970	0.0400	2.7359
R7	Flat ceiling (inverted)	88.8930	0.0400	3.5557
R4	Ridge (vaulted ceiling)	43.4780	0.0800	3.4782
R5	Ridge (inverted)	30.6370	0.0400	1.2255
E20	Exposed floor (normal)	104.0220	0.3200	33.2870
E1	Steel lintel with perforated steel base plate	103.8900	0.0500	5.1945
R6	Flat ceiling	82.1420	0.0600	4.9285
E5	Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 105.6662 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 782.1117 (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	1282.7699	1277.9845	1273.2938	1251.2620	1247.1399	1227.9509	1227.9509	1224.3974	1235.3423	1247.1399	1255.4789	1264.1968	(38)
Heat transfer coeff	2064.8816	2060.0962	2055.4056	2033.3737	2029.2517	2010.0627	2010.0627	2006.5091	2017.4540	2029.2517	2037.5906	2046.3086	(39)

Average = Sum(39)m / 12 = 2033.3540

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0102	1.0078	1.0055	0.9947	0.9927	0.9833	0.9833	0.9816	0.9870	0.9927	0.9968	1.0011	(40)
HLP (average)												0.9947	
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 5.3993 (42)
Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(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)
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)
50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)

Total heat required for water heating calculated for each month

421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
-52.4583	-46.3945	-48.5817	-40.2275	-37.4906	-32.0810	-30.0708	-31.9773	-33.1922	-39.1300	-44.3295	-51.4868	(63a)
-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)
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)
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

369.3234	325.9246	345.1960	301.7571	291.1502	260.9303	256.8255	268.0449	272.0442	304.9781	326.1514	365.1307	(64)

Total per year (kWh/year) = Sum(64)m = 3687.4564 (64)
12Total per year (kWh/year) 3687 (64)
Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

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

Heat gains from water heating, kWh/month

136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(69)

Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)
Total internal gains	2601.6832	2703.4614	2566.0808	2494.8122	2352.6232	2269.6593	2169.7070	2160.3838	2233.8071	2302.8486	2451.2848	2534.7903	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.6300	0.7000	0.7700	139.7047	(74)
East	40.1700	19.6403	0.6300	0.7000	0.7700	241.1132	(76)
South	55.6800	46.7521	0.6300	0.7000	0.7700	795.5580	(78)
West	61.6900	19.6403	0.6300	0.7000	0.7700	370.2831	(80)
North	7.4700	26.0000	0.6300	0.7000	1.0000	77.0859	(82)

Solar gains	1623.7449	2926.0243	4367.6578	5921.8979	7026.1416	7128.8867	6810.5324	5976.0523	4910.9688	3337.9878	1975.5304	1368.9444	(83)
Total gains	4225.4282	5629.4857	6933.7386	8416.7101	9378.7647	9398.5460	8980.2394	8136.4361	7144.7759	5640.8364	4426.8153	3903.7347	(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	68.7459	68.9056	69.0628	69.8111	69.9529	70.6207	70.6207	70.7458	70.3620	69.9529	69.6666	69.3698	
alpha	5.5831	5.5937	5.6042	5.6541	5.6635	5.7080	5.7080	5.7164	5.6908	5.6635	5.6444	5.6247	
util living area	1.0000	1.0000	0.9998	0.9985	0.9903	0.9489	0.8444	0.8991	0.9889	0.9996	1.0000	1.0000	(86)
MIT	19.3717	19.5174	19.7682	20.1257	20.4826	20.7866	20.9318	20.8964	20.6295	20.1650	19.7109	19.3573	(87)
Th 2	20.0749	20.0768	20.0787	20.0877	20.0894	20.0972	20.0972	20.0987	20.0942	20.0894	20.0860	20.0824	(88)
util rest of house	1.0000	0.9999	0.9997	0.9977	0.9844	0.9104	0.7307	0.8093	0.9789	0.9993	1.0000	1.0000	(89)
MIT 2	18.1174	18.3058	18.6289	19.0939	19.5496	19.9242	20.0648	20.0406	19.7406	19.1459	18.5607	18.1044	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	18.3711	18.5508	18.8593	19.3026	19.7383	20.0986	20.2401	20.2137	19.9204	19.3520	18.7933	18.3578	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3711	18.5508	18.8593	19.3026	19.7383	20.0986	20.2401	20.2137	19.9204	19.3520	18.7933	18.3578	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9999	0.9995	0.9967	0.9810	0.9105	0.7520	0.8238	0.9760	0.9990	0.9999	1.0000	(94)
Useful gains	4225.3519	5628.9287	6930.2530	8388.9830	9200.8037	8557.5050	6753.2923	6702.7354	6973.0604	5635.0210	4426.5455	3903.6918	(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	29055.1256	28122.0576	25403.3884	21152.2745	16311.6697	11052.5771	7316.8455	7652.2274	11742.3144	17760.0038	23826.2544	28971.2634	(97)
Space heating kWh	18473.3517	15115.3826	13744.0127	9189.5699	5290.4843	0.0000	0.0000	0.0000	0.0000	9020.9872	13967.7904	18650.2733	(98a)
Space heating requirement - total per year (kWh/year)												103451.8520	
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	18473.3517	15115.3826	13744.0127	9189.5699	5290.4843	0.0000	0.0000	0.0000	0.0000	9020.9872	13967.7904	18650.2733	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												103451.8520	
Space heating per m2										(98c) / (4) =		50.6097	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	92.4000 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	18473.3517	15115.3826	13744.0127	9189.5699	5290.4843	0.0000	0.0000	0.0000	0.0000	9020.9872	13967.7904	18650.2733	(98)
Space heating efficiency (main heating system 1)	92.4000	92.4000	92.4000	92.4000	92.4000	0.0000	0.0000	0.0000	0.0000	92.4000	92.4000	92.4000	(210)
Space heating fuel (main heating system)	19992.8048	16358.6392	14874.4726	9945.4220	5725.6324	0.0000	0.0000	0.0000	0.0000	9762.9731	15116.6563	20184.2784	(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

369.3234	325.9246	345.1960	301.7571	291.1502	260.9303	256.8255	268.0449	272.0442	304.9781	326.1514	365.1307 (64)
Efficiency of water heater											80.3000 (216)
(217)m 88.7138	88.6995	88.6673	88.5983	88.4061	80.3000	80.3000	80.3000	80.3000	88.5897	88.6833	88.7176 (217)
Fuel for water heating, kWh/month											
416.3090	367.4481	389.3158	340.5901	329.3326	324.9443	319.8325	333.8044	338.7848	344.2590	367.7710	411.5654 (219)
Space cooling fuel requirement											
(221)m 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (221)
Pumps and Fa 7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041 (231)
Lighting 176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132 (232)
Electricity generated by PVs (Appendix M) (negative quantity)											
(233a)m -518.8628	-638.3779	-800.2989	-778.9560	-747.6295	-664.1853	-652.9153	-656.5780	-658.0942	-660.8854	-534.3403	-460.0025 (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 -657.9415	-1315.5016	-2500.0893	-3602.9494	-4628.7306	-4606.0738	-4554.2966	-3918.0200	-2955.9008	-1829.5829	-859.5966	-526.0655 (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	111960.8788 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	80.3000
Water heating fuel used	4283.9569 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
Total electricity for the above, kWh/year	86.0000 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-39725.8747 (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	78027.1220 (238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	111960.8788	0.2100	23511.7846	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4283.9569	0.2100	899.6310	(264)
Space and water heating			24411.4155	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7771.1260	0.1378	-1070.7849	
PV Unit electricity exported	-31954.7486	0.1271	-4062.9282	
Total			-5133.7131	(269)
Total CO2, kg/year			19494.8934	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.5400	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	111960.8788	1.1300	126515.7931	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4283.9569	1.1300	4840.8713	(278)
Space and water heating			131356.6644	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1422.1609	1.5338	2181.3578	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7771.1260	1.5094	-11729.8932	
PV Unit electricity exported	-31954.7486	0.4668	-14915.3908	
Total			-26645.2840	(283)
Total Primary energy kWh/year			107022.8391	(286)
Target Primary Energy Rate (TPER)			52.3600	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(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	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0807	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0807	(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	0.1029	0.1009	0.0988	0.0888	0.0867	0.0767	0.0767	0.0746	0.0807	0.0867	0.0908	0.0948	(22b)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.0000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												0.0000	(23c)
Effective ac	0.5053	0.5051	0.5049	0.5039	0.5038	0.5029	0.5029	0.5028	0.5033	0.5038	0.5041	0.5045	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833

E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
R6 Flat ceiling	82.1420	0.1200	9.8570
E5 Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 224.1321 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 795.1272 (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	1171.8072	1171.3306	1170.8635	1168.6693	1168.2587	1166.3476	1166.3476	1165.9937	1167.0838	1168.2587	1169.0892	1169.9575	(38)
Heat transfer coeff	1966.9344	1966.4578	1965.9907	1963.7965	1963.3859	1961.4749	1961.4749	1961.1210	1962.2110	1963.3859	1964.2164	1965.0847	(39)

Average = Sum(39)m / 12 = 1963.7945

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9622	0.9620	0.9618	0.9607	0.9605	0.9596	0.9596	0.9594	0.9599	0.9605	0.9609	0.9613	(40)
HLP (average)												0.9607	
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 5.3993 (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

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 109.4327 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	119.3928	116.1154	112.5382	108.0879	104.1168	99.9903	99.1348	102.7048	106.3661	110.6035	115.0931	119.2256	(44)
Energy conte	189.0890	165.3468	172.9670	147.9669	140.1612	122.9497	119.8949	127.1700	131.1600	150.0880	163.9712	186.6784	(45)

Energy content (annual) Total = Sum(45)m = 1817.4433

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

160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(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

160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(64)

Total per year (kWh/year) = Sum(64)m = 1544.8268 (64)

12Total per year (kWh/year) 1545 (64)

Electric shower(s)

91.8945	81.8788	89.4085	85.3214	86.9224	82.9156	85.6794	86.9224	85.3214	89.4085	87.7273	91.8945	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 1045.2947 (64a)

Heat gains from water heating, kWh/month

63.1550	55.6059	59.1076	52.7733	51.5149	46.8557	46.8975	48.7542	49.2019	54.2458	56.7757	62.6428	(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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(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)	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)	84.8858	82.7469	79.4457	73.2963	69.2404	65.0774	63.0343	65.5299	68.3359	72.9110	78.8551	84.1973	(72)
Total internal gains	2500.7219	2604.6386	2472.1946	2412.8287	2277.6419	2205.0731	2110.1755	2097.4819	2166.8339	2224.6254	2361.7005	2435.4484	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	3789.4083	4926.8801	5938.5897	7112.7477	7853.9447	7862.9197	7515.3600	6840.3805	6064.4281	4873.8221	3929.5818	3521.9122	(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	72.1692	72.1867	72.2038	72.2845	72.2996	72.3701	72.3701	72.3831	72.3429	72.2996	72.2691	72.2371	
alpha	5.8113	5.8124	5.8136	5.8190	5.8200	5.8247	5.8247	5.8255	5.8229	5.8200	5.8179	5.8158	
util living area	1.0000	1.0000	0.9999	0.9994	0.9958	0.9745	0.9055	0.9432	0.9948	0.9998	1.0000	1.0000	(86)
MIT	19.4222	19.5484	19.7744	20.0955	20.4330	20.7343	20.9009	20.8604	20.5922	20.1556	19.7306	19.3984	(87)
Th 2	20.1149	20.1151	20.1153	20.1162	20.1164	20.1172	20.1172	20.1173	20.1169	20.1164	20.1160	20.1157	(88)
util rest of house	1.0000	1.0000	0.9999	0.9991	0.9930	0.9520	0.8146	0.8792	0.9898	0.9997	1.0000	1.0000	(89)
MIT 2	18.6316	18.7580	18.9842	19.3058	19.6424	19.9359	20.0749	20.0480	19.8016	19.3662	18.9409	18.6084	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	18.7915	18.9178	19.1440	19.4655	19.8023	20.0974	20.2420	20.2123	19.9615	19.5258	19.1006	18.7682	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7915	18.9178	19.1440	19.4655	19.8023	20.0974	20.2420	20.2123	19.9615	19.5258	19.1006	18.7682	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9998	0.9987	0.9916	0.9513	0.8310	0.8886	0.9885	0.9996	1.0000	1.0000	(94)
Useful gains	3789.3818	4926.6979	5937.4923	7103.5327	7788.0207	7480.2381	6245.0614	6078.3364	5994.5406	4871.7721	3929.4844	3521.8964	(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	28503.8064	27565.4223	24857.9810	20748.5173	15907.9956	10782.9762	7143.6498	7476.3668	11501.4902	17524.8055	23571.7495	28627.7090	(97)
Space heating kWh	18387.5319	15213.2228	14076.8436	9824.3889	6041.2613	0.0000	0.0000	0.0000	0.0000	9413.8569	14142.4309	18678.7246	(98a)
Space heating requirement - total per year (kWh/year)												105778.2610	
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	18387.5319	15213.2228	14076.8436	9824.3889	6041.2613	0.0000	0.0000	0.0000	0.0000	9413.8569	14142.4309	18678.7246	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												105778.2610	
Space heating per m2										(98c) / (4) =		51.7478	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	18437.8637	14514.9140	14904.5193	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.4627	0.5560	0.4950	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	8530.7717	8070.1444	7377.7293	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	8584.4977	8201.0858	7443.5642	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	38.6827	97.4204	48.9811	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		1.0000	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	9.6707	24.3551	12.2453	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												46.2711	(107)
Energy for space heating												51.7478	(99)
Energy for space cooling												0.0226	(108)
Total												51.7705	(109)
Fabric Energy Efficiency (DFEE)												51.8	(109)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(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	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(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	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.0000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												0.0000	(23c)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			4.9400	1.0000	4.9400			(26)
TER Opening Type (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Rooflight			7.4700	2.0221	15.1048			(27a)
Exposed floor			638.5600	0.1300	83.0128			(28)
Ground floor			99.6500	0.1300	12.9545			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1800	129.4686			(29a)
Sloping wall	219.5600		219.5600	0.1800	39.5208			(29a)
Basement wall	368.0100		368.0100	0.1800	66.2418			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1800	14.5710			(29a)
Dormer wall	69.8900		69.8900	0.1800	12.5802			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		676.4455			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0000	0.0000
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	0.0200	0.2781
E22 Basement floor	28.1060	0.0700	1.9674
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430

E15 Flat roof with parapet	16.9100	0.5600	9.4696	
E14 Flat roof	100.4770	0.0800	8.0382	
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608	
R9 Roof to wall (flat ceiling)	68.3970	0.0400	2.7359	
R7 Flat ceiling (inverted)	88.8930	0.0400	3.5557	
R4 Ridge (vaulted ceiling)	43.4780	0.0800	3.4782	
R5 Ridge (inverted)	30.6370	0.0400	1.2255	
E20 Exposed floor (normal)	104.0220	0.3200	33.2870	
E1 Steel lintel with perforated steel base plate	103.8900	0.0500	5.1945	
R6 Flat ceiling	82.1420	0.0600	4.9285	
E5 Ground floor (normal)	16.4920	0.1600	2.6387	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 105.6662 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 782.1117 (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	1282.7699	1277.9845	1273.2938	1251.2620	1247.1399	1227.9509	1227.9509	1224.3974	1235.3423	1247.1399	1255.4789	1264.1968	(38)
Heat transfer coeff	2064.8816	2060.0962	2055.4056	2033.3737	2029.2517	2010.0627	2010.0627	2006.5091	2017.4540	2029.2517	2037.5906	2046.3086	(39)

Average = Sum(39)m / 12 = 2033.3540

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0102	1.0078	1.0055	0.9947	0.9927	0.9833	0.9833	0.9816	0.9870	0.9927	0.9968	1.0011	(40)
HLP (average)												0.9947	
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 5.3993 (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

