Innisfree, East Horsley

Energy and Sustainability Statement

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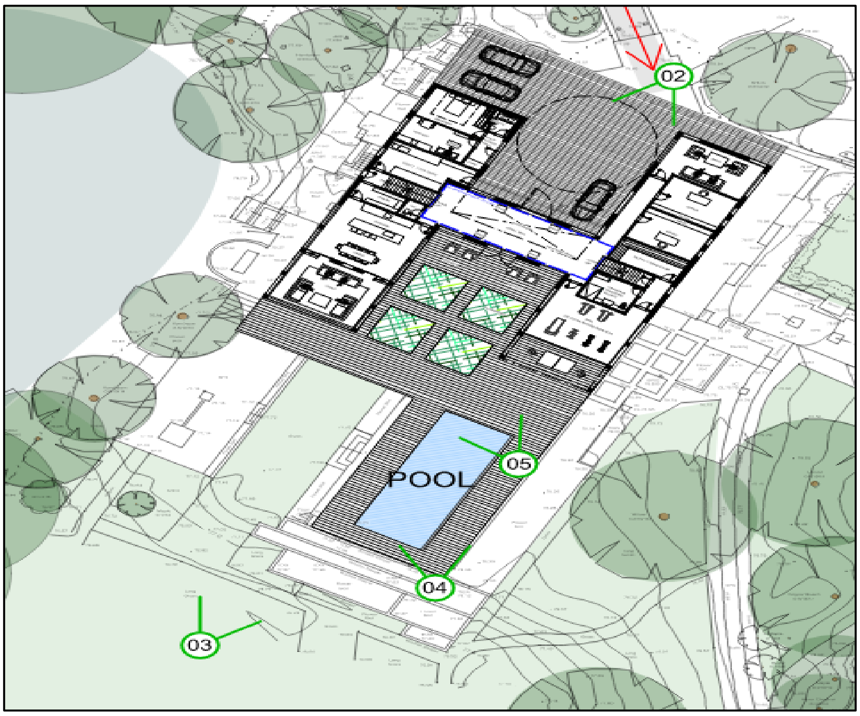

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Cudd Bentley Consulting

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RECORD OF REVISIONS.

Date.	Revision.	Description of change.
01/02/2024	1	Issued

1 EXECUTIVE SUMMARY

This report considers the energy and sustainability measures to be incorporated within the proposed development in East Horsley. This document reviews the requirements at both national and local level, as set out in the National Planning Policy Framework (2023), the Guildford Local Plan: Strategy and Site (Adopted April 2019) and the Guildford Local Plan: Development Management Policies (Adopted March 2023)

The recommended sustainability features for the development, resulting from a dynamic energy model, will allow for an 100.37% reduction in carbon emission from a base Part L 2021 compliant build, this is anticipated through the incorporation of water Source Heat Pumps and passive energy efficiency measures. The sustainability features used will allow for over 100% regulated energy used on site sourced from renewable means such as PV and WSHP. A total of 79.13 kWp PV has been proposed for the development, which is in line with the local planning policy. The energy and carbon savings are to be achieved through passive design, energy efficient measures incorporating design features such as energy efficient lighting, submetering of relevant areas, upgrading of 'U' values and occupancy sensing in relative areas, as well as the incorporation of Water Source Heat Pumps. The proposed heating source for this development is 100% electric through use of WSHP. To reduce the energy demand of the development as well as help to conserve water resources within the local area, it is anticipated that the fit-out works will provide for sanitary fittings which will be water efficient through measures such as dual flush toilets and low flow taps.

The development is located within East Horsley and as such is in proximity to public transport nodes, as well as a range of primary local amenities such as food outlets. These features allow for the reduction of car-based travel and transport related pollution.

The incorporation of these sustainability measures allows for the proposed development to be deemed sustainable whilst targeting compliance with local and national policy.

2 INTRODUCTION

This report has been prepared by Cudd Bentley Consulting Ltd, to investigate the issues of energy and sustainability surrounding the development in East Horsley.

Government policies now require significant energy reductions from proposed buildings. Building a greener future sets a planned trajectory outlined via Part L 2021 of the Building Regulations. These commitments have been the key focus point in addressing policies and strategies to reduce energy use and carbon emissions through energy efficiency and low or zero carbon technologies (LZC).

The recommended strategy takes into consideration the site layout and requirements for the building to produce a design that incorporates the most appropriate technologies available to the site that are commercially viable, whilst targeting compliance with all policies applicable to this development.

The proposed development in East Horsley is a residential dwelling. A detailed overview of the scheme is presented in the Design & Access Statement.

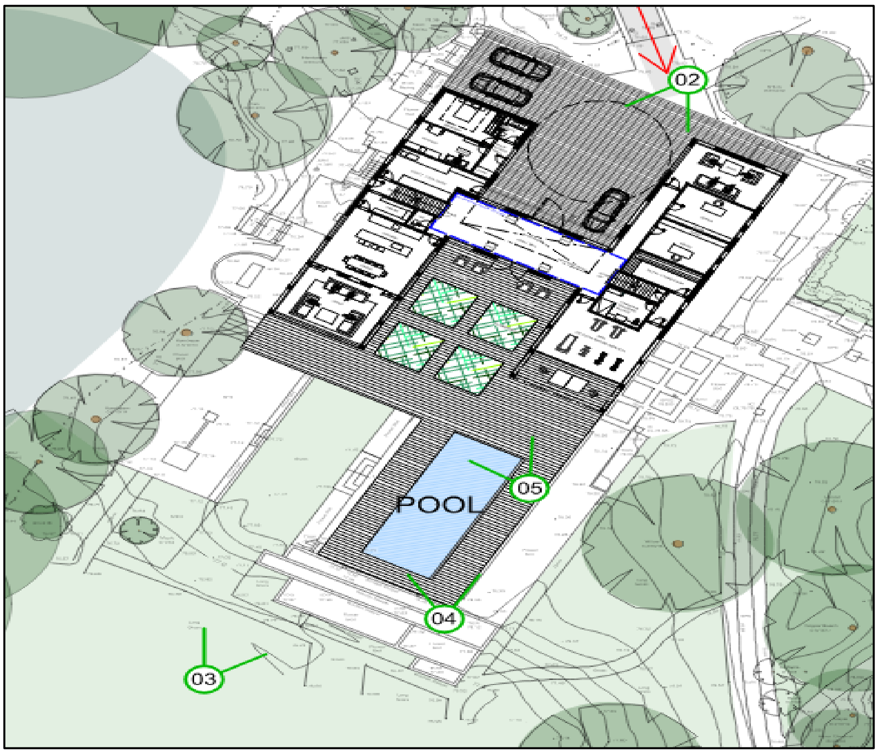

Figure 2.1: Proposed Site Plan

3 DRIVERS OF SUSTAINABILITY

The term Sustainable Development, is defined by the Department for the Environment, Food and Rural Affairs as:

'… making sure people throughout the world can satisfy their basic needs now, while making sure that future generations can also look forward to the same quality of life. It recognises that the "three pillars" – economy, society and environment – are interconnected.'

United Nations Framework Convention on Climate Change

To achieve this objective of sustainable development in any industry, sector strict regulations have been put in place that have filtered down through EU Directives from the European Climate Change Programme, to National UK Acts such as the Climate Change Act 2008, to Local Policy in the form of Core Strategies. However, there are larger drivers behind the concept of sustainable development.

Kyoto Protocol

In 1997, the Kyoto Protocol was adopted as part of the United Nations Framework Convention on Climate Change, to which the UK is a signatory. The key feature of the protocol was the binding targets that were set for industrialised countries to reduce their Green House Gas emissions by 12.5% below 1990 levels by 2008-2012.

Cancun Agreements

Since the initial adoption of the Kyoto Protocol, extensive research has been put forward as to the causes and markers of climate change from the Intergovernmental Panel on Climate Change, which has led to new targets and objectives being made. In 2012, the international community met to discuss new directions for responding to climate change by adopting new agreements. The key objectives of the Cancun Agreements are:

- *Establish clear objectives for reducing human-generated greenhouse gas emissions over time to keep the global average temperature rise below two degrees.*
- *Mobilise the development and transfer of clean technology to boost efforts to address climate change, getting it to the right place at the right time and for the best effect.*
- *Assist the particularly vulnerable people in the world to adapt to the inevitable impacts of climate change.*
- *Protect the world's forests, which are a major repository of carbon.*
- *Establish effective institutions and systems which will ensure these objectives are implemented successfully.*

COP21: Paris Global Climate Agreement

In December 2015, a global climate deal was reached in a summit involving all of the world's nations. The targets of this aimed principally to curb the dangerous levels of climate change and drive an increase low-carbon infrastructure investment. Numerous organisations and corporations also committed to helping create a greener future by making their own pledges through the course of the summit. The key elements of the agreement are:

- *To keep global temperatures "well below" 2.0°C above pre-industrial times and "endeavour to limit" them even more, to 1.5C*
- *To limit the amount of greenhouse gases emitted by human activity to the same levels that trees, soil and oceans can absorb naturally, beginning at some point between 2050 and 2100*
- *To review each country's contribution to cutting emissions every five years so they scale up to the challenge*
- *For rich countries to help poorer nations by providing "climate finance" to adapt to climate change and switch to renewable energy.*

BRE’s COP21 Climate Pledge (December 2015)

"We commit to continue to drive best practice and carbon reduction, as we have through the use of BREEAM for the past 25 years. By reaching over 9,000 BREEAM rated buildings we predict emissions savings will be in excess of 900,000 tonnes of CO_2, compared to regulatory minimum performance requirements, by 2020. Saving not only carbon but bringing wider benefits to both the owner and occupiers."

4 NATIONAL POLICY

National Planning Policy

An effective planning system is required to contribute to achieving sustainable development. The ***National Planning Policy Framework*** (NPPF), 2023, outlines what the government deems as sustainable development in England.

Sustainable development is defined as having the following three overarching objectives which are interdependent and need to be pursued in mutually supportive ways: an economic objective, a social objective, and an environmental objective.

1. Economic objective – to help build a strong, responsive, and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation, and improved productivity; and by identifying and coordinating the provision of infrastructure.
2. Social objective – to support strong, vibrant, and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and
3. Environmental objective – to contribute to protecting and enhancing our natural, built, and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

The above objectives can be described as an energy trilemma, this is demonstrated in Figure 4.1 below. Each dimension is dependent on each other, and sustainable development proposals should adhere to each role. This energy statement shall ensure the proposed Development is one that contributes economically, socially, and environmentally in accordance with the NPPF, 2023.

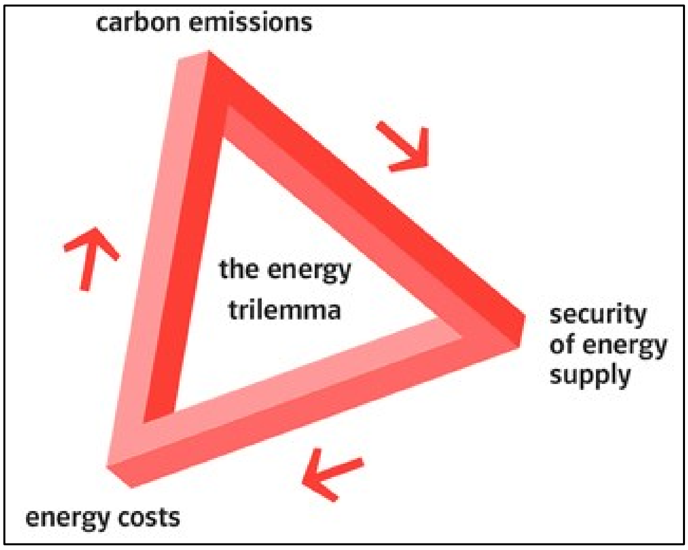

Figure 4.1 The Energy Trilemma

Guidance has been followed from the (NPPF), 2023, to provide an energy strategy which reduces energy use and carbon emissions, in line with best practice. This will provide a balanced scheme which focuses on optimal use of non-renewable resources (energy efficiency measures) whilst providing a renewable energy strategy best suited to the sites and their building uses. Below are some key extracts relevant to the development from Chapter fourteen 'Meeting the Challenge of Climate Change, Flooding & Coastal Change':

<u>Paragraph 158</u>

Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure.

<u>Paragraph 159</u>

New development should be planned for in ways that:

a. avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

b. can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

<u>Paragraph 160</u>

To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a. provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b. consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c. identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for locating potential heat customers and suppliers.

<u>Paragraph 161</u>

Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in local plans or other strategic policies that are being taken forward through neighbourhood planning.

<u>Paragraph 162</u>

In determining planning applications, local planning authorities should expect new development to:

a. comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and

b. take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

<u>Paragraph 163</u>

When determining planning applications for renewable and low carbon development, local planning authorities should:

a. not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

b. approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

5 LOCAL POLICY

This section aims to highlight guidance available and the minimum requirements at local level from Guildford Local Plan, which states the Council's vision, spatial strategy, and policies for the future development of the area.

Guildford Local Plan: Development Management Policies

POLICY D16: Carbon Emissions from Buildings

1) The development of low and zero carbon and decentralised energy, including low carbon heat distribution networks, is strongly supported and encouraged.
2) Where low carbon heat distribution networks already exist, new developments are required to connect to them or be connection-ready unless it can be clearly demonstrated that utilizing a different energy supply would be more sustainable or connection is not feasible.
3) Proposals for development within Heat Priority Areas as shown on the Policies Map and all sufficiently large or intensive developments must demonstrate that low carbon heat networks have been given adequate consideration as the primary source of heat.
4) New buildings must achieve an emission rate no higher than the relevant Target Emission Rate (TER) set out in the Building Regulations (Part L).

POLICY D17: Renewable and Low Carbon Energy Generation and Storage

1) Proposals for renewable and low carbon energy generation and energy storage development, covering both power and heat, will be supported, with strong support for community-led initiatives.
2) Where such development is proposed in the Green Belt, climate change mitigation and other benefits will be taken into account when considering whether very special circumstances exist.
3) Proposals are required to demonstrate that the design of the scheme has sought to minimise visual impacts and that the management of the site will maximise opportunities for biodiversity while avoiding practices that are harmful to biodiversity.
4) For temporary permissions, provision must be made for the decommissioning of the infrastructure and associated works and the full restoration of the site once operation has ceased.

POLICY P11: Sustainable Surface Water Management

All development proposals

1) Drainage schemes are required to intercept as much rainwater and runoff as possible, including runoff from outside the site.
2) Development proposals are required to maximise the use of permeable surfaces across the development site.
3) Drainage schemes are expected to avoid the use of boreholes or other deep structures for the discharge of surface water to ground, except for clean roof water.

POLICY D14: Sustainable and Low Impact Development

Fabric first

1) Development proposals are required to demonstrate how they have followed a 'fabric first' approach in line with the energy hierarchy.

Embodied carbon

2) Development proposals are required to demonstrate that embodied carbon emissions have been minimised by:

a. sourcing materials locally where possible; and
b. taking into account the embodied carbon emissions of materials based on information provided in a respected materials rating database.

Energy improvements

4) Development proposals that will improve the energy efficiency and carbon emission rate of existing buildings to a level significantly better than the Council's adopted standards or national standards for new buildings, whichever is most challenging, are encouraged.

Waste

5) Proposals for major development, and development proposals that involve the demolition of at least one building and/or engineering works that involve the importation or excavation of hard core, soils, sand and other material, are required to submit a Site Waste Management Plan.