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 109.4327 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	119.3928	116.1154	112.5382	108.0879	104.1168	99.9903	99.1348	102.7048	106.3661	110.6035	115.0931	119.2256	(44)
Energy conte	189.0890	165.3468	172.9670	147.9669	140.1612	122.9497	119.8949	127.1700	131.1600	150.0880	163.9712	186.6784	(45)

Energy content (annual) Total = Sum(45)m = 1817.4433

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

160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(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

160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(64)

Total per year (kWh/year) = Sum(64)m = 1544.8268 (64)

12Total per year (kWh/year) 1545 (64)

Electric shower(s)

91.8945	81.8788	89.4085	85.3214	86.9224	82.9156	85.6794	86.9224	85.3214	89.4085	87.7273	91.8945	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 1045.2947 (64a)

Heat gains from water heating, kWh/month

63.1550	55.6059	59.1076	52.7733	51.5149	46.8557	46.8975	48.7542	49.2019	54.2458	56.7757	62.6428	(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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)

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

848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)

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

1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)

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

49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(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)

-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)

Water heating gains (Table 5)

84.8858	82.7469	79.4457	73.2963	69.2404	65.0774	63.0343	65.5299	68.3359	72.9110	78.8551	84.1973	(72)

Total internal gains

2500.7219	2604.6386	2472.1946	2412.8287	2277.6419	2205.0731	2110.1755	2097.4819	2166.8339	2224.6254	2361.7005	2435.4484	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.6300	0.7000	0.7700	139.7047	(74)
East	40.1700	19.6403	0.6300	0.7000	0.7700	241.1132	(76)
South	55.6800	46.7521	0.6300	0.7000	0.7700	795.5580	(78)
West	61.6900	19.6403	0.6300	0.7000	0.7700	370.2831	(80)
North	7.4700	26.0000	0.6300	0.7000	1.0000	77.0859	(82)

Solar gains	1623.7449	2926.0243	4367.6578	5921.8979	7026.1416	7128.8867	6810.5324	5976.0523	4910.9688	3337.9878	1975.5304	1368.9444	(83)
Total gains	4124.4668	5530.6629	6839.8524	8334.7266	9303.7834	9333.9598	8920.7080	8073.5341	7077.8026	5562.6133	4337.2309	3804.3927	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	68.7459	68.9056	69.0628	69.8111	69.9529	70.6207	70.6207	70.7458	70.3620	69.9529	69.6666	69.3698	
alpha	5.5831	5.5937	5.6042	5.6541	5.6635	5.7080	5.7080	5.7164	5.6908	5.6635	5.6444	5.6247	
util living area													
	1.0000	1.0000	0.9998	0.9985	0.9907	0.9502	0.8472	0.9017	0.9894	0.9996	1.0000	1.0000	(86)
MIT	19.3663	19.5121	19.7631	20.1213	20.4787	20.7839	20.9304	20.8945	20.6261	20.1608	19.7061	19.3520	(87)
Th 2	20.0749	20.0768	20.0787	20.0877	20.0894	20.0972	20.0972	20.0987	20.0942	20.0894	20.0860	20.0824	(88)
util rest of house													
	1.0000	0.9999	0.9997	0.9978	0.9849	0.9125	0.7343	0.8130	0.9798	0.9994	1.0000	1.0000	(89)
MIT 2	18.5440	18.6913	18.9438	19.3088	19.6650	19.9603	20.0713	20.0523	19.8154	19.3499	18.8925	18.5356	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	18.7103	18.8573	19.1095	19.4732	19.8296	20.1269	20.2451	20.2226	19.9794	19.5139	19.0570	18.7007	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7103	18.8573	19.1095	19.4732	19.8296	20.1269	20.2451	20.2226	19.9794	19.5139	19.0570	18.7007	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9999	0.9996	0.9971	0.9826	0.9142	0.7562	0.8284	0.9779	0.9991	1.0000	1.0000	(94)
Useful gains	4124.4094	5530.2209	6836.9700	8310.6363	9141.9501	8532.6947	6746.1050	6688.5118	6921.7121	5557.7668	4337.0213	3804.3609	(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													
	29755.5192	28753.4403	25917.6628	21499.1778	16496.9631	11109.3416	7326.7843	7670.1455	11861.3659	18088.5491	24363.5667	29672.9161	(97)
Space heating kWh													
	19069.5457	15606.0034	14196.0354	9495.7499	5472.1297	0.0000	0.0000	0.0000	0.0000	9322.9020	14419.1126	19246.2051	(98a)
Space heating requirement - total per year (kWh/year)												106827.6839	
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													
	19069.5457	15606.0034	14196.0354	9495.7499	5472.1297	0.0000	0.0000	0.0000	0.0000	9322.9020	14419.1126	19246.2051	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												106827.6839	
Space heating per m2											(98c) / (4) =	52.2612	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	18894.5889	14874.4636	15249.4694	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5364	0.6381	0.5703	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	10135.2744	9491.0303	8696.7396	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	10283.2373	9824.1785	8868.6961	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	106.5333	247.8623	127.9357	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		1.0000	(105)
Intermittency factor (Table 10b)													
	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	26.6333	61.9656	31.9839	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												120.5828	(107)
Energy for space heating												52.2612	(99)
Energy for space cooling												0.0590	(108)
Total												52.3202	(109)
Fabric Energy Efficiency (TFEE)												52.3	(109)

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)	
Basement floor	803.7200	(1a)	x 3.6000	(2a) =	2893.3920	(1a) -
Ground floor	427.1700	(1b)	x 3.9000	(2b) =	1665.9630	(1b) -
First floor	406.6100	(1c)	x 3.9000	(2c) =	1585.7790	(1c) -
Second floor	406.6100	(1d)	x 2.1700	(2d) =	882.3437	(1d) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(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	0 * 10 =	0.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		1.5000 (17)
Infiltration rate		0.0750 (18)
Number of sides sheltered		0 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750 (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	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881	(22b)

Balanced mechanical ventilation with heat recovery	
If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000 (23c)

Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994

E16 Corner (normal)	207.1440	0.0900	18.6430	
E15 Flat roof with parapet	16.9100	0.3000	5.0730	
E14 Flat roof	100.4770	0.1600	16.0763	
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608	
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870	
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672	
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174	
R5 Ridge (inverted)	30.6370	0.1200	3.6764	
E20 Exposed floor (normal)	104.0220	0.3200	33.2870	
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450	
R6 Flat ceiling	82.1420	0.1200	9.8570	
E5 Ground floor (normal)	16.4920	0.1600	2.6387	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 224.1321 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 795.1272 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1332.2813	1327.9330	1323.5848	1301.8435	1297.4952	1275.7540	1275.7540	1271.4057	1284.4505	1297.4952	1306.1917	1314.8882	(39)

Average = Sum(39)m / 12 = 1300.7564

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6518	0.6496	0.6475	0.6369	0.6347	0.6241	0.6241	0.6220	0.6284	0.6347	0.6390	0.6433	(40)
HLP (average)												0.6363	
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 5.3993 (42)

Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Total storage loss

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)

If cylinder contains dedicated solar storage

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss 50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)

Total heat required for water heating calculated for each month

421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
WWHRS -99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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

322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)

Total per year (kWh/year) = Sum(64)m = 3248.1149 (64)

Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

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

Heat gains from water heating, kWh/month

136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)
Total internal gains	2752.6664	2748.5499	2649.7908	2474.7901	2282.4106	2110.7429	2012.8449	2018.5500	2115.9487	2288.7222	2487.3490	2659.5583	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	4041.3528	5070.7914	6116.1859	7174.7090	7858.7134	7768.5895	7418.0294	6761.4487	6013.5430	4937.9189	4055.2303	3746.0221	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	106.5481	106.8970	107.2482	109.0393	109.4047	111.2692	111.2692	111.6497	110.5158	109.4047	108.6763	107.9575	
alpha	8.1032	8.1265	8.1499	8.2693	8.2936	8.4179	8.4179	8.4433	8.3677	8.2936	8.2451	8.1972	
util living area	1.0000	1.0000	0.9999	0.9992	0.9899	0.9147	0.7377	0.8190	0.9871	0.9998	1.0000	1.0000	(86)
MIT	20.1740	20.2559	20.3957	20.5899	20.7763	20.9169	20.9569	20.9496	20.8356	20.5910	20.3507	20.1672	(87)
Th 2	20.3836	20.3855	20.3874	20.3969	20.3988	20.4083	20.4083	20.4103	20.4045	20.3988	20.3950	20.3912	(88)
util rest of house	1.0000	1.0000	0.9999	0.9988	0.9844	0.8715	0.6484	0.7357	0.9773	0.9998	1.0000	1.0000	(89)
MIT 2	19.3693	19.4760	19.6570	19.9143	20.1529	20.3252	20.3582	20.3560	20.2329	19.9175	19.6058	19.3670	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	19.5320	19.6338	19.8064	20.0509	20.2790	20.4448	20.4793	20.4760	20.3548	20.0537	19.7565	19.5288	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.3820	19.4838	19.6564	19.9009	20.1290	20.2948	20.3293	20.3260	20.2048	19.9037	19.6065	19.3788	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9984	0.9810	0.8615	0.6358	0.7224	0.9724	0.9996	1.0000	1.0000	(94)
Useful gains	4041.3455	5070.7216	6115.4002	7162.8968	7709.1066	6692.7687	4716.4086	4884.7329	5847.6025	4936.1591	4055.1991	3746.0187	(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	20093.4734	19366.2557	17413.6063	14321.5055	10936.5522	7265.2269	4757.6093	4991.5771	7841.3185	12071.5163	16335.8666	19958.4899	(97)
Space heating kWh	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98a)
Space heating requirement - total per year (kWh/year)												63723.5301	
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	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												63723.5301	
Space heating per m2										(98c) / (4) =		31.1742	(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 %)	89.5000	(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	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	13343.8918	10733.6301	9392.0283	5758.8808	2682.9268	0.0000	0.0000	0.0000	0.0000	5931.5148	9879.4197	13477.1827	(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	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)

Fuel for water heating, kWh/month

	359.8208	317.4373	336.7669	296.6453	287.5504	259.2332	256.6713	267.2870	270.5318	301.3496	319.7705	356.1146 (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	1077.7026	973.4088	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026 (231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132 (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	71199.4750 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	89.5000
Water heating fuel used	3629.1787 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)	
mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
central heating pump	41.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	12689.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (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	88939.8931 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	71199.4750	3.6400	2591.6609	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	3.6400	132.1021	(247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(247a)
Pumps, fans and electric keep-hot	12689.0785	16.4900	2092.4290	(249)
Energy for lighting	1422.1609	16.4900	234.5143	(250)
Additional standing charges			92.0000	(251)
Total energy cost			5142.7064	(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] =	0.8862 (257)
SAP value		85.6347
SAP rating (Section 12)		86 (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	71199.4750	0.2100	14951.8898	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3629.1787	0.2100	762.1275	(264)
Space and water heating			15714.0173	(265)
Pumps, fans and electric keep-hot	12689.0785	0.1387	1760.1316	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Total CO2, kg/year			17679.4107	(272)
CO2 emissions per m2			8.6500	(273)
EI value			88.6600	
EI rating			89	(274)
EI band			B	

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)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(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	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0750	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.0000	4.8000	4.8000	4.3000	4.3000	3.9000	4.0000	4.0000	4.1000	4.4000	4.3000	4.7000	(22)
Wind factor	1.2500	1.2000	1.2000	1.0750	1.0750	0.9750	1.0000	1.0000	1.0250	1.1000	1.0750	1.1750	(22a)
Adj infilt rate	0.0938	0.0900	0.0900	0.0806	0.0806	0.0731	0.0750	0.0750	0.0769	0.0825	0.0806	0.0881	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000 (23c)

Effective ac	0.2298	0.2260	0.2260	0.2166	0.2166	0.2091	0.2110	0.2110	0.2129	0.2185	0.2166	0.2241	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488

E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
R6 Flat ceiling	82.1420	0.1200	9.8570
E5 Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 224.1321 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 795.1272 (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	532.8058	524.1093	524.1093	502.3680	502.3680	484.9750	489.3233	489.3233	493.6715	506.7163	502.3680	519.7610	(38)
Heat transfer coeff	1327.9330	1319.2365	1319.2365	1297.4952	1297.4952	1280.1022	1284.4505	1284.4505	1288.7987	1301.8435	1297.4952	1314.8882	(39)

Average = Sum(39)m / 12 = 1301.1188

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6496	0.6454	0.6454	0.6347	0.6347	0.6262	0.6284	0.6284	0.6305	0.6369	0.6347	0.6433	(40)
HLP (average)												0.6365	
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 5.3993 (42)

Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Total storage loss

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)

If cylinder contains dedicated solar storage

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss 50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)

Total heat required for water heating calculated for each month

421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
WWHRS -99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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

322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)

Total per year (kWh/year) = Sum(64)m = 3248.1149 (64)

Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

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

Heat gains from water heating, kWh/month

136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(69)
Pumps, fans 3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)	
Losses e.g. evaporation (negative values) (Table 5)	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)

Total internal gains
2752.6664 2748.5499 2649.7908 2474.7901 2282.4106 2110.7429 2012.8449 2018.5500 2115.9487 2288.7222 2487.3490 2659.5583 (73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	11.5821	0.5000	0.7000	0.7700	120.7687	(74)
East	40.1700	21.5869	0.5000	0.7000	0.7700	210.3266	(76)
South	55.6800	49.2853	0.5000	0.7000	0.7700	665.6074	(78)
West	61.6900	21.5869	0.5000	0.7000	0.7700	323.0034	(80)
North	7.4700	29.0000	0.5000	0.7000	1.0000	68.2384	(82)

Solar gains 1387.9446 2248.1173 3375.6619 4736.8329 5479.0990 5938.9484 5657.8466 5114.8339 4171.7170 2803.1466 1744.3685 1148.4828 (83)
Total gains 4140.6110 4996.6672 6025.4527 7211.6230 7761.5095 8049.6913 7670.6915 7133.3840 6287.6657 5091.8689 4231.7175 3808.0411 (84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	106.8970	107.6017	107.6017	109.4047	109.4047	110.8912	110.5158	110.5158	110.1429	109.0393	109.4047	107.9575	
alpha	8.1265	8.1734	8.1734	8.2936	8.2936	8.3927	8.3677	8.3677	8.3429	8.2693	8.2936	8.1972	
util living area	1.0000	1.0000	0.9999	0.9984	0.9757	0.7682	0.4850	0.5563	0.9487	0.9996	1.0000	1.0000	(86)
MIT	20.2214	20.2870	20.4458	20.6498	20.8406	20.9535	20.9626	20.9622	20.9027	20.6579	20.4140	20.2154	(87)
Th 2	20.3855	20.3893	20.3893	20.3988	20.3988	20.4064	20.4045	20.4045	20.4026	20.3969	20.3988	20.3912	(88)
util rest of house	1.0000	1.0000	0.9999	0.9976	0.9619	0.6897	0.3858	0.4507	0.9119	0.9993	1.0000	1.0000	(89)
MIT 2	19.4318	19.5191	19.7229	19.9926	20.2318	20.3539	20.3567	20.3567	20.3078	20.0015	19.6903	19.4290	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	19.5915	19.6744	19.8691	20.1255	20.3549	20.4752	20.4793	20.4791	20.4281	20.1343	19.8367	19.5880	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.4415	19.5244	19.7191	19.9755	20.2049	20.3252	20.3293	20.3291	20.2781	19.9843	19.6867	19.4380	(93)