POLICY P4: Flooding, flood risk and groundwater protection zones

1) Flood zones in the borough of Guildford are defined based on definitions contained within national planning practice guidance and the Council's Strategic Flood Risk Assessment (Level 1).
2) Development in areas at medium or high risk of flooding, as identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment, including the 'developed' flood zone 3b (functional floodplain), will be permitted provided that:
   a) the vulnerability of the proposed use is appropriate for the level of flood risk on the site
   b) the proposal passes the sequential and exception test (where required) as outlined in the NPPF and Government guidance.
   c) a site–specific flood risk assessment demonstrates that the development, including the access and egress, will be safe for its lifetime, taking into account climate change, without increasing flooding elsewhere, and where possible, will reduce flood risk overall.
   d) the scheme incorporates flood protection, flood resilience and resistance measures appropriate to the character and biodiversity of the area and the specific requirements of the site.
   e) when relevant, appropriate flood warning and evacuation plans are in place and approved.
3) Development proposals in the 'developed' flood zone 3b will also only be approved where the footprint of the proposed building(s) is not greater than that of the existing building(s) and there will be no increase in development vulnerability. Proposals within these areas should facilitate greater floodwater storage.
4) With the exception of the provision of essential infrastructure, 'undeveloped' flood zone 3b will be safeguarded for flood management purposes.
5) All development proposals are required to demonstrate that land drainage will be adequate and that they will not result in an increase in surface water run-off. Proposals should have regard to appropriate mitigation measures identified in the Guildford Surface Water Management Plan or Ash Surface Water Study. Priority will be given to incorporating SuDs (Sustainable Drainage Systems) to manage surface water drainage

POLICY D11: Noise Impacts

1) Development proposals for noise sensitive uses are required to clearly identify any likely adverse noise impacts on the sensitive receptors that are intended to use or occupy the development from existing nearby sources of noise.

2) Development proposals for noise generating uses are required to clearly identify any likely adverse noise impacts arising from the proposed development on existing nearby sensitive receptors, including the natural environment.
3) Where consideration under (1) or (2) indicates the potential for Observed Adverse Effect Levels of noise, planning applications are required to include a Noise Impact Assessment, which considers the relationship in detail.
4) Where evidence of an Observed Adverse Effect Level noise impact exists, as defined in the Noise Exposure Hierarchy, the applicant is required to demonstrate how the proposed development proposal will be designed and implemented in order to:
    a) prevent any present and very disruptive Significant Observed Adverse Effect levels,
    b) avoid any present and disruptive Significant Observed Adverse Effect levels; and
    c) mitigate any present and intrusive Lowest Observed Adverse Effect levels.
5) The applicant proposing the development proposal (or 'agent of change') is responsible for ensuring that:
    a) all potential Observed Adverse Effect Levels of noise, either impacting on or emanating from the proposed development proposal, are identified, and
    b) the prevention, avoidance and/or mitigation measures required to manage those noise impacts are implemented effectively.
6) A Verification Report is required to be submitted to the Council and approved prior to the development's occupation or use, which demonstrates the agreed avoidance and mitigation measures have been implemented effectively.
7) Where there will be an unacceptable adverse effect on sensitive receptors which cannot be adequately prevented, avoided, and/or mitigated, the planning application will be refused.

POLICY P12: Regionally Important Geological / Geomorphological Sites

1) Development proposals that are likely to materially harm the conservation interests of Regionally Important Geological/Geomorphological Sites (RIGS) as shown on the Policies Map, and any unmapped features that meet the definition of a RIGS, are required to demonstrate that the need for the development clearly outweighs the impact on the conservation interests.
2) Development proposals are required to make every effort to prevent harm to the conservation interests of the RIGS through avoidance measures. Where this is not possible, every effort is required be made to minimise harm through mitigation measures. The applicant is required to demonstrate that any necessary avoidance and mitigation measures will be implemented and maintained effectively.

Guildford Local Plan: Strategy and Sites

POLICY D2: Climate Change, sustainable design, construction and energy

Sustainable design and construction

1) Proposals for zero carbon development are strongly supported. Applications for development, including refurbishment, conversion and extensions to existing buildings should include information setting out how sustainable design and construction practice will be incorporated including (where applicable):
    a) the efficient use of mineral resources and the incorporation of a proportion of recycled and/or secondary aggregates
    b) waste minimisation and reusing material derived from excavation and demolition

   c) the use of landform, layout, building orientation, massing and landscaping to reduce energy consumption
   d) water efficiency that meets the highest national standard and
   e) measures that enable sustainable lifestyles for the occupants of the buildings, including electric car charging points.

2) When meeting these requirements, the energy and waste hierarchies should be followed except where it can be demonstrated that greater sustainability can be achieved by utilising measures further down the hierarchy.
3) Major development should include a sustainability statement setting out how the matters in this policy have been addressed. Smaller developments should include information proportionate to the size of the development in the planning application.

6 ENERGY USAGE AND CARBON EMISSIONS

Government policies require significant energy reductions from buildings. Building a Greener Future sets a planned trajectory (delivered via Part L of the building regulations 2021) with an aspiration for all non-domestic new buildings to be zero carbon by 2020. The Climate Change Act (Nov 2008) sets the UK targets of; CO_2 reduction of 26% by 2020 and CO_2 reduction of 80% by 2050.

6.1 POLICY REVIEW

<u>National Planning Policy Framework (2023)</u>

<u>Paragraph 160 – Meeting the Challenge of Climate Change, Flooding and Coastal Change</u>

To help increase the use and supply of renewable and low carbon energy and heat, plans should;

a. provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b. consider identifying suitable areas for renewable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

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<u>Guildford Local Plan: Development Management Policies</u>

<u>POLICY DE16: Carbon Emissions from Buildings</u>

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2) Where low carbon heat distribution networks already exist, new developments are required to connect to them or be connection-ready unless it can be clearly demonstrated that utilizing a different energy supply would be more sustainable or connection is not feasible.
3) Proposals for development within Heat Priority Areas as shown on the Policies Map and all sufficiently large or intensive developments must demonstrate that low carbon heat networks have been given adequate consideration as the primary source of heat.
4) New buildings must achieve an emission rate no higher than the relevant Target Emission Rate (TER) set out in the Building Regulations (Part L).

<u>Policy D17: Renewable and Low Carbon Energy Generation and Storage</u>

1) Proposals for renewable and low carbon energy generation and energy storage development, covering both power and heat, will be supported, with strong support for community-led initiatives.
2) Where such development is proposed in the Green Belt, climate change mitigation and other benefits will be taken into account when considering whether very special circumstances exist.
3) Proposals are required to demonstrate that the design of the scheme has sought to minimise visual impacts and that the management of the site will maximise opportunities for biodiversity while avoiding practices that are harmful to biodiversity.
4) For temporary permissions, provision must be made for the decommissioning of the infrastructure and associated works and the full restoration of the site once operation has ceased.

6.2 DEVELOPEMENT SUSTAINABILITY FEATURES

Energy modelling has been undertaken which adopts the following hierarchy for reducing carbon emissions for the development; Be Lean, Be Clean, Be Green.

The total baseline energy and carbon emissions for the development (built to Part L 2021), taking into account regulated energy demands are:

- *587,191.76 kWh/annum*
- *7.45 Tonnes CO_2/annum*

The primary energy demands of the development will be:

- *Lighting;*
- *General power;*
- *Heating and ventilation;*
- *Cooling*
- *Hot water supply.*

Unregulated energy use is not covered by existing regulations and includes energy consumed by the occupants through activities and appliances; in this case it would typically be small power usage (appliances, computers etc.). The following unregulated energy use for the development was calculated:

- *36,732 kWh/annum*
- *20.10 Tonnes CO_2/annum*

<u>Be Lean</u>

To provide energy and carbon saving further to a base Part L (2021) build; targeting compliance with local and national policies, the following passive design and energy efficiency measures are recommended.

The following 'U' values shall be incorporated within the development, in accordance with Part L1 (2021):

U – Values targeted for the development:

Feature	Applied U – Value for New Build Residential (W/m².K)
External Walls	0.14
Exposed Floors	0.10
Exposed Roofs	0.11
Triple Glazing	0.8 (with a g value of 0.36)
Doors	1
Air Permeability	1 m³/hr/m²@ 50 Pa

Together with the above passive design measures, the proposed energy strategy includes the following energy efficiency measures throughout the development:

- *The provision of energy efficient lighting*
- *The provision of zonal thermal and lighting controls;*
- *The provision of variable speed pumps and fans;*

- *The enhancement of pipework and ductwork, thermal insulation;*
- *Specific Fan Powers improved beyond Part L requirements.*

Be Clean

It was investigated to establish if there were any existing decentralised energy networks near the proposed site using the Department of Energy and Climate Change CHP database. It has been concluded that there are no suitable existing nearby CHP systems or source of waste heat or power to which a connection may be possible.

In order to economically justify installing a CHP unit on any site, a minimum requirement of 4,000 hours running time per year is necessary. Based on the building types being residential, there is a low heating and hot water demand for a continuous period over the year, typically a maximum of circa 2,117 hours is anticipated.