---
8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9998	0.9968	0.9559	0.6782	0.3732	0.4371	0.9017	0.9989	1.0000	1.0000	(94)
Useful gains	4140.5983	4996.5894	6024.3129	7188.2457	7419.0766	5459.6033	2862.9191	3118.3512	5669.8703	5086.4419	4231.6404	3808.0353	(95)
Ext temp.	5.0000	5.4000	7.4000	9.9000	13.0000	16.0000	18.1000	17.9000	15.3000	11.7000	8.0000	5.0000	(96)
Heat loss rate W	19177.2894	18633.4384	16251.8011	13072.9751	9348.3302	5536.6372	2863.3900	3120.0869	6415.7385	10784.8392	15163.4132	18984.3835	(97)
Space heating kWh	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98a)
Space heating requirement - total per year (kWh/year)												57034.5689	
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	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												57034.5689	
Space heating per m2											(98c) / (4) =	27.9019	(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 %) 89.5000 (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	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	12499.7745	10239.0643	8501.9567	4734.0839	1603.7595	0.0000	0.0000	0.0000	0.0000	4736.9917	8794.2754	12615.8694	(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

	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225 (64)
Efficiency of water heater												89.5000 (216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000 (217)
Fuel for water heating, kWh/month												
	359.8208	317.4373	336.7669	296.6453	287.5504	259.2332	256.6713	267.2870	270.5318	301.3496	319.7705	356.1146 (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	1077.7026	973.4088	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026 (231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132 (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	63725.7753 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	89.5000
Water heating fuel used	3629.1787 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)	
mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
central heating pump	41.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	12689.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (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	81466.1934 (238)

10a. Fuel costs - using BEDF prices (524)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	63725.7753	4.8000	3058.8372	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	4.8000	174.2006	(247)
Energy for instantaneous electric shower(s)	0.0000	21.5100	0.0000	(247a)
Pumps, fans and electric keep-hot	12689.0785	21.5100	2729.4208	(249)
Energy for lighting	1422.1609	21.5100	305.9068	(250)
Additional standing charges			98.0000	(251)
Total energy cost			6366.3654	(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	63725.7753	0.2100	13382.4128	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3629.1787	0.2100	762.1275	(264)
Space and water heating			14144.5403	(265)
Pumps, fans and electric keep-hot	12689.0785	0.1387	1760.1316	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Total CO2, kg/year			16109.9337	(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	63725.7753	1.1300	72010.1261	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	1.1300	4100.9719	(278)
Space and water heating			76111.0980	(279)

Pumps, fans and electric keep-hot	12689.0785	1.5128	19196.0380 (281)
Energy for lighting	1422.1609	1.5338	2181.3578 (282)
Total Primary energy kWh/year			97488.4938 (286)

SAP 10 EPC IMPROVEMENTS

LEAN

Current energy efficiency rating: B 86
Current environmental impact rating: B 89

N Solar water heating		SAP increase too small
U Solar photovoltaic panels		SAP increase too small
V2 Wind turbine		Not applicable

Recommended measures:	SAP change	Cost change	CO2 change
(none)			

Measures omitted - SAP change or cost saving too small:

N Solar water heating	+ 0.0	-£ 20	-152 kg (0.9%)
U Solar photovoltaic panels	+ 0.6	-£ 296	-181 kg (1.1%)

	Typical annual savings	Energy efficiency	Environmental impact
Recommended measures			
(none)			
Total Savings	£0	0.00 kg/m²	

Potential energy efficiency rating: B 86
Potential environmental impact rating: B 89

Fuel prices for cost data on this page from database revision number 524 TEST (01 Aug 2023)
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	£3035	£3035	£0
Mains gas	£3331	£3331	£0
Space heating	£5886	£5886	£0
Water heating	£174	£174	£0
Lighting	£306	£306	£0
Total cost of fuels	£6366	£6366	£0
Total cost of uses	£6366	£6366	£0
Delivered energy	40 kWh/m²	40 kWh/m²	0 kWh/m²
Carbon dioxide emissions	16 tonnes	16 tonnes	0.0 tonnes
CO2 emissions per m²	8 kg/m²	8 kg/m²	0 kg/m²
Primary energy	48 kWh/m²	48 kWh/m²	0 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)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0750	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750	(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	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241	(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	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E6	Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24	Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22	Basement floor	28.1060	0.2200	6.1833
E17	Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16	Corner (normal)	207.1440	0.0900	18.6430
E15	Flat roof with parapet	16.9100	0.3000	5.0730
E14	Flat roof	100.4770	0.1600	16.0763
E11	Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9	Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7	Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4	Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5	Ridge (inverted)	30.6370	0.1200	3.6764
E20	Exposed floor (normal)	104.0220	0.3200	33.2870
E1	Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
R6	Flat ceiling	82.1420	0.1200	9.8570
E5	Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		224.1321 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	795.1272 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1332.2813	1327.9330	1323.5848	1301.8435	1297.4952	1275.7540	1275.7540	1271.4057	1284.4505	1297.4952	1306.1917	1314.8882	(39)
Average = Sum(39)m / 12 =												1300.7564	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6518	0.6496	0.6475	0.6369	0.6347	0.6241	0.6241	0.6220	0.6284	0.6347	0.6390	0.6433	(40)
HLP (average)												0.6363	
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												5.3993 (42)
Hot water usage for mixer showers												
	114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090 (42a)
Hot water usage for baths												
	49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016 (42b)
Hot water usage for other uses												
	69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240 (42c)
Average daily hot water use (litres/day)												215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)
Energy content (annual)										Total = Sum(45)m =		3574.8767	
Distribution loss (46)m = 0.15 x (45)m													
	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)
Water storage loss:													
Total storage loss													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month													
	421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
WWHRS	-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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													
	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
										Total per year (kWh/year) = Sum(64)m =		3248.1149	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month													
	136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)
Total internal gains													
	2752.6664	2748.5499	2649.7908	2474.7901	2282.4106	2110.7429	2012.8449	2018.5500	2115.9487	2288.7222	2487.3490	2659.5583	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	4041.3528	5070.7914	6116.1859	7174.7090	7858.7134	7768.5895	7418.0294	6761.4487	6013.5430	4937.9189	4055.2303	3746.0221	(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	106.5481	106.8970	107.2482	109.0393	109.4047	111.2692	111.2692	111.6497	110.5158	109.4047	108.6763	107.9575	
alpha	8.1032	8.1265	8.1499	8.2693	8.2936	8.4179	8.4179	8.4433	8.3677	8.2936	8.2451	8.1972	
util living area													
	1.0000	1.0000	0.9999	0.9992	0.9899	0.9147	0.7377	0.8190	0.9871	0.9998	1.0000	1.0000	(86)

MIT	20.1740	20.2559	20.3957	20.5899	20.7763	20.9169	20.9569	20.9496	20.8356	20.5910	20.3507	20.1672 (87)
Th 2	20.3836	20.3855	20.3874	20.3969	20.3988	20.4083	20.4083	20.4103	20.4045	20.3988	20.3950	20.3912 (88)
util rest of house												
	1.0000	1.0000	0.9999	0.9988	0.9844	0.8715	0.6484	0.7357	0.9773	0.9998	1.0000	1.0000 (89)
MIT 2	19.3693	19.4760	19.6570	19.9143	20.1529	20.3252	20.3582	20.3560	20.2329	19.9175	19.6058	19.3670 (90)
Living area fraction										fLA = Living area / (4) =		0.2022 (91)
MIT	19.5320	19.6338	19.8064	20.0509	20.2790	20.4448	20.4793	20.4760	20.3548	20.0537	19.7565	19.5288 (92)
Temperature adjustment												-0.1500
adjusted MIT	19.3820	19.4838	19.6564	19.9009	20.1290	20.2948	20.3293	20.3260	20.2048	19.9037	19.6065	19.3788 (93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9984	0.9810	0.8615	0.6358	0.7224	0.9724	0.9996	1.0000	1.0000	(94)
Useful gains	4041.3455	5070.7216	6115.4002	7162.8968	7709.1066	6692.7687	4716.4086	4884.7329	5847.6025	4936.1591	4055.1991	3746.0187	(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													
	20093.4734	19366.2557	17413.6063	14321.5055	10936.5522	7265.2269	4757.6093	4991.5771	7841.3185	12071.5163	16335.8666	19958.4899	(97)
Space heating kWh													
	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98a)
Space heating requirement - total per year (kWh/year)												63723.5301	
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													
	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												63723.5301	
Space heating per m2											(98c) / (4) =	31.1742	(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 %)												89.5000	(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													
	11942.7832	9606.5989	8405.8653	5154.1983	2401.2195	0.0000	0.0000	0.0000	0.0000	5308.7057	8842.0806	12062.0786	(98)
Space heating efficiency (main heating system 1)													
	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)													
	13343.8918	10733.6301	9392.0283	5758.8808	2682.9268	0.0000	0.0000	0.0000	0.0000	5931.5148	9879.4197	13477.1827	(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													
	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month													
	359.8208	317.4373	336.7669	296.6453	287.5504	259.2332	256.6713	267.2870	270.5318	301.3496	319.7705	356.1146	(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	1077.7026	973.4088	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(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												71199.4750	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												89.5000	
Water heating fuel used												3629.1787	(219)
Space cooling fuel												0.0000	(221)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)

mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
central heating pump	41.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	12689.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (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	88939.8931 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	71199.4750	3.6400	2591.6609	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	3.6400	132.1021	(247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(247a)
Pumps, fans and electric keep-hot	12689.0785	16.4900	2092.4290	(249)
Energy for lighting	1422.1609	16.4900	234.5143	(250)
Additional standing charges			92.0000	(251)
Total energy cost			5142.7064	(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] =	0.8862 (257)
SAP value		85.6347
SAP rating (Section 12)		86 (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	71199.4750	0.2100	14951.8898	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3629.1787	0.2100	762.1275	(264)
Space and water heating			15714.0173	(265)
Pumps, fans and electric keep-hot	12689.0785	0.1387	1760.1316	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Total CO2, kg/year			17679.4107	(272)
CO2 emissions per m2			8.6500	(273)
EI value			88.6600	
EI rating			89	(274)
EI band			B	

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)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 2044.1100						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(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	0 * 10 =	0.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)
	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		1.5000 (17)
Infiltration rate		0.0750 (18)
Number of sides sheltered		0 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.0000	4.8000	4.8000	4.3000	4.3000	3.9000	4.0000	4.0000	4.1000	4.4000	4.3000	4.7000	(22)
Wind factor	1.2500	1.2000	1.2000	1.0750	1.0750	0.9750	1.0000	1.0000	1.0250	1.1000	1.0750	1.1750	(22a)
Adj infilt rate	0.0938	0.0900	0.0900	0.0806	0.0806	0.0731	0.0750	0.0750	0.0769	0.0825	0.0806	0.0881	(22b)

Balanced mechanical ventilation with heat recovery		
If mechanical ventilation		0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)		0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =		72.8000 (23c)

Effective ac	0.2298	0.2260	0.2260	0.2166	0.2166	0.2091	0.2110	0.2110	0.2129	0.2185	0.2166	0.2241	(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	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)

List of Thermal Bridges

	K1	Element	Length	Psi-value	Total
	E6	Intermediate floor within a dwelling	212.1260	0.0700	14.8488
	E24	Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
	E23	Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
	E22	Basement floor	28.1060	0.2200	6.1833
	E17	Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
	E16	Corner (normal)	207.1440	0.0900	18.6430
	E15	Flat roof with parapet	16.9100	0.3000	5.0730
	E14	Flat roof	100.4770	0.1600	16.0763
	E11	Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
	R9	Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
	R7	Flat ceiling (inverted)	88.8930	0.1200	10.6672
	R4	Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
	R5	Ridge (inverted)	30.6370	0.1200	3.6764
	E20	Exposed floor (normal)	104.0220	0.3200	33.2870
	E1	Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
	R6	Flat ceiling	82.1420	0.1200	9.8570
	E5	Ground floor (normal)	16.4920	0.1600	2.6387

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		224.1321 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	795.1272 (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	532.8058	524.1093	524.1093	502.3680	502.3680	484.9750	489.3233	489.3233	493.6715	506.7163	502.3680	519.7610	(38)
Heat transfer coeff	1327.9330	1319.2365	1319.2365	1297.4952	1297.4952	1280.1022	1284.4505	1284.4505	1288.7987	1301.8435	1297.4952	1314.8882	(39)
Average = Sum(39)m / 12 =												1301.1188	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6496	0.6454	0.6454	0.6347	0.6347	0.6262	0.6284	0.6284	0.6305	0.6369	0.6347	0.6433	(40)
HLP (average)												0.6365	
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 5.3993 (42)
Hot water usage for mixer showers
114.7486 113.0242 110.5113 105.7034 102.1553 98.1985 95.9494 98.4432 101.1770 105.4254 110.3366 114.3090 (42a)
Hot water usage for baths
49.4689 48.7342 47.6996 45.7920 44.3636 42.7798 41.9243 42.9516 44.0702 45.7650 47.7118 49.3016 (42b)
Hot water usage for other uses
69.9240 67.3813 64.8386 62.2959 59.7532 57.2105 57.2105 59.7532 62.2959 64.8386 67.3813 69.9240 (42c)
Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)
Energy content (annual)										Total = Sum(45)m =		3574.8767	
Distribution loss (46)m = 0.15 x (45)m													
	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)
Water storage loss:													
Total storage loss													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month													
	421.7817	372.3191	393.7776	341.9847	328.6408	293.0113	286.8963	300.0222	305.2364	344.1081	370.4810	416.6176	(62)
WWHRS	-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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													
	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
										Total per year (kWh/year) = Sum(64)m =		3248.1149	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month													
	136.0383	119.9989	126.7270	109.6414	105.0690	93.3577	91.1889	95.5533	97.4226	110.2118	119.1164	134.3212	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	182.8472	178.5697	170.3319	152.2797	141.2217	129.6635	122.5657	128.4318	135.3092	148.1342	165.4395	180.5393	(72)
Total internal gains													
	2752.6664	2748.5499	2649.7908	2474.7901	2282.4106	2110.7429	2012.8449	2018.5500	2115.9487	2288.7222	2487.3490	2659.5583	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	11.5821	0.5000	0.7000	0.7700	120.7687	(74)
East	40.1700	21.5869	0.5000	0.7000	0.7700	210.3266	(76)
South	55.6800	49.2853	0.5000	0.7000	0.7700	665.6074	(78)
West	61.6900	21.5869	0.5000	0.7000	0.7700	323.0034	(80)
North	7.4700	29.0000	0.5000	0.7000	1.0000	68.2384	(82)

Solar gains	1387.9446	2248.1173	3375.6619	4736.8329	5479.0990	5938.9484	5657.8466	5114.8339	4171.7170	2803.1466	1744.3685	1148.4828	(83)
Total gains	4140.6110	4996.6672	6025.4527	7211.6230	7761.5095	8049.6913	7670.6915	7133.3840	6287.6657	5091.8689	4231.7175	3808.0411	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	106.8970	107.6017	107.6017	109.4047	109.4047	110.8912	110.5158	110.5158	110.1429	109.0393	109.4047	107.9575

alpha	8.1265	8.1734	8.1734	8.2936	8.2936	8.3927	8.3677	8.3677	8.3429	8.2693	8.2936	8.1972	
util living area													
	1.0000	1.0000	0.9999	0.9984	0.9757	0.7682	0.4850	0.5563	0.9487	0.9996	1.0000	1.0000	(86)
MIT	20.2214	20.2870	20.4458	20.6498	20.8406	20.9535	20.9626	20.9622	20.9027	20.6579	20.4140	20.2154	(87)
Th 2	20.3855	20.3893	20.3893	20.3988	20.3988	20.4064	20.4045	20.4045	20.4026	20.3969	20.3988	20.3912	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9976	0.9619	0.6897	0.3858	0.4507	0.9119	0.9993	1.0000	1.0000	(89)
MIT 2	19.4318	19.5191	19.7229	19.9926	20.2318	20.3539	20.3567	20.3567	20.3078	20.0015	19.6903	19.4290	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	19.5915	19.6744	19.8691	20.1255	20.3549	20.4752	20.4793	20.4791	20.4281	20.1343	19.8367	19.5880	(92)
Temperature adjustment												-0.1500	
adjusted MIT	19.4415	19.5244	19.7191	19.9755	20.2049	20.3252	20.3293	20.3291	20.2781	19.9843	19.6867	19.4380	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9998	0.9968	0.9559	0.6782	0.3732	0.4371	0.9017	0.9989	1.0000	1.0000	(94)
Useful gains	4140.5983	4996.5894	6024.3129	7188.2457	7419.0766	5459.6033	2862.9191	3118.3512	5669.8703	5086.4419	4231.6404	3808.0353	(95)
Ext temp.	5.0000	5.4000	7.4000	9.9000	13.0000	16.0000	18.1000	17.9000	15.3000	11.7000	8.0000	5.0000	(96)
Heat loss rate W													
	19177.2894	18633.4384	16251.8011	13072.9751	9348.3302	5536.6372	2863.3900	3120.0869	6415.7385	10784.8392	15163.4132	18984.3835	(97)
Space heating kWh													
	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98a)
Space heating requirement - total per year (kWh/year)												57034.5689	
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													
	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												57034.5689	
Space heating per m2											(98c) / (4) =	27.9019	(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 %)												89.5000	(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													
	11187.2982	9163.9625	7609.2512	4237.0051	1435.3647	0.0000	0.0000	0.0000	0.0000	4239.6076	7870.8765	11291.2031	(98)
Space heating efficiency (main heating system 1)													
	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)													
	12499.7745	10239.0643	8501.9567	4734.0839	1603.7595	0.0000	0.0000	0.0000	0.0000	4736.9917	8794.2754	12615.8694	(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													
	322.0396	284.1064	301.4064	265.4976	257.3576	232.0137	229.7208	239.2218	242.1260	269.7079	286.1946	318.7225	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month													
	359.8208	317.4373	336.7669	296.6453	287.5504	259.2332	256.6713	267.2870	270.5318	301.3496	319.7705	356.1146	(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	1077.7026	973.4088	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	1077.7026	1042.9380	1077.7026	1042.9380	1077.7026	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(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												63725.7753	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												89.5000	
Water heating fuel used												3629.1787	(219)

Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)	
mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
central heating pump	41.0000 (230c)
main heating flue fan	45.0000 (230e)
Total electricity for the above, kWh/year	12689.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (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	81466.1934 (238)

10a. Fuel costs - using BEDF prices (524)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	63725.7753	4.8000	3058.8372	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	4.8000	174.2006	(247)
Energy for instantaneous electric shower(s)	0.0000	21.5100	0.0000	(247a)
Pumps, fans and electric keep-hot	12689.0785	21.5100	2729.4208	(249)
Energy for lighting	1422.1609	21.5100	305.9068	(250)
Additional standing charges			98.0000	(251)
Total energy cost			6366.3654	(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	63725.7753	0.2100	13382.4128	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3629.1787	0.2100	762.1275	(264)
Space and water heating			14144.5403	(265)
Pumps, fans and electric keep-hot	12689.0785	0.1387	1760.1316	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Total CO2, kg/year			16109.9337	(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	63725.7753	1.1300	72010.1261	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3629.1787	1.1300	4100.9719	(278)
Space and water heating			76111.0980	(279)
Pumps, fans and electric keep-hot	12689.0785	1.5128	19196.0380	(281)
Energy for lighting	1422.1609	1.5338	2181.3578	(282)
Total Primary energy kWh/year			97488.4938	(286)

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Be Green- DER from the Be Green scenario DER SAP worksheet

Full SAP Calculation Printout

Property Reference	GREEN	Issued on Date	08/09/2023
Assessment Reference	GREEN	Prop Type Ref	
Property	Sproughton, Courtenay Avenue, London, N6 4LR		

SAP Rating	79 C	DER	3.43	TER	9.66
Environmental	96 A	% DER < TER			64.49
CO_2 Emissions (t/year)	6.35	DFEE	52.38	TFEE	52.95
Compliance Check	See BREL	% DFEE < TFEE			1.08
% DPER < TPER	34.04	DPER	34.98	TPER	53.04

Assessor Details	Ms. Vanessa Vienna	Assessor ID	T798-0001
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200	(1a)	x 3.6000	(2a) =	2893.3920	(1a) -
Ground floor	427.1700	(1b)	x 3.9000	(2b) =	1665.9630	(1b) -
First floor	406.6100	(1c)	x 3.9000	(2c) =	1585.7790	(1c) -
Second floor	406.6100	(1d)	x 2.1700	(2d) =	882.3437	(1d) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(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	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0750	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750	(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	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881	(22b)

Balanced mechanical ventilation with heat recovery		
If mechanical ventilation	0.5000	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000	(23c)

Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K

window (Uw = 1.20)			200.5300	1.1450	229.6145	(27)
Door			4.9400	1.4000	6.9160	(26)
Rooflight			7.4700	1.3258	9.9034	(27a)
Exposed floor			638.5600	0.1100	70.2416	(28)
Ground floor			99.6500	0.1100	10.9615	(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124	(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472	(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612	(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140	(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868	(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313	(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052	(30)
Total net area of external elements Aum(A, m2)			3030.9800			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951	(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.1200	9.8570
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3 Sill	101.8400	0.0400	4.0736
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		245.3177 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	816.3128 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1353.4669	1349.1186	1344.7704	1323.0291	1318.6808	1296.9396	1296.9396	1292.5913	1305.6361	1318.6808	1327.3773	1336.0738	(39)

Average = Sum(39)m / 12 = 1321.9420

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6621	0.6600	0.6579	0.6472	0.6451	0.6345	0.6345	0.6323	0.6387	0.6451	0.6494	0.6536	(40)
HLP (average)												0.6467	
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 5.3993 (42)

Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.2000 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.6480 (55)

Total storage loss

20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(56)

If cylinder contains dedicated solar storage

20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(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

390.9108	344.4357	362.9067	312.1096	297.7699	263.1362	256.0254	269.1513	275.3613	313.2372	340.6059	385.7466	(62)
WWHRS -99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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

291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)

Total per year (kWh/year) = Sum(64)m = 2884.6349 (64)

12Total per year (kWh/year) 2885 (64)
Electric shower(s)
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)
Heat gains from water heating, kWh/month
123.2986 108.4920 113.9872 97.3126 92.3292 81.0290 78.4492 82.8135 85.0938 97.4721 106.7877 121.5815 (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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(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)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	165.7239	161.4464	153.2086	135.1564	124.0984	112.5403	105.4425	111.3085	118.1859	131.0109	148.3162	163.4160	(72)
Total internal gains													
	2581.5599	2683.3381	2545.9575	2474.6889	2332.4999	2252.5360	2152.5837	2143.2605	2216.6838	2282.7253	2431.1616	2514.6670	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	3870.2464	5005.5796	6012.3526	7174.6078	7908.8027	7910.3826	7557.7681	6886.1591	6114.2781	4931.9220	3999.0429	3601.1308	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	104.8804	105.2184	105.5586	107.2932	107.6470	109.4516	109.4516	109.8198	108.7225	107.6470	106.9418	106.2457	
alpha	7.9920	8.0146	8.0372	8.1529	8.1765	8.2968	8.2968	8.3213	8.2482	8.1765	8.1295	8.0830	
util living area													
	1.0000	1.0000	0.9999	0.9992	0.9900	0.9126	0.7357	0.8168	0.9865	0.9999	1.0000	1.0000	(86)
Living	20.1524	20.2393	20.3786	20.5791	20.7699	20.9155	20.9561	20.9486	20.8331	20.5815	20.3363	20.1466	
Non living	19.3337	19.4468	19.6271	19.8924	20.1366	20.3147	20.3481	20.3458	20.2216	19.8973	19.5794	19.3327	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	26	30	31	
16 / 9	0	0	0	0	8	0	0	0	0	5	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	20.7956	20.9155	20.9561	20.9486	20.8331	20.9618	21.0000	21.0000	(87)
Th 2	20.3744	20.3763	20.3782	20.3877	20.3896	20.3991	20.3991	20.4010	20.3953	20.3896	20.3858	20.3820	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9988	0.9845	0.8686	0.6453	0.7325	0.9761	0.9998	1.0000	1.0000	(89)
MIT 2	20.3744	20.3763	20.3782	20.3877	20.1731	20.3147	20.3481	20.3458	20.2216	20.3545	20.3858	20.3820	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	20.5009	20.5024	20.5039	20.5115	20.2990	20.4362	20.4711	20.4677	20.3452	20.4773	20.5100	20.5070	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.5009	20.5024	20.5039	20.5115	20.2990	20.4362	20.4711	20.4677	20.3452	20.4773	20.5100	20.5070	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9989	0.9835	0.8717	0.6566	0.7427	0.9750	0.9998	1.0000	1.0000	(94)
Useful gains	3870.2434	5005.5414	6011.9292	7166.8973	7778.2813	6895.7840	4962.6511	5114.6366	5961.2661	4930.8308	3999.0263	3601.1294	(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													
	21927.4146	21049.5350	18832.0906	15362.3623	11339.2998	7569.2073	5020.5480	5257.9361	8154.0108	13025.0457	17800.1221	21787.3141	(97)
Space heating kWh													
	13434.5354	10781.5637	9538.2000	5900.7348	2649.3978	0.0000	0.0000	0.0000	0.0000	6022.0958	9936.7890	13530.5214	(98a)
Space heating requirement - total per year (kWh/year)												71793.8380	
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
13434.5354 10781.5637 9538.2000 5900.7348 2649.3978 0.0000 0.0000 0.0000 0.0000 6022.0958 9936.7890 13530.5214 (98c)
Space heating requirement after solar contribution - total per year (kWh/year) 71793.8380
Space heating per m2 (98c) / (4) = 35.1223 (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 %) 167.3025 (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													
	13434.5354	10781.5637	9538.2000	5900.7348	2649.3978	0.0000	0.0000	0.0000	0.0000	6022.0958	9936.7890	13530.5214	(98)
Space heating efficiency (main heating system 1)													
	167.3025	167.3025	167.3025	167.3025	167.3025	0.0000	0.0000	0.0000	0.0000	167.3025	167.3025	167.3025	(210)
Space heating fuel (main heating system)													
	8030.0842	6444.3512	5701.1684	3526.9844	1583.5968	0.0000	0.0000	0.0000	0.0000	3599.5243	5939.4129	8087.4569	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
Efficiency of water heater												319.8676	(216)
(217)m	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	(217)
Fuel for water heating, kWh/month													
	91.0279	80.1028	84.5773	73.6625	70.8064	63.1945	62.1663	65.1366	66.3559	74.6675	80.1330	89.9909	(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	1070.3984	966.8115	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-639.8433	-948.2758	-1404.6303	-1543.2052	-1466.0623	-1053.8776	-1052.3590	-1003.9758	-905.0030	-1044.5760	-711.1894	-548.3995	(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 42912.5790 (211)
Space heating fuel - main system 2 0.0000 (213)
Space heating fuel - secondary 0.0000 (215)
Efficiency of water heater 319.8676
Water heating fuel used 901.8217 (219)
Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)
mechanical ventilation fans (SFP = 1.4700) 12603.0785 (230a)
Total electricity for the above, kWh/year 12603.0785 (231)
Electricity for lighting (calculated in Appendix L) 1422.1609 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation -12321.3974 (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 45518.2427 (238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	42912.5790	0.1545	6630.3143	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	901.8217	0.1411	127.2724	(264)
Space and water heating			6757.5868	(265)
Pumps, fans and electric keep-hot	12603.0785	0.1387	1748.2024	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)

Energy saving/generation technologies			
PV Unit electricity used in dwelling	-12321.3974	0.1372	-1690.0995
PV Unit electricity exported	0.0000	0.0000	0.0000
Total			-1690.0995 (269)
Total CO2, kg/year			7020.9514 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			3.4300 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	42912.5790	1.5720	67460.1436 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	901.8217	1.5219	1372.4385 (278)
Space and water heating			68832.5821 (279)
Pumps, fans and electric keep-hot	12603.0785	1.5128	19065.9372 (281)
Energy for lighting	1422.1609	1.5338	2181.3578 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-12321.3974	1.5072	-18570.3707
PV Unit electricity exported	0.0000	0.0000	0.0000
Total			-18570.3707 (283)
Total Primary energy kWh/year			71509.5064 (286)
Dwelling Primary energy Rate (DPER)			34.9800 (287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(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	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			4.9400	1.0000	4.9400			(26)
TER Opening Type (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Rooflight			7.4700	2.0221	15.1048			(27a)
Exposed floor			638.5600	0.1300	83.0128			(28)
Ground floor			99.6500	0.1300	12.9545			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1800	129.4686			(29a)
Sloping wall	219.5600		219.5600	0.1800	39.5208			(29a)
Basement wall	368.0100		368.0100	0.1800	66.2418			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1800	14.5710			(29a)
Dormer wall	69.8900		69.8900	0.1800	12.5802			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		676.4455			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0000	0.0000
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	0.0200	0.2781
E22 Basement floor	28.1060	0.0700	1.9674
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.5600	9.4696
E14 Flat roof	100.4770	0.0800	8.0382
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.0400	2.7359
R7 Flat ceiling (inverted)	88.8930	0.0400	3.5557
R4 Ridge (vaulted ceiling)	43.4780	0.0800	3.4782
R5 Ridge (inverted)	30.6370	0.0400	1.2255
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.0600	4.9285
E1 Steel lintel with perforated steel base plate	103.8900	0.0500	5.1945
E3 Sill	101.8400	0.0500	5.0920
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 127.8702 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 804.3157 (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	1282.7699	1277.9845	1273.2938	1251.2620	1247.1399	1227.9509	1227.9509	1224.3974	1235.3423	1247.1399	1255.4789	1264.1968	(38)
Heat transfer coeff	2087.0856	2082.3002	2077.6096	2055.5777	2051.4557	2032.2667	2032.2667	2028.7131	2039.6580	2051.4557	2059.7946	2068.5126	(39)

Average = Sum(39)m / 12 = 2055.5580

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0210	1.0187	1.0164	1.0056	1.0036	0.9942	0.9942	0.9925	0.9978	1.0036	1.0077	1.0119	(40)
HLP (average)												1.0056	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3993 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)
Hot water usage for baths	49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)
Hot water usage for other uses	69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)
Energy content (annual)										Total = Sum(45)m =		3574.8767	
Distribution loss (46)m = 0.15 x (45)m	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Store volume 150.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.3938 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.7527 (55)

Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	417.4177	368.3775	389.4136	337.7614	324.2768	288.7880	282.5323	295.6582	301.0132	339.7441	366.2577	412.2535	(62)
WWHRS	-52.4583	-46.3945	-48.5817	-40.2275	-37.4906	-32.0810	-30.0708	-31.9773	-33.1922	-39.1300	-44.3295	-51.4868	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)

FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h													
	364.9594	321.9829	340.8320	297.5339	286.7862	256.7070	252.4615	263.6809	267.8209	300.6141	321.9282	360.7667	(64)
										Total per year (kWh/year) = Sum(64)m =		3636.0738	(64)
12Total per year (kWh/year)												3636	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month													
	160.5745	142.1606	151.2631	133.3861	129.6052	117.1025	115.7251	120.0895	121.1673	134.7480	142.8611	158.8574	(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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	215.8259	211.5485	203.3107	185.2585	174.2005	162.6423	155.5445	161.4106	168.2879	181.1130	198.4182	213.5180	(72)
Total internal gains													
	2634.6620	2736.4402	2599.0596	2527.7909	2385.6019	2302.6381	2202.6857	2193.3626	2266.7859	2335.8273	2484.2636	2567.7691	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.6300	0.7000	0.7700	139.7047	(74)
East	40.1700	19.6403	0.6300	0.7000	0.7700	241.1132	(76)
South	55.6800	46.7521	0.6300	0.7000	0.7700	795.5580	(78)
West	61.6900	19.6403	0.6300	0.7000	0.7700	370.2831	(80)
North	7.4700	26.0000	0.6300	0.7000	1.0000	77.0859	(82)