Months	Load per Day (hrs)	Load per week (hrs)	Load per month (hrs)	Load for 6 months (hrs)	
April to Sept	2	14	58.8	352.8	
October to March	10	70	294	1,764.0	
		Total approximate Load for a year		2,116.8	hours
		Minimum required hours		4,000.0	hours

Table 6.1 CHP Analysis

Be Green

Further means of reducing energy and carbon emissions for the development have been explored, through the use of renewable technologies. The following, Table 6.2, reviews the primary options for generation of on-site renewable/ Low or Zero Carbon (LZC) energy and considers their suitability for use on the development.

Renewable Technology Feasibility Assessment		Viable?
Bio Fuel Boilers 	Bio-fuel boilers are specifically designed to burn solid biomass or liquid bio-fuel in order to heat water, or raise steam. This can then be used for space heating or Domestic Hot Water (DHW) supply. Bio-fuel boilers could potentially provide the annual space heating and DHW demand for the Unit, however they are not recommended for this development for the following reasons:- 1. Biomass boilers generate increased Oxides of Nitrogen (NOx) and particulates (PM10) which would affect air quality. 2. The storage requirements for the biofuel would require a large plant space, with an auxiliary storage facility to allow for a two week period where delivery of fuel might not be available.	No
Land Use Large volumes of storage is required for fuel at ground level or basement level with sufficient vehicular access for fuel delivered. Noise Noise levels are generated by the operation of the bio-fuel boiler and associated deliveries of the bio-fuel. The plant room enclosure will have to be attenuated to acceptable levels imposed by planning and Acoustician recommendations.		

Renewable Technology Feasibility Assessment		Viable?
Wind Turbines 	Wind turbines convert the kinetic energy in the wind into mechanical energy which is then converted into electricity. Wind turbines can provide electrical power either directly to a load or via a battery system. The use of wind turbines is not recommended for this development for the following reasons:- 1. Wind turbines, of a size necessary to make a contribution to the Unit renewable energy requirements are considered inappropriate on spatial, planning, aesthetic and noise grounds. Noise pollution from commercial wind turbines can be quiet significant within a few hundred metres. 2. The site is not ideal; an ideal site is a hill with a flat, clear exposure. It should be free from strong turbulence and obstructions like large trees, houses or other buildings. As the development is surrounded by trees, turbulent wind flow will be experienced across the site which is not ideal for wind turbine installations. 3. The financial viability of a small scale installation on the site would be compromised by the operational efficiency of the unit (circa 30%). 4. Wind turbines, can cause electrical interference within a 2km radius. 5. Finally, the main disadvantage is down to the winds unreliability factor. The wind strength is often too low in many areas, where this site is located the wind speed is 4.8 m/s at 10m, as can be seen in the wind map presented in Appendix C, in order for the wind turbines to be feasible, wind speeds of greater than 6 m/s are required.	No
Land Use There would be an adverse visual impact on the site which will be dependent on the height at which the wind turbines are located. Noise Noise levels are generated by the rotating blades; these noise levels will vary dependent on wind velocity and will need to be in acceptable levels imposed by planning and Acoustician recommendations.		
Ground Source Heat Pumps 	Space cooling and heating can be provided by circulating water cooled or heated directly by the ground or via subterranean water. Ground water cooling and heating through the use of aquifers makes use of the relatively stable ground/ water temperature which is available at a temperature range of 10 – 14°C. The use of Ground Source Heat Pumps is not recommended for this development for the following reasons:- 1. Cost of boreholes may be prohibitive (subject to site geological conditions). 2. Favourable ground conditions may not exist. 3. Problems can arise with boreholes silting up (open-loop). 4. Changes in local ground conditions could affect water quality and the amount that can be extracted (open-loop).	No

<table>
<tr><th colspan="2">Renewable Technology Feasibility Assessment</th><th>Viable?</th></tr>
<tr><td colspan="2"><u>Land Use</u>
This installation would require Environmental Agency approval. Ground and Hydrology analysis would be required to investigate if favourable conditions exist.
<u>Noise</u>
There are no noise issues generated by this technology.</td><td></td></tr>
<tr><td>Solar Water Heating
</td><td>Solar Water Heating systems use radiant energy from the sun to heat water. Systems comprise of a roof mounted heat collector piped to a coil located within a hot water storage cylinder. The use of Solar Panels are not recommended for this development for the following reasons:
1. The roof area is better utilised for the provision of PV Panels.</td><td rowspan="2">No</td></tr>
<tr><td colspan="2"><u>Land Use</u>
Roof space is better served for the installation of Photovoltaic panels.
<u>Noise</u>
Noise levels are generated by pumps at roof level, these are insignificant so should pose no issues.</td></tr>
<tr><td>Air Source Heat Pumps
</td><td>An Air Source Heat Pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can extract heat from the air even when the outside temperature is as low as minus 15°C and typically draws approximately a quarter to a third of the electricity of a standard resistance heater for the same amount of heating, reducing utility bills. This typical efficiency compares to 70-95% for a fossil-fuel powered boiler.</td><td rowspan="2">No</td></tr>
<tr><td colspan="2"><u>Land Use</u>
Air Source Heat Pumps can be installed on ground mounted, roof mounted or wall mounted frames. When installing Air Source Heat Pumps there are various factors to consider; Heat Pumps should be positioned to provide shelter from high winds which can reduce efficiency by causing defrost problems.
<u>Noise</u>
Noise levels are generated by fans, and compressors causing vibrations. The noise levels are dependent on manufacturer and vary accordingly, these will need to be in acceptable levels imposed by planning and Acousticians recommendations.</td></tr>
<tr><td>Water Source Heat Pump
</td><td>A water source heat pump (WSHP) is a type of heating, ventilation, and air conditioning (HVAC) system that uses the constant temperature of a water source, as a heat exchange medium for both heating and cooling purposes.
Water Source Heat Pumps (WSHP) are proposed for use within the whole development to provide the heating and cooling requirements.</td><td>Yes</td></tr>
</table>

<table>
<tr><th colspan="2">Renewable Technology Feasibility Assessment</th><th>Viable?</th></tr>
<tr><td colspan="2">The benefits of WSHP are as follows:
• WSHPs take advantage of the relatively stable temperature of water sources, which tends to remain more constant than air temperatures throughout the year. This stability enhances the efficiency of the heat exchange process.
• Water source heat pumps are known for lower energy consumption compared to traditional air-source heat pumps, especially in regions with extreme temperature variations.
• Depending on the location and available water source, WSHPs can be installed horizontally or vertically in the ground, or directly in a water body.</td><td></td></tr>
<tr><td>Photovoltaics
</td><td>Photovoltaic (PV) modules convert sunlight directly to DC electricity. The solar cells consist of a thin piece of semiconductor material, in most cases silicon.
The use of PV has been proposed for this scheme to supply renewable energy to every unit to comply with Building Regulations 2021.
A total of 79.13 kWp of PV has been proposed for the development.</td><td rowspan="2">Yes</td></tr>
<tr><td colspan="2"><u>Land Use</u>
There are no land issues or adverse visual impacts as the photovoltaic panels are roof mounted.
<u>Noise</u>
There are no noise issues generated by this technology.</td></tr>
</table>

<u>Table 6.2 Renewable Technology Feasibility Assessment</u>

Total PV for development	No of Panels	Area (m^2)
79.13 kWp	Circa 211	Circa 379.8

<u>Table 6.3 PV requirements</u>

6.3 SUMMARY

By applying the above passive design measures the savings generated are displayed in Table 6.4, and Figures 6.1 – 6.2. The full calculations can be seen in Appendix D.

	Carbon Dioxide Emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2021 of the Building Regulations Compliant Development	7.45	20.10

After Energy Efficient, Passive Measures and WSHP	5.97	It is anticipated that a circa 5% saving can be achieved through the use of energy efficient fittings, for example A or A+ appliances. This would reduce the unregulated carbon emissions to: 19.095
After the inclusion of PV panels	-0.03	
Total Cumulative Saving	**7.48 (100.37%)**	**1.005 (5%)**

Table 6.4 Carbon Dioxide Emissions

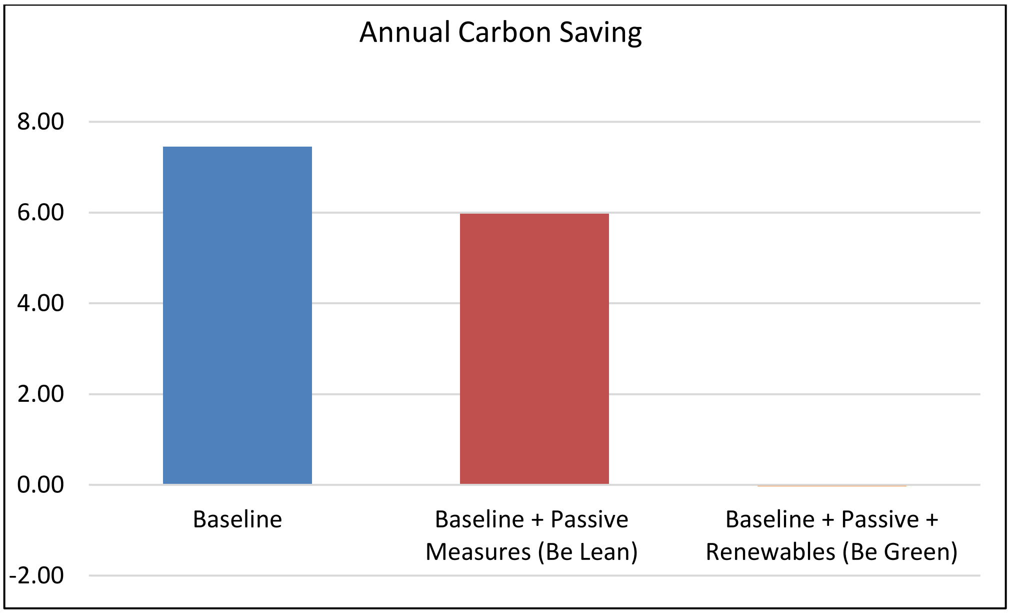


Figure 6.1 Site Carbon Emissions

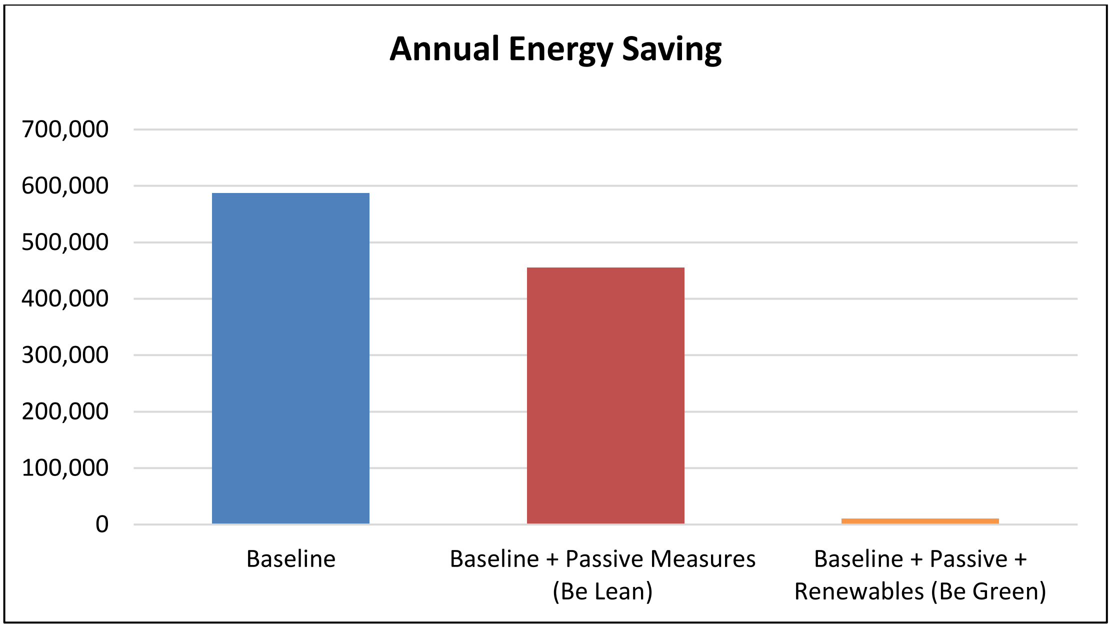


Figure 6.2 Site Energy Consumption

6.4 PROPOSED ENERGY STRATEGY

A summary of proposed energy strategy can be seen in table 6.5 below.

	Residential Elements
Heating	On-Site Communal Heating Network via WSHP
Hot Water	Low Temperature On-Site Communal Heating Network via WSHP
Cooling	Cooling within all area's (except storage) via WSHP
Ventilation	Natural Ventilation via openable windows, and Cooling system in accordance with Approved Document F
Lighting	Energy efficient LED lighting where applicable
This makes the scheme 100% electric	

Table 6.5 Proposed Energy Strategy

The above review has resulted in the formulation of an Energy Strategy that may be adopted for the development involving the use of passive design and energy efficiency measures aimed at achieving the targets and recommendations set out by Guildford Borough Council. The current energy strategy for the development includes the use of water Source Heat Pumps and 79.13 kWp PV.

The recommended schemes take into consideration the most appropriate technologies available to the site, which provides a scheme that is commercially viable whilst keeping in compliance with National and Local Policies. The use of further/emerging technologies may be included for use within this development if their feasibility increases in the future, in accordance with best practice.

7 WATER CONSUMPTION

The ever-increasing impacts of climate change are continuously inflating demand for water, as well as increasing a need for awareness towards water usage. The UK is already under a large amount of pressure regarding water resources. To contribute towards mitigating this issue, the proposed development will consider various means of being economical with water consumption.

7.1 POLICY REVIEW

National Planning Policy Framework (2023)

Paragraph 180 - Conserving and enhancing the natural environment

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

Guildford Borough Local Plan: Development Management Policies (2023):

POLICY P11: Sustainable Surface Water Management

All development proposals

1) Drainage schemes are required to intercept as much rainwater and runoff as possible, including runoff from outside the site.
2) Development proposals are required to maximise the use of permeable surfaces across the development site.
3) Drainage schemes are expected to avoid the use of boreholes or other deep structures for the discharge of surface water to ground, except for clean roof water.

7.2 DEVELOPMENT SUSTAINABILITY FEATURES

In order to ensure the reduction and management of water consumption within the proposed development, it is anticipated that various measures shall be undertaken, and specific features installed during the fit out works to minimise the building's portable water consumption.

It is anticipated that improvements in the consumption of portable water will be achieved through the specification of water efficient components within sanitary areas during the fit out works. Such features include the specification of low flow taps as well as dual flush toilets with reduced flush volumes.

7.3 SUMMARY

To ensure the sustainability of the development it is anticipated that water efficient fixtures will be incorporated into the design, such as low flow taps and dual flush toilets with reduced effective flush volumes.

To be further sustainable, it is anticipated that pulsed water meters will be installed on the mains water supply, to effectively monitor water consumption. The inclusion of the above sustainability features allows for the development to be deemed sustainable with regard to water consumption.

8 TRANSPORT

Transport produces a large proportion of the country's greenhouse gas emissions, something which government at both national and local level are striving to combat, especially through planning frameworks for new developments. Solutions to transport issues are to be incorporated into the design of the development.

8.1 POLICY REVIEW

National Planning Policy Framework (2021)

Paragraph 108 – Promoting Sustainable Transport

Transport issues should be considered from the earliest stages of plan-making and development proposals, so that:

a) the potential impacts of development on transport networks can be addressed;

b) opportunities from existing or proposed transport infrastructure, and changing transport technology and usage, are realised – for example in relation to the scale, location or density of development that can be accommodated;

c) opportunities to promote walking, cycling and public transport use are identified and pursued;

8.2 DEVELOPMENT SUSTAINABILITY FEATURES

The proposed development is located in East Horsley. The site is approximately 0.7 miles from the nearest bus stop.