Solar gains	1623.7449	2926.0243	4367.6578	5921.8979	7026.1416	7128.8867	6810.5324	5976.0523	4910.9688	3337.9878	1975.5304	1368.9444	(83)
Total gains	4258.4069	5662.4645	6966.7174	8449.6888	9411.7435	9431.5248	9013.2181	8169.4148	7177.7547	5673.8152	4459.7940	3936.7135	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	68.0145	68.1708	68.3247	69.0570	69.1958	69.8491	69.8491	69.9715	69.5960	69.1958	68.9157	68.6252	
alpha	5.5343	5.5447	5.5550	5.6038	5.6131	5.6566	5.6566	5.6648	5.6397	5.6131	5.5944	5.5750	
util living area													
	1.0000	1.0000	0.9998	0.9984	0.9903	0.9494	0.8464	0.9003	0.9889	0.9996	1.0000	1.0000	(86)
MIT	19.3569	19.5030	19.7551	20.1148	20.4743	20.7813	20.9291	20.8932	20.6238	20.1561	19.6987	19.3424	(87)
Th 2	20.0659	20.0678	20.0697	20.0787	20.0803	20.0882	20.0882	20.0896	20.0851	20.0803	20.0769	20.0734	(88)
util rest of house													
	1.0000	0.9999	0.9997	0.9977	0.9843	0.9111	0.7324	0.8104	0.9788	0.9993	1.0000	1.0000	(89)
MIT 2	18.0918	18.2807	18.6056	19.0732	19.5323	19.9108	20.0544	20.0297	19.7265	19.1277	18.5384	18.0786	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	18.3476	18.5279	18.8381	19.2839	19.7228	20.0869	20.2313	20.2044	19.9079	19.3357	18.7731	18.3342	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3476	18.5279	18.8381	19.2839	19.7228	20.0869	20.2313	20.2044	19.9079	19.3357	18.7731	18.3342	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9999	0.9995	0.9966	0.9809	0.9110	0.7537	0.8248	0.9758	0.9989	0.9999	1.0000	(94)
Useful gains	4258.3230	5661.8685	6963.0659	8421.2658	9232.3510	8592.2659	6793.2025	6737.8883	7003.8496	5667.7180	4459.5011	3936.6659	(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													
	29318.6291	28377.3843	25633.6762	21344.8182	16458.3371	11150.7912	7379.7634	7717.9448	11846.2077	17920.9016	24044.1502	29236.7880	(97)
Space heating kWh													
	18644.8678	15264.8266	13890.9340	9304.9578	5376.1337	0.0000	0.0000	0.0000	0.0000	9116.3686	14100.9474	18823.2908	(98a)
Space heating requirement - total per year (kWh/year)												104522.3268	
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													

	18644.8678	15264.8266	13890.9340	9304.9578	5376.1337	0.0000	0.0000	0.0000	0.0000	9116.3686	14100.9474	18823.2908 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												104522.3268
Space heating per m2											(98c) / (4) =	51.1334 (99)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	18644.8678	15264.8266	13890.9340	9304.9578	5376.1337	0.0000	0.0000	0.0000	0.0000	9116.3686	14100.9474	18823.2908	(98)
Space heating efficiency (main heating system 1)													
	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)													
	20200.2901	16538.2737	15049.7660	10081.2110	5824.6302	0.0000	0.0000	0.0000	0.0000	9876.8891	15277.2995	20393.5979	(211)
Space heating efficiency (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	364.9594	321.9829	340.8320	297.5339	286.7862	256.7070	252.4615	263.6809	267.8209	300.6141	321.9282	360.7667	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.6081	88.5936	88.5608	88.4908	88.2957	79.8000	79.8000	79.8000	79.8000	88.4814	88.5770	88.6121	(217)
Fuel for water heating, kWh/month													
	411.8802	363.4382	384.8565	336.2316	324.8020	321.6880	316.3678	330.4272	335.6152	339.7482	363.4444	407.1305	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-518.8628	-638.3779	-800.2989	-778.9560	-747.6295	-664.1853	-652.9153	-656.5780	-658.0942	-660.8854	-534.3403	-460.0025	(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	-657.9415	-1315.5016	-2500.0893	-3602.9494	-4628.7306	-4606.0738	-4554.2966	-3918.0200	-2955.9008	-1829.5829	-859.5966	-526.0655	(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	113241.9575 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	79.8000
Water heating fuel used	4235.6297 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
Total electricity for the above, kWh/year	86.0000 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-39725.8747 (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	79259.8734 (238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	113241.9575	0.2100	23780.8111	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4235.6297	0.2100	889.4822	(264)
Space and water heating			24670.2933	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7771.1260	0.1378	-1070.7849	
PV Unit electricity exported	-31954.7486	0.1271	-4062.9282	

Total	-5133.7131 (269)
Total CO2, kg/year	19753.7712 (272)
EPC Target Carbon Dioxide Emission Rate (TER)	9.6600 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	113241.9575	1.1300	127963.4120	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4235.6297	1.1300	4786.2616	(278)
Space and water heating			132749.6736	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1422.1609	1.5338	2181.3578	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7771.1260	1.5094	-11729.8932	
PV Unit electricity exported	-31954.7486	0.4668	-14915.3908	
Total			-26645.2840	(283)
Total Primary energy kWh/year			108415.8482	(286)
Target Primary Energy Rate (TPER)			53.0400	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(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	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0807	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0807	(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	0.1029	0.1009	0.0988	0.0888	0.0867	0.0767	0.0767	0.0746	0.0807	0.0867	0.0908	0.0948	(22b)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.0000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												0.0000	(23c)
Effective ac	0.5053	0.5051	0.5049	0.5039	0.5038	0.5029	0.5029	0.5028	0.5033	0.5038	0.5041	0.5045	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.1200	9.8570
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3 Sill	101.8400	0.0400	4.0736
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 245.3177 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 816.3128 (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	1171.8072	1171.3306	1170.8635	1168.6693	1168.2587	1166.3476	1166.3476	1165.9937	1167.0838	1168.2587	1169.0892	1169.9575	(38)
Heat transfer coeff	1988.1200	1987.6434	1987.1763	1984.9821	1984.5715	1982.6605	1982.6605	1982.3066	1983.3966	1984.5715	1985.4020	1986.2703	(39)

Average = Sum(39)m / 12 = 1984.9801

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9726	0.9724	0.9721	0.9711	0.9709	0.9699	0.9699	0.9698	0.9703	0.9709	0.9713	0.9717	(40)
HLP (average)												0.9711	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3993 (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

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 109.4327 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	119.3928	116.1154	112.5382	108.0879	104.1168	99.9903	99.1348	102.7048	106.3661	110.6035	115.0931	119.2256	(44)
Energy conte	189.0890	165.3468	172.9670	147.9669	140.1612	122.9497	119.8949	127.1700	131.1600	150.0880	163.9712	186.6784	(45)
Energy content (annual)										Total = Sum(45)m =		1817.4433	
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													
	160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(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													
	160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(64)
										Total per year (kWh/year) = Sum(64)m =		1544.8268	(64)
12Total per year (kWh/year)												1545	(64)

Electric shower(s)

	91.8945	81.8788	89.4085	85.3214	86.9224	82.9156	85.6794	86.9224	85.3214	89.4085	87.7273	91.8945 (64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 1045.2947 (64a)

Heat gains from water heating, kWh/month

	63.1550	55.6059	59.1076	52.7733	51.5149	46.8557	46.8975	48.7542	49.2019	54.2458	56.7757	62.6428 (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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)

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

	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864 (67)

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

	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755 (68)

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

	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964 (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)

	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709 (71)

Water heating gains (Table 5)

	84.8858	82.7469	79.4457	73.2963	69.2404	65.0774	63.0343	65.5299	68.3359	72.9110	78.8551	84.1973 (72)

Total internal gains

	2500.7219	2604.6386	2472.1946	2412.8287	2277.6419	2205.0731	2110.1755	2097.4819	2166.8339	2224.6254	2361.7005	2435.4484 (73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	3789.4083	4926.8801	5938.5897	7112.7477	7853.9447	7862.9197	7515.3600	6840.3805	6064.4281	4873.8221	3929.5818	3521.9122	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	71.4002	71.4173	71.4341	71.5130	71.5278	71.5968	71.5968	71.6096	71.5702	71.5278	71.4979	71.4667	
alpha	5.7600	5.7612	5.7623	5.7675	5.7685	5.7731	5.7731	5.7740	5.7713	5.7685	5.7665	5.7644	
util living area													
	1.0000	1.0000	0.9999	0.9994	0.9958	0.9750	0.9079	0.9446	0.9949	0.9998	1.0000	1.0000	(86)
MIT	19.4061	19.5327	19.7602	20.0833	20.4235	20.7277	20.8969	20.8559	20.5851	20.1453	19.7171	19.3822	(87)
Th 2	20.1062	20.1064	20.1066	20.1075	20.1077	20.1085	20.1085	20.1086	20.1082	20.1077	20.1073	20.1070	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9991	0.9931	0.9529	0.8175	0.8813	0.9899	0.9997	1.0000	1.0000	(89)
MIT 2	18.6086	18.7354	18.9630	19.2868	19.6260	19.9225	20.0644	20.0368	19.7876	19.3489	18.9205	18.5853	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	18.7699	18.8966	19.1242	19.4479	19.7873	20.0854	20.2328	20.2025	19.9489	19.5100	19.0816	18.7465	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7699	18.8966	19.1242	19.4479	19.7873	20.0854	20.2328	20.2025	19.9489	19.5100	19.0816	18.7465	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9998	0.9987	0.9917	0.9521	0.8336	0.8904	0.9886	0.9996	1.0000	1.0000	(94)
Useful gains	3789.3804	4926.6909	5937.4661	7103.4632	7788.4457	7486.2251	6265.1382	6090.6634	5995.0555	4871.7357	3929.4803	3521.8955	(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													
	28767.8347	27820.3027	25086.5371	20937.2984	16049.7299	10875.6368	7202.5708	7537.7121	11600.6268	17682.4969	23788.2406	28893.2566	(97)
Space heating kWh													
	18583.9700	15384.5071	14246.9088	9960.3614	6146.3954	0.0000	0.0000	0.0000	0.0000	9531.2064	14298.3074	18876.2927	(98a)

Space heating requirement - total per year (kWh/year) 107027.9492

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

	18583.9700	15384.5071	14246.9088	9960.3614	6146.3954	0.0000	0.0000	0.0000	0.0000	9531.2064	14298.3074	18876.2927	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 107027.9492

Space heating per m2 (98c) / (4) = 52.3592 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	18637.0083	14671.6874	15065.5298	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.4578	0.5502	0.4898	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	8531.4934	8072.6965	7378.7709	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	8584.4977	8201.0858	7443.5642	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	38.1631	95.5217	48.2062	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		1.0000	(105)
Intermittency factor (Table 10b)													
	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	9.5408	23.8804	12.0516	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												45.4728	(107)
Energy for space heating												52.3592	(99)
Energy for space cooling												0.0222	(108)
Total												52.3814	(109)
Fabric Energy Efficiency (DFEE)												52.4	(109)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200	(1a)	x 3.6000	(2a) =	2893.3920	(1a) -
Ground floor	427.1700	(1b)	x 3.9000	(2b) =	1665.9630	(1b) -
First floor	406.6100	(1c)	x 3.9000	(2c) =	1585.7790	(1c) -
Second floor	406.6100	(1d)	x 2.1700	(2d) =	882.3437	(1d) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(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													
	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.0000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												0.0000	(23c)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			4.9400	1.0000	4.9400			(26)
TER Opening Type (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Rooflight			7.4700	2.0221	15.1048			(27a)
Exposed floor			638.5600	0.1300	83.0128			(28)
Ground floor			99.6500	0.1300	12.9545			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1800	129.4686			(29a)
Sloping wall	219.5600		219.5600	0.1800	39.5208			(29a)
Basement wall	368.0100		368.0100	0.1800	66.2418			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1800	14.5710			(29a)
Dormer wall	69.8900		69.8900	0.1800	12.5802			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	676.4455			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0000	0.0000
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	0.0200	0.2781
E22 Basement floor	28.1060	0.0700	1.9674
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.5600	9.4696
E14 Flat roof	100.4770	0.0800	8.0382
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.0400	2.7359
R7 Flat ceiling (inverted)	88.8930	0.0400	3.5557
R4 Ridge (vaulted ceiling)	43.4780	0.0800	3.4782
R5 Ridge (inverted)	30.6370	0.0400	1.2255
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.0600	4.9285
E1 Steel lintel with perforated steel base plate	103.8900	0.0500	5.1945
E3 Sill	101.8400	0.0500	5.0920
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 127.8702 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 804.3157 (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	1282.7699	1277.9845	1273.2938	1251.2620	1247.1399	1227.9509	1227.9509	1224.3974	1235.3423	1247.1399	1255.4789	1264.1968	(38)
Heat transfer coeff	2087.0856	2082.3002	2077.6096	2055.5777	2051.4557	2032.2667	2032.2667	2028.7131	2039.6580	2051.4557	2059.7946	2068.5126	(39)

Average = Sum(39)m / 12 = 2055.5580

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0210	1.0187	1.0164	1.0056	1.0036	0.9942	0.9942	0.9925	0.9978	1.0036	1.0077	1.0119	(40)
HLP (average)												1.0056	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3993 (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

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 109.4327 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	119.3928	116.1154	112.5382	108.0879	104.1168	99.9903	99.1348	102.7048	106.3661	110.6035	115.0931	119.2256	(44)
Energy conte	189.0890	165.3468	172.9670	147.9669	140.1612	122.9497	119.8949	127.1700	131.1600	150.0880	163.9712	186.6784	(45)
Energy content (annual)										Total = Sum(45)m =		1817.4433	
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													
	160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(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													
	160.7257	140.5448	147.0219	125.7719	119.1371	104.5073	101.9107	108.0945	111.4860	127.5748	139.3756	158.6767	(64)
										Total per year (kWh/year) = Sum(64)m =		1544.8268	(64)
12Total per year (kWh/year)												1545	(64)

Electric shower(s)

	91.8945	81.8788	89.4085	85.3214	86.9224	82.9156	85.6794	86.9224	85.3214	89.4085	87.7273	91.8945 (64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 1045.2947 (64a)

Heat gains from water heating, kWh/month

	63.1550	55.6059	59.1076	52.7733	51.5149	46.8557	46.8975	48.7542	49.2019	54.2458	56.7757	62.6428 (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	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	269.9636	(66)

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

	848.0864	938.9528	848.0864	876.3560	848.0864	876.3560	848.0864	848.0864	876.3560	848.0864	876.3560	848.0864 (67)

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

	1463.7605	1478.9498	1440.6734	1359.1874	1256.3260	1159.6507	1095.0657	1079.8765	1118.1529	1199.6389	1302.5003	1399.1755 (68)

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

	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964	49.9964 (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)

	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709 (71)

Water heating gains (Table 5)

	84.8858	82.7469	79.4457	73.2963	69.2404	65.0774	63.0343	65.5299	68.3359	72.9110	78.8551	84.1973 (72)

Total internal gains

	2500.7219	2604.6386	2472.1946	2412.8287	2277.6419	2205.0731	2110.1755	2097.4819	2166.8339	2224.6254	2361.7005	2435.4484 (73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.6300	0.7000	0.7700	139.7047	(74)
East	40.1700	19.6403	0.6300	0.7000	0.7700	241.1132	(76)
South	55.6800	46.7521	0.6300	0.7000	0.7700	795.5580	(78)
West	61.6900	19.6403	0.6300	0.7000	0.7700	370.2831	(80)
North	7.4700	26.0000	0.6300	0.7000	1.0000	77.0859	(82)