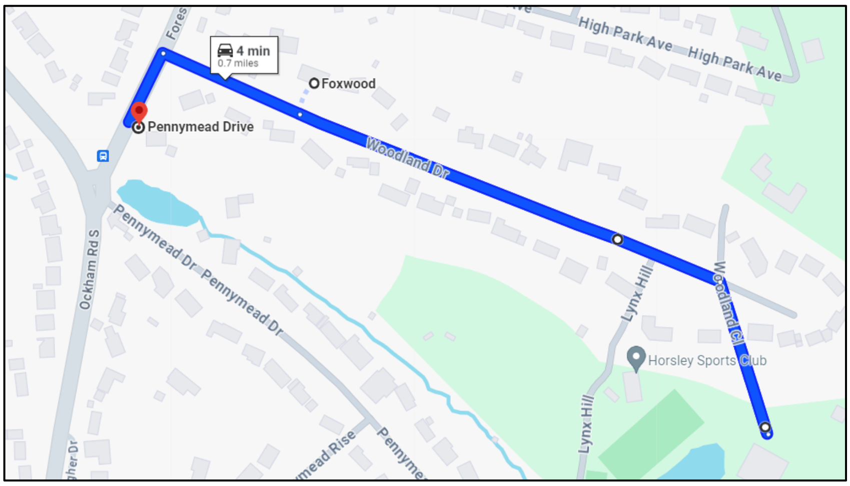


Figure 8.1 Public Transport Links

The proposed development is within vicinity to the public transport links as shown in Figure 8.1.

8.3 SUMMARY

The above provisions aim to make the proposed development easier to access for all building users, as well as offering a sustainable means of commuting rather than using a private vehicle.

The proposed development is located in East Horsley. The site is situated 10 minutes' walk from Pennymead Drive bus stop, this allows for a fair provision of public transport. These links can be used to travel to Central Guildford within 30 minutes.

9 CONSTRUCTION SITE MANAGEMENT

The requirement for new materials needs to be minimised, by re-using existing buildings and materials where possible and providing a Site Waste Management Plan for all construction sites. This responsibility lies with the contractor and needs to be clarified at an early design stage. It is becoming a greater requirement now to construct buildings that are flexible and can be re-used.

9.1 POLICY REVIEW

National Planning Policy Framework (2021)

Local plans should set out strategic priorities for the area; this should include strategic policies to deliver the provision of infrastructure for waste management, water supply and wastewater.

Guildford Local Plan: Development Management Policies

POLICY D14: Sustainable and Low Impact Development

Fabric first

1) Development proposals are required to demonstrate how they have followed a 'fabric first' approach in line with the energy hierarchy.

Embodied carbon

2) Development proposals are required to demonstrate that embodied carbon emissions have been minimised by:
   a. sourcing materials locally where possible; and
   b. taking into account the embodied carbon emissions of materials based on information provided in a respected materials rating database.

Energy improvements

4) Development proposals that will improve the energy efficiency and carbon emission rate of existing buildings to a level significantly better than the Council's adopted standards or national standards for new buildings, whichever is most challenging, are encouraged.

Waste

5) Proposals for major development, and development proposals that involve the demolition of at least one building and/or engineering works that involve the importation or excavation of hard core, soils, sand and other material, are required to submit a Site Waste Management Plan.

9.2 DEVELOPMENT SUSTAINABILITY FEATURES

In order to comply with national and local policy, it is anticipated that certain measures will be put into place for this development, such as a Site Waste Management Plan which monitors the site energy and water consumption and ensures that that site timber is legally and responsibly sourced in accordance with the UK Government's Timber Procurement Policy. Further to this the Site Waste Management Plan should also monitor the resource efficiency of the development construction works as well as the percentage of non-hazardous materials, excavation and construction, which have been diverted from landfill.

It is expected that the main contractor will also set targets and monitor site consumption data for water consumption, energy consumption as well as fuel from deliveries and collection of waste and materials to and from site. Monitoring of such actions can encourage contractors to become more resource efficient to meet given targets.

Additionally, it is expected the main contractor will comply with best standards as set out in the Considerate Constructors Scheme, achieving a score which is considered as exceeding compliance with the criteria of the scheme.

To ensure the sustainable construction of the development, the project will consider the concept of the waste hierarchy as seen in Figure 9.1 below. The waste hierarchy recognises the need for waste to be considered for a variety of waste streams before being sent to land fill as a last resort. The hierarchy is as follows:

- *Waste minimisation;*
- *Reusing or waste or up cycling;*
- *Recycling of all applicable materials;*
- *Recovery of energy from waste (anaerobic digestion plants);*
- *Waste is sent to landfill.*

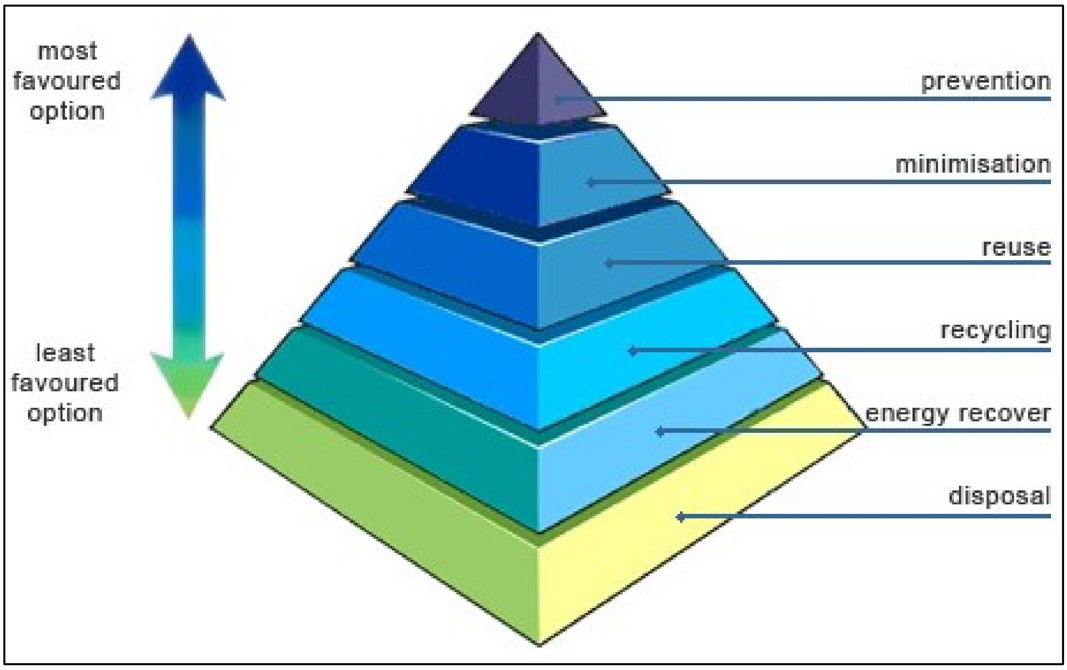


Figure 9.1 Waste Hierarchy Diagram

9.3 SUMMARY

It is anticipated that this development will produce a Site Waste Management Plan, highlighting key refurbishment materials and the correct waste streams for recycling these materials.

The development should adhere to a Considerate Constructors Scheme, achieving a targeted score which exceeds 'compliance' with the criteria of the scheme. As a result of these measures, the development may be deemed sustainable as regards to construction site management.

10 SUSTAINABLE DESIGN

Good urban design is essential in providing a varied and sustainable environment, which can facilitate opportunities for positive contributions within communities. As part of sustainable design for developments, it is essential that suitable design principles are followed to maximise opportunities for energy reduction through design as well as ensuring buildings follow or enhance the character of an area. Developments should also give further consideration to the level of security and comfort that is provided for future building users, including thermal and visual comfort, inclusivity and safe access.

10.1 POLICY REVIEW

National Planning Policy Framework (2023)

Paragraph 131 - Achieving Well-Designed Places

The creation of high-quality buildings and places is fundamental to what the planning and development process should achieve. Good design is a key aspect of sustainable development, creates better places in which to live and work and helps make development acceptable to communities. Being clear about design expectations, and how these will be tested, is essential for achieving this. So too is effective engagement between applicants, communities, local planning authorities and other interests throughout the process.