Solar gains	1623.7449	2926.0243	4367.6578	5921.8979	7026.1416	7128.8867	6810.5324	5976.0523	4910.9688	3337.9878	1975.5304	1368.9444	(83)
Total gains	4124.4668	5530.6629	6839.8524	8334.7266	9303.7834	9333.9598	8920.7080	8073.5341	7077.8026	5562.6133	4337.2309	3804.3927	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	68.0145	68.1708	68.3247	69.0570	69.1958	69.8491	69.8491	69.9715	69.5960	69.1958	68.9157	68.6252	
alpha	5.5343	5.5447	5.5550	5.6038	5.6131	5.6566	5.6566	5.6648	5.6397	5.6131	5.5944	5.5750	
util living area													
	1.0000	1.0000	0.9998	0.9985	0.9908	0.9514	0.8508	0.9041	0.9896	0.9996	1.0000	1.0000	(86)
MIT	19.3497	19.4959	19.7483	20.1087	20.4687	20.7773	20.9270	20.8903	20.6187	20.1501	19.6921	19.3352	(87)
Th 2	20.0659	20.0678	20.0697	20.0787	20.0803	20.0882	20.0882	20.0896	20.0851	20.0803	20.0769	20.0734	(88)
util rest of house													
	1.0000	0.9999	0.9997	0.9978	0.9851	0.9142	0.7379	0.8160	0.9800	0.9994	1.0000	1.0000	(89)
MIT 2	18.5202	18.6680	18.9219	19.2890	19.6479	19.9467	20.0608	20.0412	19.8008	19.3320	18.8714	18.5117	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	18.6880	18.8355	19.0890	19.4548	19.8139	20.1147	20.2360	20.2129	19.9662	19.4974	19.0374	18.6783	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.6880	18.8355	19.0890	19.4548	19.8139	20.1147	20.2360	20.2129	19.9662	19.4974	19.0374	18.6783	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9999	0.9996	0.9971	0.9828	0.9156	0.7598	0.8312	0.9782	0.9991	0.9999	1.0000	(94)
Useful gains	4124.4066	5530.2064	6836.9173	8310.5822	9143.6476	8546.4785	6777.5870	6710.5565	6923.4221	5557.7044	4337.0134	3804.3592	(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													
	30028.9811	29017.7994	26155.0797	21696.1267	16645.2952	11207.3764	7389.3464	7735.2741	11965.1279	18252.7147	24588.4890	29948.5112	(97)
Space heating kWh													
	19273.0034	15783.6625	14372.7128	9637.5920	5581.2259	0.0000	0.0000	0.0000	0.0000	9445.0876	14581.0624	19451.2491	(98a)

Space heating requirement - total per year (kWh/year) 108125.5958

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

	19273.0034	15783.6625	14372.7128	9637.5920	5581.2259	0.0000	0.0000	0.0000	0.0000	9445.0876	14581.0624	19451.2491	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 108125.5958

Space heating per m2 (98c) / (4) = 52.8962 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	19103.3065	15038.7732	15418.2198	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5307	0.6316	0.5643	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	10137.9997	9498.6375	8700.2220	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	10283.2373	9824.1785	8868.6961	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	104.5711	242.2025	125.3448	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		1.0000	(105)
Intermittency factor (Table 10b)													
	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	26.1428	60.5506	31.3362	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												118.0296	(107)
Energy for space heating												52.8962	(99)
Energy for space cooling												0.0577	(108)
Total												52.9539	(109)
Fabric Energy Efficiency (TFEE)												53.0	(109)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200	(1a)	x 3.6000	(2a) =	2893.3920	(1a) -
Ground floor	427.1700	(1b)	x 3.9000	(2b) =	1665.9630	(1b) -
First floor	406.6100	(1c)	x 3.9000	(2c) =	1585.7790	(1c) -
Second floor	406.6100	(1d)	x 2.1700	(2d) =	882.3437	(1d) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0750	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750	(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													
	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881	(22b)
Balanced mechanical ventilation with heat recovery													
If mechanical ventilation												0.5000	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.5000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												72.8000	(23c)
Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241	(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	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.1200	9.8570
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3 Sill	101.8400	0.0400	4.0736
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 245.3177 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 816.3128 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1353.4669	1349.1186	1344.7704	1323.0291	1318.6808	1296.9396	1296.9396	1292.5913	1305.6361	1318.6808	1327.3773	1336.0738	(39)

Average = Sum(39)m / 12 = 1321.9420

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6621	0.6600	0.6579	0.6472	0.6451	0.6345	0.6345	0.6323	0.6387	0.6451	0.6494	0.6536	(40)
HLP (average)												0.6467	
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 5.3993 (42)

Hot water usage for mixer showers

114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)

Hot water usage for baths

49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)

Hot water usage for other uses

69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

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

55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.2000 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.6480 (55)

Total storage loss

20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(56)

If cylinder contains dedicated solar storage

20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(57)
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)
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)

Primary loss

Combi loss

Total heat required for water heating calculated for each month

390.9108	344.4357	362.9067	312.1096	297.7699	263.1362	256.0254	269.1513	275.3613	313.2372	340.6059	385.7466	(62)
-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(63a)

WWHRS

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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
									Total per year (kWh/year) = Sum(64)m =			2884.6349	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
								Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =				0.0000	(64a)
Heat gains from water heating, kWh/month													
	123.2986	108.4920	113.9872	97.3126	92.3292	81.0290	78.4492	82.8135	85.0938	97.4721	106.7877	121.5815	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(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)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	165.7239	161.4464	153.2086	135.1564	124.0984	112.5403	105.4425	111.3085	118.1859	131.0109	148.3162	163.4160	(72)
Total internal gains													
	2732.5431	2728.4266	2629.6675	2454.6668	2262.2873	2093.6196	1995.7216	2001.4267	2098.8254	2268.5989	2467.2257	2639.4350	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	4021.2295	5050.6681	6096.0626	7154.5858	7838.5901	7751.4662	7400.9061	6744.3254	5996.4197	4917.7956	4035.1070	3725.8988	(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	104.8804	105.2184	105.5586	107.2932	107.6470	109.4516	109.4516	109.8198	108.7225	107.6470	106.9418	106.2457	
alpha	7.9920	8.0146	8.0372	8.1529	8.1765	8.2968	8.2968	8.3213	8.2482	8.1765	8.1295	8.0830	
util living area													
	1.0000	1.0000	0.9999	0.9992	0.9906	0.9204	0.7486	0.8287	0.9881	0.9999	1.0000	1.0000	(86)
Living	20.1589	20.2412	20.3822	20.5782	20.7670	20.9118	20.9553	20.9471	20.8285	20.5809	20.3378	20.1520	
Non living	19.3421	19.4493	19.6318	19.8913	20.1331	20.3113	20.3477	20.3449	20.2160	19.8965	19.5814	19.3397	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	26	30	31	
16 / 9	0	0	0	0	8	0	0	0	0	5	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	20.7931	20.9118	20.9553	20.9471	20.8285	20.9617	21.0000	21.0000	(87)
Th 2	20.3744	20.3763	20.3782	20.3877	20.3896	20.3991	20.3991	20.4010	20.3953	20.3896	20.3858	20.3820	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9989	0.9854	0.8785	0.6580	0.7454	0.9788	0.9998	1.0000	1.0000	(89)
MIT 2	20.3744	20.3763	20.3782	20.3877	20.1701	20.3113	20.3477	20.3449	20.2160	20.3545	20.3858	20.3820	(90)
Living area fraction									fLA = Living area / (4) =			0.2022	(91)
MIT	20.5009	20.5024	20.5039	20.5115	20.2961	20.4327	20.4706	20.4667	20.3399	20.4773	20.5100	20.5070	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.5009	20.5024	20.5039	20.5115	20.2961	20.4327	20.4706	20.4667	20.3399	20.4773	20.5100	20.5070	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9989	0.9844	0.8812	0.6693	0.7554	0.9776	0.9998	1.0000	1.0000	(94)
Useful gains	4021.2253	5050.6268	6095.5860	7147.0518	7715.9717	6830.8665	4953.6273	5094.9749	5862.1881	4916.7309	4035.0891	3725.8969	(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													
	21927.4146	21049.5350	18832.0906	15362.3623	11335.5035	7564.7088	5019.9013	5256.5606	8147.0388	13024.9721	17800.1221	21787.3141	(97)
Space heating kWh													

	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944 (98a)
Space heating requirement - total per year (kWh/year)												71538.4356
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												
	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												71538.4356
Space heating per m2											(98c) / (4) =	34.9974 (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 %)	167.3025 (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													
	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944	(98)
Space heating efficiency (main heating system 1)													
	167.3025	167.3025	167.3025	167.3025	167.3025	0.0000	0.0000	0.0000	0.0000	167.3025	167.3025	167.3025	(210)
Space heating fuel (main heating system)													
	7962.9420	6426.2418	5663.9660	3535.5251	1609.6179	0.0000	0.0000	0.0000	0.0000	3605.7618	5923.8930	8031.9724	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
Efficiency of water heater													
(217)m	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	(217)
Fuel for water heating, kWh/month													
	91.0279	80.1028	84.5773	73.6625	70.8064	63.1945	62.1663	65.1366	66.3559	74.6675	80.1330	89.9909	(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	1070.3984	966.8115	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-639.2905	-947.8961	-1402.9678	-1543.9993	-1470.6525	-1053.8776	-1052.3590	-1003.9758	-905.0030	-1044.8657	-710.9665	-548.0418	(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	42759.9200 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	319.8676
Water heating fuel used	901.8217 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)	
mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
Total electricity for the above, kWh/year	12603.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-12323.8956 (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	45363.0855 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	42759.9200	16.4900	7051.1108	(240)
Total CO2 associated with community systems			0.0000	(473)

Water heating (other fuel)	901.8217	16.4900	148.7104	(247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(247a)
Pumps, fans and electric keep-hot	12603.0785	16.4900	2078.2476	(249)
Energy for lighting	1422.1609	16.4900	234.5143	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12323.8956	16.4900	-2032.2104	
PV Unit electricity exported	0.0000	5.5900	0.0000	
Total			-2032.2104	(252)
Total energy cost			7480.3728	(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] =	1.2890	(257)
SAP value		79.1048	
SAP rating (Section 12)		79	(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	42759.9200	0.1545	6604.8976	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	901.8217	0.1411	127.2724	(264)
Space and water heating			6732.1701	(265)
Pumps, fans and electric keep-hot	12603.0785	0.1387	1748.2024	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12323.8956	0.1372	-1690.3611	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1690.3611	(269)
Total CO2, kg/year			6995.2731	(272)
CO2 emissions per m2			3.4200	(273)
EI value			95.5131	
EI rating			96	(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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(5)

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2. Ventilation rate

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	m3 per hour		
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	

Pressure Test Method												Blower Door	
Measured/design AP50												1.5000	(17)
Infiltration rate												0.0750	(18)
Number of sides sheltered												0	(19)
Shelter factor								(20) = 1 - [0.075 x (19)] =				1.0000	(20)
Infiltration rate adjusted to include shelter factor								(21) = (18) x (20) =				0.0750	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.0000	4.8000	4.8000	4.3000	4.3000	3.9000	4.0000	4.0000	4.1000	4.4000	4.3000	4.7000	(22)
Wind factor	1.2500	1.2000	1.2000	1.0750	1.0750	0.9750	1.0000	1.0000	1.0250	1.1000	1.0750	1.1750	(22a)
Adj infilt rate	0.0938	0.0900	0.0900	0.0806	0.0806	0.0731	0.0750	0.0750	0.0769	0.0825	0.0806	0.0881	(22b)

Balanced mechanical ventilation with heat recovery		
If mechanical ventilation	0.5000	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2298	0.2260	0.2260	0.2166	0.2166	0.2091	0.2110	0.2110	0.2129	0.2185	0.2166	0.2241	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.1200	9.8570
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3 Sill	101.8400	0.0400	4.0736
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	245.3177	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	816.3128	(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	532.8058	524.1093	524.1093	502.3680	502.3680	484.9750	489.3233	489.3233	493.6715	506.7163	502.3680	519.7610	(38)
Heat transfer coeff	1349.1186	1340.4221	1340.4221	1318.6808	1318.6808	1301.2878	1305.6361	1305.6361	1309.9843	1323.0291	1318.6808	1336.0738	(39)
Average = Sum(39)m / 12 =												1322.3044	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6600	0.6557	0.6557	0.6451	0.6451	0.6366	0.6387	0.6387	0.6409	0.6472	0.6451	0.6536	(40)
HLP (average)												0.6469	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy	5.3993	(42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090	(42a)
Hot water usage for baths	49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016	(42b)
Hot water usage for other uses	69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240	(42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)
Energy content (annual)										Total = Sum(45)m =		3574.8767	
Distribution loss (46)m = 0.15 x (45)m													
	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)
Water storage loss:													
Store volume												180.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.6480	(55)
Total storage loss													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(56)
If cylinder contains dedicated solar storage													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(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													
	390.9108	344.4357	362.9067	312.1096	297.7699	263.1362	256.0254	269.1513	275.3613	313.2372	340.6059	385.7466	(62)
WWHRS	-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
										Total per year (kWh/year) = Sum(64)m =		2884.6349	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month													
	123.2986	108.4920	113.9872	97.3126	92.3292	81.0290	78.4492	82.8135	85.0938	97.4721	106.7877	121.5815	(65)

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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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(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)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	165.7239	161.4464	153.2086	135.1564	124.0984	112.5403	105.4425	111.3085	118.1859	131.0109	148.3162	163.4160	(72)
Total internal gains													
	2732.5431	2728.4266	2629.6675	2454.6668	2262.2873	2093.6196	1995.7216	2001.4267	2098.8254	2268.5989	2467.2257	2639.4350	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	11.5821	0.5000	0.7000	0.7700	120.7687	(74)
East	40.1700	21.5869	0.5000	0.7000	0.7700	210.3266	(76)
South	55.6800	49.2853	0.5000	0.7000	0.7700	665.6074	(78)
West	61.6900	21.5869	0.5000	0.7000	0.7700	323.0034	(80)
North	7.4700	29.0000	0.5000	0.7000	1.0000	68.2384	(82)

Solar gains	1387.9446	2248.1173	3375.6619	4736.8329	5479.0990	5938.9484	5657.8466	5114.8339	4171.7170	2803.1466	1744.3685	1148.4828	(83)
Total gains	4120.4877	4976.5439	6005.3294	7191.4997	7741.3862	8032.5680	7653.5682	7116.2607	6270.5424	5071.7456	4211.5943	3787.9178	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	105.2184	105.9010	105.9010	107.6470	107.6470	109.0858	108.7225	108.7225	108.3617	107.2932	107.6470	106.2457	
alpha	8.0146	8.0601	8.0601	8.1765	8.1765	8.2724	8.2482	8.2482	8.2241	8.1529	8.1765	8.0830	
util living area													
	1.0000	1.0000	0.9999	0.9985	0.9775	0.7786	0.4940	0.5664	0.9524	0.9996	1.0000	1.0000	(86)
Living	20.2069	20.2727	20.4330	20.6389	20.8327	20.9514	20.9620	20.9615	20.8973	20.6486	20.4018	20.2009	
Non living	19.4052	19.4929	19.6986	19.9707	20.2140	20.3431	20.3468	20.3467	20.2935	19.9817	19.6667	19.4024	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	26	30	31	
16 / 9	0	0	0	0	8	0	0	0	0	5	0	0	