Guildford Local Plan: Strategy and Sites

POLICY D2: Climate Change, sustainable design, construction and energy

Sustainable design and construction

1) Proposals for zero carbon development are strongly supported. Applications for development, including refurbishment, conversion and extensions to existing buildings should include information setting out how sustainable design and construction practice will be incorporated including (where applicable):
   a) the efficient use of mineral resources and the incorporation of a proportion of recycled and/or secondary aggregates
   b) waste minimisation and reusing material derived from excavation and demolition
   c) the use of landform, layout, building orientation, massing and landscaping to reduce energy consumption
   d) water efficiency that meets the highest national standard and
   e) measures that enable sustainable lifestyles for the occupants of the buildings, including electric car charging points.
2) When meeting these requirements, the energy and waste hierarchies should be followed except where it can be demonstrated that greater sustainability can be achieved by utilising measures further down the hierarchy.
3) Major development should include a sustainability statement setting out how the matters in this policy have been addressed. Smaller developments should include information proportionate to the size of the development in the planning application.

10.2 DEVELOPMENT SUSTAINABILITY FEATURES

The proposed development shall include a variety of features which are regarded as having a good sustainable design. It is anticipated that any external lighting specified will be designed to reduce unnecessary light pollution during night-time hours, a lighting assessment has been undertaken to ensure this. This can be achieved through the use of time switches or daylight sensors which switch off lighting between 2300hrs and 0700hrs as well as cut off luminaires which reduce light spill.

To ensure the risk of potential overheating is minimised building modelling of the unit has confirmed that no occupied space is at risk from excessive solar gains; this being achieved through use of glazing with a low shading coefficient. Additionally, to ensure that overheating will not occur during summer months and the building is suitably insulated as well as allowing for adaptation due to the effects of climate change, it is anticipated that the development will use building fabrics with enhanced 'U' values which go beyond the minimum requirements of Part L1 (2021), as seen within Table 10.1. Further to this the energy efficiency measures discussed within Section 6.0 will be incorporated into the design of the development. It is anticipated that such measures will lower the building's energy requirements making its operation feasible and practical for years to come.

Feature	Applied U – Value for New Build Residential (W/m².K)
External Walls	0.14
Exposed Floors	0.10
Exposed Roofs	0.11
Triple Glazing	0.8 (with a g value of 0.36)
Doors	1

Table 10.1: U – Values targeted in the New-Build Residential development.

To provide a fully sustainable development it is also anticipated that the materials used for the following main elements of the development shall be rated under the Green Guide to Specification targeting ratings between A+ and D:

- *External walls;*
- *Ground floor;*
- *Roof;*
- *Windows.*

To provide a development which remains sustainable during its operation phase, it is anticipated that space will be provided for the provision of waste storage facilities with additional space of recyclable waste streams. This is to enable building users to sort waste before collection and minimise the quantity of waste that may end up at landfill.

10.3 SUMMARY

In order to comply with national and local policies, the development shall strive to provide both to building users and the local community a building of sustainable design.

Measures should be taken to ensure the thermal comfort of future building users, through efforts such as ensuring no occupied areas will result in excessive solar gains and in turn over heating.

External lighting except safety and security lighting should be designed to be switched off automatically through the use of timers of day light sensors as well as the specification of cut off luminaires to reduce any potential light spill on to neighbouring properties as covered in the lighting assessment.

The above design features allow for the proposed development to be of sustainable design.

11 FLOOD RISK

To prevent an increase in surface water run off through development of a site, it is imperative that consideration is given to the reduction of over land flow during storm events as well as the impact of development in potential flood risk areas.

11.1 POLICY REVIEW

National Planning Policy Framework (2021)

Paragraph 165 - Meeting the Challenge of Climate Change, Flooding and Coastal Change

Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

Guildford Local Plan: Development Management Policies

POLICY P4: Flooding, flood risk and groundwater protection zones

1) Flood zones in the borough of Guildford are defined based on definitions contained within national planning practice guidance and the Council's Strategic Flood Risk Assessment (Level 1).
2) Development in areas at medium or high risk of flooding, as identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment, including the 'developed' flood zone 3b (functional floodplain), will be permitted provided that:
    a) the vulnerability of the proposed use is appropriate for the level of flood risk on the site
    b) the proposal passes the sequential and exception test (where required) as outlined in the NPPF and Government guidance.
    c) a site–specific flood risk assessment demonstrates that the development, including the access and egress, will be safe for its lifetime, taking into account climate change, without increasing flooding elsewhere, and where possible, will reduce flood risk overall.
    d) the scheme incorporates flood protection, flood resilience and resistance measures appropriate to the character and biodiversity of the area and the specific requirements of the site.
    e) when relevant, appropriate flood warning and evacuation plans are in place and approved.
3) Development proposals in the 'developed' flood zone 3b will also only be approved where the footprint of the proposed building(s) is not greater than that of the existing building(s) and there will be no increase in development vulnerability. Proposals within these areas should facilitate greater floodwater storage.
4) With the exception of the provision of essential infrastructure, 'undeveloped' flood zone 3b will be safeguarded for flood management purposes.
5) All development proposals are required to demonstrate that land drainage will be adequate and that they will not result in an increase in surface water run-off. Proposals should have regard to appropriate mitigation measures identified in the Guildford Surface Water Management Plan or Ash Surface Water Study. Priority will be given to incorporating SuDs (Sustainable Drainage Systems) to manage surface water drainage.

11.2 DEVELOPMENT SUSTAINABILITY FEATURES

The flood map sourced from The Government Flood Warning Information Service seen below in Figure 11.1, demonstrates that the proposed site is predominantly located within low risk of flooding from fluvial or reservoir sources.

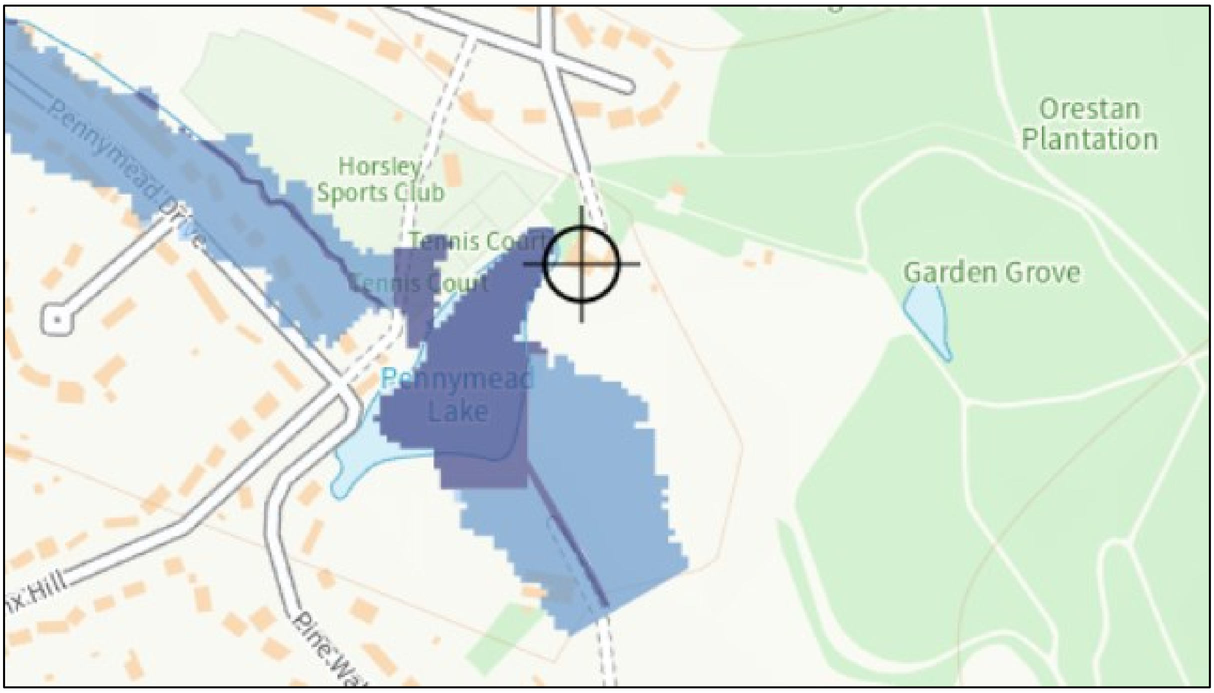


Figure 11.1: Fluvial Flooding (Sourced from Flood Warning Information Service)

Figure A.2: Reservoir Flooding (Sourced from Flood Warning Information Service)

11.3 SUMMARY

The above map confirms that the site is located within a low-risk flooding area from reservoir sources.