MIT	21.0000	21.0000	21.0000	21.0000	20.8515	20.9514	20.9620	20.9615	20.8973	20.9679	21.0000	21.0000 (87)
Th 2	20.3763	20.3801	20.3801	20.3896	20.3896	20.3972	20.3953	20.3953	20.3934	20.3877	20.3896	20.3820 (88)
util rest of house	1.0000	1.0000	0.9999	0.9977	0.9644	0.6994	0.3914	0.4574	0.9171	0.9993	1.0000	1.0000 (89)
MIT 2	20.3763	20.3801	20.3801	20.3896	20.2393	20.3431	20.3468	20.3467	20.2935	20.3588	20.3896	20.3820 (90)
Living area fraction									fLA = Living area / (4) =			0.2022 (91)
MIT	20.5024	20.5055	20.5055	20.5130	20.3631	20.4661	20.4712	20.4710	20.4156	20.4820	20.5130	20.5070 (92)
Temperature adjustment												0.0000
adjusted MIT	20.5024	20.5055	20.5055	20.5130	20.3631	20.4661	20.4712	20.4710	20.4156	20.4820	20.5130	20.5070 (93)

---

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9979	0.9637	0.7090	0.4044	0.4712	0.9188	0.9993	1.0000	1.0000	(94)
Useful gains	4120.4803	4976.4980	6004.6382	7176.3554	7460.0069	5695.4342	3094.8726	3353.2029	5761.2102	5068.4251	4211.5499	3787.9144	(95)
Ext temp.	5.0000	5.4000	7.4000	9.9000	13.0000	16.0000	18.1000	17.9000	15.3000	11.7000	8.0000	5.0000	(96)
Heat loss rate W	20914.6231	20247.6879	17566.8437	13995.1885	9709.6313	5811.6954	3095.9285	3356.8139	6701.4189	11618.7847	16500.6821	20718.4550	(97)
Space heating kWh	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98a)
Space heating requirement - total per year (kWh/year)												64260.6082	
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	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												64260.6082	
Space heating per m2										(98c) / (4) =		31.4370	(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 %)												167.2815	(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	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98)
Space heating efficiency (main heating system 1)	167.2815	167.2815	167.2815	167.2815	167.2815	0.0000	0.0000	0.0000	0.0000	167.2815	167.2815	167.2815	(210)
Space heating fuel (main heating system)	7469.3507	6134.7127	5142.3981	2934.9090	1000.5413	0.0000	0.0000	0.0000	0.0000	2913.3332	5289.3925	7530.0149	(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	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
Efficiency of water heater												319.8677	(216)
(217)m	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	(217)
Fuel for water heating, kWh/month	91.0279	80.1028	84.5773	73.6625	70.8064	63.1945	62.1663	65.1366	66.3558	74.6674	80.1330	89.9908	(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	1070.3984	966.8115	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-680.0569	-921.8117	-1356.8434	-1493.9913	-1344.8043	-1070.5610	-1068.4531	-1032.9852	-934.1736	-1055.0241	-768.6849	-574.5446	(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												38414.6524	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												319.8677	
Water heating fuel used												901.8213	(219)
Space cooling fuel												0.0000	(221)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)

mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
Total electricity for the above, kWh/year	12603.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-12301.9342 (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	41039.7789 (238)

10a. Fuel costs - using BEDF prices (524)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	38414.6524	21.5100	8262.9917	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	901.8213	21.5100	193.9818	(247)
Energy for instantaneous electric shower(s)	0.0000	21.5100	0.0000	(247a)
Pumps, fans and electric keep-hot	12603.0785	21.5100	2710.9222	(249)
Energy for lighting	1422.1609	21.5100	305.9068	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	21.5100	-2646.1460	
PV Unit electricity exported	0.0000	5.5900	0.0000	
Total			-2646.1460	(252)
Total energy cost			8827.6564	(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	38414.6524	0.1551	5959.9126	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	901.8213	0.1411	127.2724	(264)
Space and water heating			6087.1849	(265)
Pumps, fans and electric keep-hot	12603.0785	0.1387	1748.2024	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	0.1371	-1687.0257	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1687.0257	(269)
Total CO2, kg/year			6353.6233	(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	38414.6524	1.5744	60480.6637	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	901.8213	1.5219	1372.4379	(278)
Space and water heating			61853.1016	(279)
Pumps, fans and electric keep-hot	12603.0785	1.5128	19065.9372	(281)
Energy for lighting	1422.1609	1.5338	2181.3578	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	1.5070	-18539.3183	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-18539.3183	(283)
Total Primary energy kWh/year			64561.0783	(286)

SAP 10 EPC IMPROVEMENTS

GREEN

Current energy efficiency rating:	C 79
Current environmental impact rating:	A 96

N	Solar water heating	SAP increase too small
U	Solar photovoltaic panels	Already installed
V2	Wind turbine	Not applicable

Recommended measures:	SAP change	Cost change	CO2 change

(none)

Measures omitted - SAP change or cost saving too small:
N Solar water heating + 0.0 -£ 21 -12 kg (0.2%)

	Typical annual savings	Energy efficiency	Environmental impact
Recommended measures			
(none)			
Total Savings	£0	0.00 kg/m²	

Potential energy efficiency rating: C 79
Potential environmental impact rating: A 96

Fuel prices for cost data on this page from database revision number 524 TEST (01 Aug 2023)
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	£11474	£11474	£0
Space heating	£10974	£10974	£0
Water heating	£194	£194	£0
Lighting	£306	£306	£0
Generated (PV)	-£2646	-£2646	£0
Total cost of fuels	£8828	£8828	£0
Total cost of uses	£8828	£8828	£0
Delivered energy	20 kWh/m²	20 kWh/m²	0 kWh/m²
Carbon dioxide emissions	6.4 tonnes	6.4 tonnes	0.0 tonnes
CO2 emissions per m²	3 kg/m²	3 kg/m²	0 kg/m²
Primary energy	32 kWh/m²	32 kWh/m²	0 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)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2044.1100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7027.4777	(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	0 * 10	=	0.0000 (7a)
Number of passive vents	0 * 10	=	0.0000 (7b)
Number of flueless gas fires	0 * 40	=	0.0000 (7c)

	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5)	=	0.0000 (8)
Pressure test			Yes
Pressure Test Method			Blower Door
Measured/design AP50			1.5000 (17)
Infiltration rate			0.0750 (18)
Number of sides sheltered			0 (19)
Shelter factor	(20) = 1 - [0.075 x (19)]	=	1.0000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20)	=	0.0750 (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													

	0.0956	0.0938	0.0919	0.0825	0.0806	0.0712	0.0712	0.0694	0.0750	0.0806	0.0844	0.0881 (22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation 0.5000 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.5000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 72.8000 (23c)

Effective ac	0.2316	0.2298	0.2279	0.2185	0.2166	0.2072	0.2072	0.2054	0.2110	0.2166	0.2204	0.2241 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E6	Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24	Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22	Basement floor	28.1060	0.2200	6.1833
E17	Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16	Corner (normal)	207.1440	0.0900	18.6430
E15	Flat roof with parapet	16.9100	0.3000	5.0730
E14	Flat roof	100.4770	0.1600	16.0763
E11	Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9	Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7	Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4	Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5	Ridge (inverted)	30.6370	0.1200	3.6764
E20	Exposed floor (normal)	104.0220	0.3200	33.2870
E5	Ground floor (normal)	16.4920	0.1600	2.6387
R6	Flat ceiling	82.1420	0.1200	9.8570
E1	Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3	Sill	101.8400	0.0400	4.0736
E4	Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 245.3177 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 816.3128 (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	537.1540	532.8058	528.4575	506.7163	502.3680	480.6268	480.6268	476.2785	489.3233	502.3680	511.0645	519.7610	(38)
Heat transfer coeff	1353.4669	1349.1186	1344.7704	1323.0291	1318.6808	1296.9396	1296.9396	1292.5913	1305.6361	1318.6808	1327.3773	1336.0738	(39)

Average = Sum(39)m / 12 = 1321.9420

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6621	0.6600	0.6579	0.6472	0.6451	0.6345	0.6345	0.6323	0.6387	0.6451	0.6494	0.6536	(40)
HLP (average)												0.6467	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3993 (42)

Hot water usage for mixer showers

	114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090 (42a)

Hot water usage for baths

	49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016 (42b)

Hot water usage for other uses

	69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240 (42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)

Energy content (annual) Total = Sum(45)m = 3574.8767

Distribution loss (46)m = 0.15 x (45)m	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488 (46)

Water storage loss:

Store volume 180.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.2000 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55)												0.6480	(55)
Total storage loss													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(56)
If cylinder contains dedicated solar storage													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(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													
	390.9108	344.4357	362.9067	312.1096	297.7699	263.1362	256.0254	269.1513	275.3613	313.2372	340.6059	385.7466	(62)
WWHRS	-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
									Total per year (kWh/year) = Sum(64)m =			2884.6349	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
								Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =				0.0000	(64a)
Heat gains from water heating, kWh/month													
	123.2986	108.4920	113.9872	97.3126	92.3292	81.0290	78.4492	82.8135	85.0938	97.4721	106.7877	121.5815	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(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)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	165.7239	161.4464	153.2086	135.1564	124.0984	112.5403	105.4425	111.3085	118.1859	131.0109	148.3162	163.4160	(72)
Total internal gains													
	2732.5431	2728.4266	2629.6675	2454.6668	2262.2873	2093.6196	1995.7216	2001.4267	2098.8254	2268.5989	2467.2257	2639.4350	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	10.6334	0.5000	0.7000	0.7700	110.8768	(74)
East	40.1700	19.6403	0.5000	0.7000	0.7700	191.3597	(76)
South	55.6800	46.7521	0.5000	0.7000	0.7700	631.3952	(78)
West	61.6900	19.6403	0.5000	0.7000	0.7700	293.8755	(80)
North	7.4700	26.0000	0.5000	0.7000	1.0000	61.1793	(82)

Solar gains	1288.6865	2322.2415	3466.3951	4699.9190	5576.3028	5657.8466	5405.1845	4742.8986	3897.5943	2649.1967	1567.8813	1086.4638	(83)
Total gains	4021.2295	5050.6681	6096.0626	7154.5858	7838.5901	7751.4662	7400.9061	6744.3254	5996.4197	4917.7956	4035.1070	3725.8988	(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	104.8804	105.2184	105.5586	107.2932	107.6470	109.4516	109.4516	109.8198	108.7225	107.6470	106.9418	106.2457	
alpha	7.9920	8.0146	8.0372	8.1529	8.1765	8.2968	8.2968	8.3213	8.2482	8.1765	8.1295	8.0830	
util living area													
	1.0000	1.0000	0.9999	0.9992	0.9906	0.9204	0.7486	0.8287	0.9881	0.9999	1.0000	1.0000	(86)
Living	20.1589	20.2412	20.3822	20.5782	20.7670	20.9118	20.9553	20.9471	20.8285	20.5809	20.3378	20.1520	
Non living	19.3421	19.4493	19.6318	19.8913	20.1331	20.3113	20.3477	20.3449	20.2160	19.8965	19.5814	19.3397	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	26	30	31	
16 / 9	0	0	0	0	8	0	0	0	0	5	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	20.7931	20.9118	20.9553	20.9471	20.8285	20.9617	21.0000	21.0000	(87)
Th 2	20.3744	20.3763	20.3782	20.3877	20.3896	20.3991	20.3991	20.4010	20.3953	20.3896	20.3858	20.3820	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9989	0.9854	0.8785	0.6580	0.7454	0.9788	0.9998	1.0000	1.0000	(89)
MIT 2	20.3744	20.3763	20.3782	20.3877	20.1701	20.3113	20.3477	20.3449	20.2160	20.3545	20.3858	20.3820	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	20.5009	20.5024	20.5039	20.5115	20.2961	20.4327	20.4706	20.4667	20.3399	20.4773	20.5100	20.5070	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.5009	20.5024	20.5039	20.5115	20.2961	20.4327	20.4706	20.4667	20.3399	20.4773	20.5100	20.5070	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9989	0.9844	0.8812	0.6693	0.7554	0.9776	0.9998	1.0000	1.0000	(94)
Useful gains	4021.2253	5050.6268	6095.5860	7147.0518	7715.9717	6830.8665	4953.6273	5094.9749	5862.1881	4916.7309	4035.0891	3725.8969	(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	21927.4146	21049.5350	18832.0906	15362.3623	11335.5035	7564.7088	5019.9013	5256.5606	8147.0388	13024.9721	17800.1221	21787.3141	(97)
Space heating kWh	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944	(98a)
Space heating requirement - total per year (kWh/year)												71538.4356	
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	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												71538.4356	
Space heating per m2											(98c) / (4) =	34.9974	(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 %)	167.3025	(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	13322.2049	10751.2663	9475.9594	5915.0236	2692.9317	0.0000	0.0000	0.0000	0.0000	6032.5314	9910.8238	13437.6944	(98)
Space heating efficiency (main heating system 1)	167.3025	167.3025	167.3025	167.3025	167.3025	0.0000	0.0000	0.0000	0.0000	167.3025	167.3025	167.3025	(210)
Space heating fuel (main heating system)	7962.9420	6426.2418	5663.9660	3535.5251	1609.6179	0.0000	0.0000	0.0000	0.0000	3605.7618	5923.8930	8031.9724	(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	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
Efficiency of water heater												319.8676	(216)
(217)m	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	319.8676	(217)
Fuel for water heating, kWh/month	91.0279	80.1028	84.5773	73.6625	70.8064	63.1945	62.1663	65.1366	66.3559	74.6675	80.1330	89.9909	(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	1070.3984	966.8115	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-639.2905	-947.8961	-1402.9678	-1543.9993	-1470.6525	-1053.8776	-1052.3590	-1003.9758	-905.0030	-1044.8657	-710.9665	-548.0418	(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	42759.9200	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	319.8676	
Water heating fuel used	901.8217	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)		
mechanical ventilation fans (SFP = 1.4700)	12603.0785	(230a)
Total electricity for the above, kWh/year	12603.0785	(231)
Electricity for lighting (calculated in Appendix L)	1422.1609	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-12323.8956	(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	45363.0855	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	42759.9200	16.4900	7051.1108	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	901.8217	16.4900	148.7104	(247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(247a)
Pumps, fans and electric keep-hot	12603.0785	16.4900	2078.2476	(249)
Energy for lighting	1422.1609	16.4900	234.5143	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12323.8956	16.4900	-2032.2104	
PV Unit electricity exported	0.0000	5.5900	0.0000	
Total			-2032.2104	(252)
Total energy cost			7480.3728	(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] =	1.2890 (257)
SAP value		79.1048
SAP rating (Section 12)		79 (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	42759.9200	0.1545	6604.8976	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	901.8217	0.1411	127.2724	(264)
Space and water heating			6732.1701	(265)
Pumps, fans and electric keep-hot	12603.0785	0.1387	1748.2024	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12323.8956	0.1372	-1690.3611	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1690.3611	(269)
Total CO2, kg/year			6995.2731	(272)
CO2 emissions per m2			3.4200	(273)
EI value			95.5131	
EI rating			96	(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)	
Basement floor	803.7200 (1a)	x	3.6000 (2a)	=	2893.3920 (1a)	-
Ground floor	427.1700 (1b)	x	3.9000 (2b)	=	1665.9630 (1b)	-
First floor	406.6100 (1c)	x	3.9000 (2c)	=	1585.7790 (1c)	-
Second floor	406.6100 (1d)	x	2.1700 (2d)	=	882.3437 (1d)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 2044.1100						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		7027.4777	(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	0 * 10 =	0.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.5000	(17)
Infiltration rate		0.0750	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0750	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.0000	4.8000	4.8000	4.3000	4.3000	3.9000	4.0000	4.0000	4.1000	4.4000	4.3000	4.7000	(22)
Wind factor	1.2500	1.2000	1.2000	1.0750	1.0750	0.9750	1.0000	1.0000	1.0250	1.1000	1.0750	1.1750	(22a)
Adj infilt rate	0.0938	0.0900	0.0900	0.0806	0.0806	0.0731	0.0750	0.0750	0.0769	0.0825	0.0806	0.0881	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.8000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2298	0.2260	0.2260	0.2166	0.2166	0.2091	0.2110	0.2110	0.2129	0.2185	0.2166	0.2241	(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	
window (Uw = 1.20)			200.5300	1.1450	229.6145			(27)
Door			4.9400	1.4000	6.9160			(26)
Rooflight			7.4700	1.3258	9.9034			(27a)
Exposed floor			638.5600	0.1100	70.2416			(28)
Ground floor			99.6500	0.1100	10.9615			(28a)
External Wall 1	913.1100	193.8400	719.2700	0.1200	86.3124			(29a)
Sloping wall	219.5600		219.5600	0.1200	26.3472			(29a)
Basement wall	368.0100		368.0100	0.1200	44.1612			(29a)
Exposed wall	92.5800	11.6300	80.9500	0.1200	9.7140			(29a)
Dormer wall	69.8900		69.8900	0.1200	8.3868			(29a)
External Roof 1	602.3000	7.4700	594.8300	0.1100	65.4313			(30)
Dormer roof	27.3200		27.3200	0.1100	3.0052			(30)
Total net area of external elements Aum(A, m2)			3030.9800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		570.9951			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E6 Intermediate floor within a dwelling	212.1260	0.0700	14.8488
E24 Eaves (insulation at ceiling level - inverted)	66.1020	0.2400	15.8645
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	13.9060	1.0000	13.9060
E22 Basement floor	28.1060	0.2200	6.1833
E17 Corner (inverted – internal area greater than external area)	96.6600	-0.0900	-8.6994
E16 Corner (normal)	207.1440	0.0900	18.6430
E15 Flat roof with parapet	16.9100	0.3000	5.0730
E14 Flat roof	100.4770	0.1600	16.0763
E11 Eaves (insulation at rafter level)	76.5200	0.0400	3.0608
R9 Roof to wall (flat ceiling)	68.3970	0.3200	21.8870
R7 Flat ceiling (inverted)	88.8930	0.1200	10.6672
R4 Ridge (vaulted ceiling)	43.4780	0.1200	5.2174
R5 Ridge (inverted)	30.6370	0.1200	3.6764
E20 Exposed floor (normal)	104.0220	0.3200	33.2870
E5 Ground floor (normal)	16.4920	0.1600	2.6387
R6 Flat ceiling	82.1420	0.1200	9.8570
E1 Steel lintel with perforated steel base plate	103.8900	0.5000	51.9450
E3 Sill	101.8400	0.0400	4.0736
E4 Jamb	342.2400	0.0500	17.1120

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		245.3177 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	816.3128 (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	532.8058	524.1093	524.1093	502.3680	502.3680	484.9750	489.3233	489.3233	493.6715	506.7163	502.3680	519.7610	(38)
Heat transfer coeff	1349.1186	1340.4221	1340.4221	1318.6808	1318.6808	1301.2878	1305.6361	1305.6361	1309.9843	1323.0291	1318.6808	1336.0738	(39)
Average = Sum(39)m / 12 =												1322.3044	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6600	0.6557	0.6557	0.6451	0.6451	0.6366	0.6387	0.6387	0.6409	0.6472	0.6451	0.6536	(40)
HLP (average)												0.6469	
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 5.3993 (42)

Hot water usage for mixer showers

	114.7486	113.0242	110.5113	105.7034	102.1553	98.1985	95.9494	98.4432	101.1770	105.4254	110.3366	114.3090 (42a)

Hot water usage for baths

	49.4689	48.7342	47.6996	45.7920	44.3636	42.7798	41.9243	42.9516	44.0702	45.7650	47.7118	49.3016 (42b)

Hot water usage for other uses

	69.9240	67.3813	64.8386	62.2959	59.7532	57.2105	57.2105	59.7532	62.2959	64.8386	67.3813	69.9240 (42c)

Average daily hot water use (litres/day) 215.2270 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	234.1414	229.1396	223.0495	213.7913	206.2721	198.1887	195.0842	201.1480	207.5430	216.0289	225.4297	233.5345	(44)
Energy conte	370.8228	326.2917	342.8187	292.6696	277.6819	243.6962	235.9374	249.0633	255.9213	293.1492	321.1659	365.6586	(45)
Energy content (annual)										Total = Sum(45)m =		3574.8767	
Distribution loss (46)m = 0.15 x (45)m													
	55.6234	48.9438	51.4228	43.9004	41.6523	36.5544	35.3906	37.3595	38.3882	43.9724	48.1749	54.8488	(46)
Water storage loss:													
Store volume												180.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2000	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.6480	(55)
Total storage loss													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(56)
If cylinder contains dedicated solar storage													
	20.0880	18.1440	20.0880	19.4400	20.0880	19.4400	20.0880	20.0880	19.4400	20.0880	19.4400	20.0880	(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													
	390.9108	344.4357	362.9067	312.1096	297.7699	263.1362	256.0254	269.1513	275.3613	313.2372	340.6059	385.7466	(62)
WWHRS	-99.7421	-88.2127	-92.3713	-76.4871	-71.2832	-60.9975	-57.1755	-60.8004	-63.1104	-74.4002	-84.2864	-97.8950	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
										Total per year (kWh/year) = Sum(64)m =		2884.6349	(64)
Electric shower(s)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month													
	123.2986	108.4920	113.9872	97.3126	92.3292	81.0290	78.4492	82.8135	85.0938	97.4721	106.7877	121.5815	(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	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	323.9564	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	201.3216	178.8121	145.4197	110.0921	82.2951	69.4770	75.0724	97.5819	130.9742	166.3019	194.0988	206.9169	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	2184.7172	2207.3878	2150.2587	2028.6379	1875.1134	1730.8220	1634.4265	1611.7559	1668.8849	1790.5058	1944.0303	2088.3217	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	72.7949	(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)													
	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	-215.9709	(71)
Water heating gains (Table 5)													
	165.7239	161.4464	153.2086	135.1564	124.0984	112.5403	105.4425	111.3085	118.1859	131.0109	148.3162	163.4160	(72)
Total internal gains													
	2732.5431	2728.4266	2629.6675	2454.6668	2262.2873	2093.6196	1995.7216	2001.4267	2098.8254	2268.5989	2467.2257	2639.4350	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	42.9900	11.5821	0.5000	0.7000	0.7700	120.7687	(74)
East	40.1700	21.5869	0.5000	0.7000	0.7700	210.3266	(76)
South	55.6800	49.2853	0.5000	0.7000	0.7700	665.6074	(78)
West	61.6900	21.5869	0.5000	0.7000	0.7700	323.0034	(80)
North	7.4700	29.0000	0.5000	0.7000	1.0000	68.2384	(82)

Solar gains	1387.9446	2248.1173	3375.6619	4736.8329	5479.0990	5938.9484	5657.8466	5114.8339	4171.7170	2803.1466	1744.3685	1148.4828	(83)
Total gains	4120.4877	4976.5439	6005.3294	7191.4997	7741.3862	8032.5680	7653.5682	7116.2607	6270.5424	5071.7456	4211.5943	3787.9178	(84)

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7. Mean internal temperature (heating season)

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

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

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

tau	105.2184	105.9010	105.9010	107.6470	107.6470	109.0858	108.7225	108.7225	108.3617	107.2932	107.6470	106.2457	
alpha	8.0146	8.0601	8.0601	8.1765	8.1765	8.2724	8.2482	8.2482	8.2241	8.1529	8.1765	8.0830	
util living area													
	1.0000	1.0000	0.9999	0.9985	0.9775	0.7786	0.4940	0.5664	0.9524	0.9996	1.0000	1.0000	(86)
Living	20.2069	20.2727	20.4330	20.6389	20.8327	20.9514	20.9620	20.9615	20.8973	20.6486	20.4018	20.2009	
Non living	19.4052	19.4929	19.6986	19.9707	20.2140	20.3431	20.3468	20.3467	20.2935	19.9817	19.6667	19.4024	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	26	30	31	
16 / 9	0	0	0	0	8	0	0	0	0	5	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	20.8515	20.9514	20.9620	20.9615	20.8973	20.9679	21.0000	21.0000	(87)
Th 2	20.3763	20.3801	20.3801	20.3896	20.3896	20.3972	20.3953	20.3953	20.3934	20.3877	20.3896	20.3820	(88)
util rest of house													
	1.0000	1.0000	0.9999	0.9977	0.9644	0.6994	0.3914	0.4574	0.9171	0.9993	1.0000	1.0000	(89)
MIT 2	20.3763	20.3801	20.3801	20.3896	20.2393	20.3431	20.3468	20.3467	20.2935	20.3588	20.3896	20.3820	(90)
Living area fraction										fLA = Living area / (4) =		0.2022	(91)
MIT	20.5024	20.5055	20.5055	20.5130	20.3631	20.4661	20.4712	20.4710	20.4156	20.4820	20.5130	20.5070	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.5024	20.5055	20.5055	20.5130	20.3631	20.4661	20.4712	20.4710	20.4156	20.4820	20.5130	20.5070	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	1.0000	0.9999	0.9979	0.9637	0.7090	0.4044	0.4712	0.9188	0.9993	1.0000	1.0000	(94)
Useful gains	4120.4803	4976.4980	6004.6382	7176.3554	7460.0069	5695.4342	3094.8726	3353.2029	5761.2102	5068.4251	4211.5499	3787.9144	(95)
Ext temp.	5.0000	5.4000	7.4000	9.9000	13.0000	16.0000	18.1000	17.9000	15.3000	11.7000	8.0000	5.0000	(96)
Heat loss rate W													
	20914.6231	20247.6879	17566.8437	13995.1885	9709.6313	5811.6954	3095.9285	3356.8139	6701.4189	11618.7847	16500.6821	20718.4550	(97)
Space heating kWh													
	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98a)
Space heating requirement - total per year (kWh/year)												64260.6082	
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													
	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												64260.6082	
Space heating per m2											(98c) / (4) =	31.4370	(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 %)	167.2815	(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													
	12494.8422	10262.2396	8602.2809	4909.5599	1673.7206	0.0000	0.0000	0.0000	0.0000	4873.4675	8848.1752	12596.3222	(98)
Space heating efficiency (main heating system 1)													
	167.2815	167.2815	167.2815	167.2815	167.2815	0.0000	0.0000	0.0000	0.0000	167.2815	167.2815	167.2815	(210)
Space heating fuel (main heating system)													
	7469.3507	6134.7127	5142.3981	2934.9090	1000.5413	0.0000	0.0000	0.0000	0.0000	2913.3332	5289.3925	7530.0149	(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													
	291.1687	256.2230	270.5354	235.6225	226.4867	202.1386	198.8499	208.3509	212.2509	238.8370	256.3195	287.8516	(64)
Efficiency of water heater												319.8677	(216)
(217)m	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	319.8677	(217)
Fuel for water heating, kWh/month													
	91.0279	80.1028	84.5773	73.6625	70.8064	63.1945	62.1663	65.1366	66.3558	74.6674	80.1330	89.9908	(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	1070.3984	966.8115	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	1070.3984	1035.8695	1070.3984	1035.8695	1070.3984	(231)
Lighting	176.2156	141.3667	127.2850	93.2545	72.0324	58.8511	65.7104	85.4129	110.9429	145.5630	164.4131	181.1132	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-680.0569	-921.8117	-1356.8434	-1493.9913	-1344.8043	-1070.5610	-1068.4531	-1032.9852	-934.1736	-1055.0241	-768.6849	-574.5446	(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	38414.6524 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	319.8677
Water heating fuel used	901.8213 (219)
Space cooling fuel	0.0000 (221)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)	
mechanical ventilation fans (SFP = 1.4700)	12603.0785 (230a)
Total electricity for the above, kWh/year	12603.0785 (231)
Electricity for lighting (calculated in Appendix L)	1422.1609 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-12301.9342 (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	41039.7789 (238)

10a. Fuel costs - using BEDF prices (524)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	38414.6524	21.5100	8262.9917	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	901.8213	21.5100	193.9818	(247)
Energy for instantaneous electric shower(s)	0.0000	21.5100	0.0000	(247a)
Pumps, fans and electric keep-hot	12603.0785	21.5100	2710.9222	(249)
Energy for lighting	1422.1609	21.5100	305.9068	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	21.5100	-2646.1460	
PV Unit electricity exported	0.0000	5.5900	0.0000	
Total			-2646.1460	(252)
Total energy cost			8827.6564	(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	38414.6524	0.1551	5959.9126	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	901.8213	0.1411	127.2724	(264)
Space and water heating			6087.1849	(265)
Pumps, fans and electric keep-hot	12603.0785	0.1387	1748.2024	(267)
Energy for lighting	1422.1609	0.1443	205.2618	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	0.1371	-1687.0257	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1687.0257	(269)
Total CO2, kg/year			6353.6233	(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	38414.6524	1.5744	60480.6637	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	901.8213	1.5219	1372.4379	(278)
Space and water heating			61853.1016	(279)
Pumps, fans and electric keep-hot	12603.0785	1.5128	19065.9372	(281)
Energy for lighting	1422.1609	1.5338	2181.3578	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-12301.9342	1.5070	-18539.3183	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-18539.3183	(283)
Total Primary energy kWh/year			64561.0783	(286)

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Conclusion

Summary

The proposal comprises demolition of the existing building and construction of a three storey dwelling with associated parking and landscaping. The development is located in the London Borough of Haringey with a total GIA of approximately 2739 sqm.

The scheme complies with the 2021 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- New build CO_2 emissions – The actual CO_2 Dwelling Emissions Rate (DER) is no greater than the notional building CO_2 Target Emissions Rate (TER).
- New dwelling Fabric efficiency – The Dwelling Fabric Energy Efficiency (DFEE) is not greater than the Target Fabric Energy Efficiency (TFEE).
- New build Primary energy – The Dwelling Primary Energy Rate (DPER) is no greater than the Target Primary Energy Rate (TPER).

In addition, the CO_2 emissions of the scheme have been calculated using the SAP 10.2 carbon emission factors, and the scheme can achieve:

- An on-site CO_2 reduction of 66.2% beyond Building Regulations through energy efficiency measures and inclusion of renewable technologies (Ground Source Heat Pump and PV panels)
- The development achieves 9.0% CO_2 improvement through energy efficiency measures, 'Be Lean' stage
- A further improvement of 57.1% CO_2 has been achieved through renewable technologies 'Be Green' stage (Ground Source Heat Pumps and PV panels)
- Overall, the scheme achieves an improvement of 66.2% through measures on-site
- Zero-carbon target can be achieved through a cash in lieu contribution to the borough's carbon offset fund. The carbon offset payment cost has been calculated as £18,795.

The scheme achieves a minimum on-site CO_2 reduction of 66.2% beyond 2021 Building Regulations. The scheme would achieve a higher reduction when compared with total emissions based on 2006 Building Regulations (policy requirement) and therefore, meet and exceed the 25% carbon reduction target set in the Haringey's Local Plan Strategic Policies 2013-2026.

However, it is worth noting that the SAP database, presents several limitations, such as underestimating the unregulated energy demand, lacking ventilation units in the SAP databased that are capable of serving more than seven wet rooms, limitation on the available capacity for the heat pump (the database's largest Ground Source Heat Pump (GSHP) is 22kW, which is significantly lower than the probable requirement of 130kW), and the maximum solar PV battery capacity being 15kW (which is a tenth of the likely need).
These constraints result in the inability to accurately capture the carbon reduction potential that the design has to offer.
Despite these limitations, the proposal under consideration is anticipated to outperform SAP results. However, this expectation necessitates verification through more advanced modelling software in subsequent stages, focusing on dynamic simulations like thermal comfort, Computational Fluid Dynamics, and operational energy, which are not equivalent to the SAP EPC conventions and will be explored during detailed design stages alongside a Net-Zero certification of the building.