12 NOISE

Noise is a subjective concept that can affect people differently, however there are set standards as to acceptable levels of noise, for different areas and times of day. In this instance, the proposed development would be subject to potential noise pollution from road sources.

12.1 POLICY REVIEW

<u>National Planning Policy Framework (2021)</u>

<u>Paragraph 180 - Conserving and Enhancing the Natural Environment</u>

Planning policies and decisions should contribute to and enhance the natural and local environment by:

a) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.

<u>Guildford Local Plan: Development Management Policies</u>

<u>POLICY D11: Noise Impacts</u>

1) Development proposals for noise sensitive uses are required to clearly identify any likely adverse noise impacts on the sensitive receptors that are intended to use or occupy the development from existing nearby sources of noise.
2) Development proposals for noise generating uses are required to clearly identify any likely adverse noise impacts arising from the proposed development on existing nearby sensitive receptors, including the natural environment.
3) Where consideration under (1) or (2) indicates the potential for Observed Adverse Effect Levels of noise, planning applications are required to include a Noise Impact Assessment, which considers the relationship in detail.
4) Where evidence of an Observed Adverse Effect Level noise impact exists, as defined in the Noise Exposure Hierarchy, the applicant is required to demonstrate how the proposed development proposal will be designed and implemented in order to:
   a) prevent any present and very disruptive Significant Observed Adverse Effect levels,
   b) avoid any present and disruptive Significant Observed Adverse Effect levels; and
   c) mitigate any present and intrusive Lowest Observed Adverse Effect levels.
5) The applicant proposing the development proposal (or 'agent of change') is responsible for ensuring that:
   a) all potential Observed Adverse Effect Levels of noise, either impacting on or emanating from the proposed development proposal, are identified, and
   b) the prevention, avoidance and/or mitigation measures required to manage those noise impacts are implemented effectively.
6) A Verification Report is required to be submitted to the Council and approved prior to the development's occupation or use, which demonstrates the agreed avoidance and mitigation measures have been implemented effectively.
7) Where there will be an unacceptable adverse effect on sensitive receptors which cannot be adequately prevented, avoided, and/or mitigated, the planning application will be refused.

12.2 DEVELOPMENT SUSTAINABILITY FEATURES

The proposed development is not subject to noise pollution from road and rail sources, as can be seen in Figures 12.1 and 12.2. It should be noted that the noise levels are 'A' weighted and as such only demonstrate sounds on a frequency that would affect human populations, it does not consider noise on frequencies that may affect any local habitats.

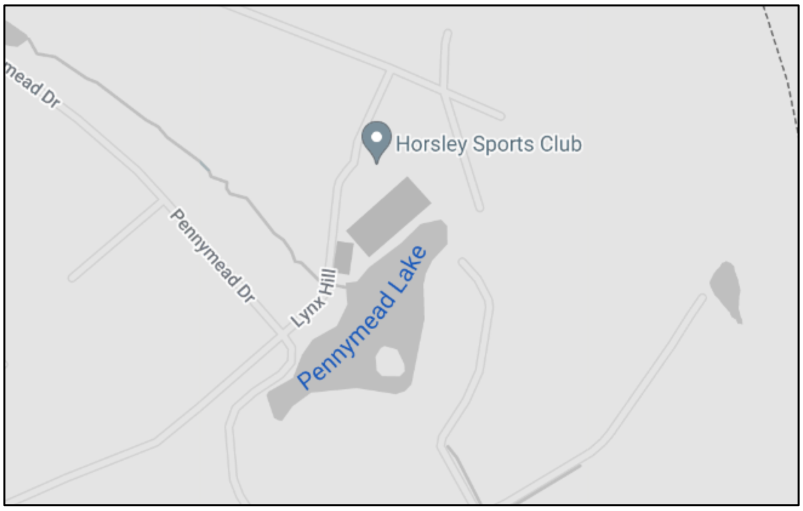


Figure 12.1: Road Noise Data Map (Postal Code Analysis, Sourced from Extrium)

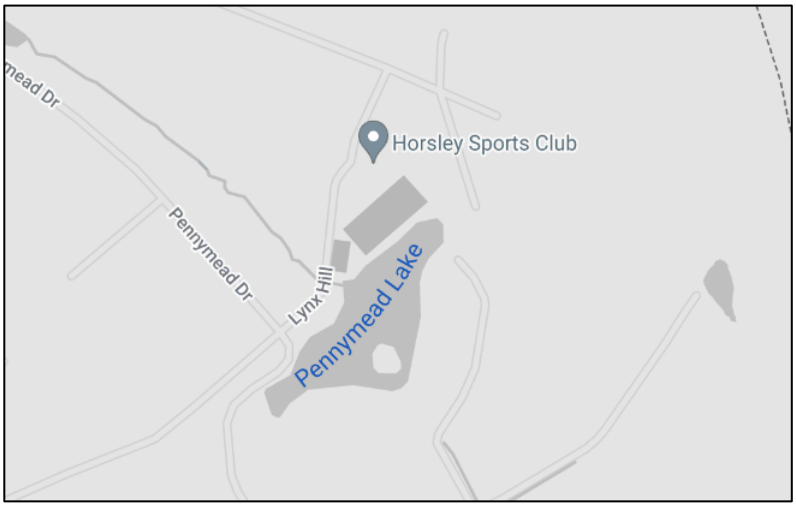


Figure 12.2 Rail Noise Data Map (Postal Code Analysis, Sourced from Extrium)

12.3 SUMMARY

The figures above demonstrate that the development will not be subject to noise pollution from the surrounding roads or rail sources. It is anticipated that any plant equipment installed will not have an impact on the local area and as such the proposed development may be deemed sustainable with regard to noise.

13 ECOLOGY

Ecology is essential within many communities, with the mix of flora and fauna facilitating benefits such as flood alleviation and pollution amelioration. In addition to this, areas with a wealth of green spaces and an abundance of biodiversity are seen to provide a positive contribution to a community.

13.1 POLICY REVIEW

<u>National Planning Policy Framework (2021)</u>

<u>Section 15 - Conserving and Enhancing the Natural Environment</u>

The planning system should protect and enhance valued landscapes, minimise impacts on biodiversity.

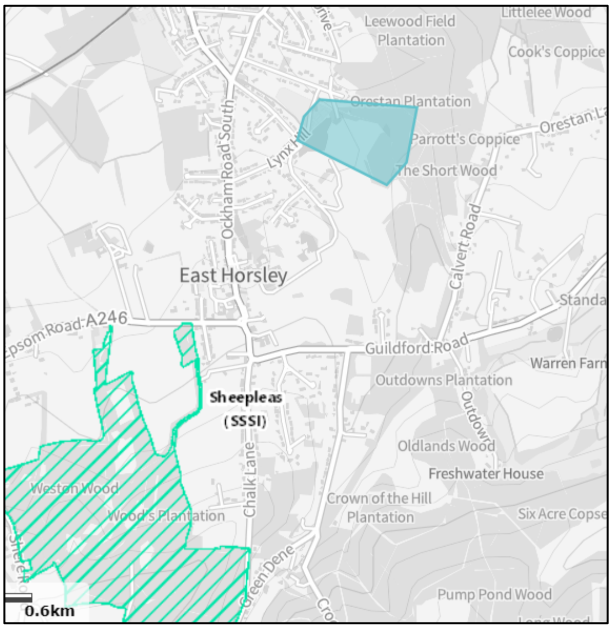
<u>Guildford Local Plan: Development Management Policies</u>

<u>POLICY P12: Regionally Important Geological / Geomorphological Sites</u>

1) Development proposals that are likely to materially harm the conservation interests of Regionally Important Geological/Geomorphological Sites (RIGS) as shown on the Policies Map, and any unmapped features that meet the definition of a RIGS, are required to demonstrate that the need for the development clearly outweighs the impact on the conservation interests.
2) Development proposals are required to make every effort to prevent harm to the conservation interests of the RIGS through avoidance measures. Where this is not possible, every effort is required be made to minimise harm through mitigation measures. The applicant is required to demonstrate that any necessary avoidance and mitigation measures will be implemented and maintained effectively.

13.2 DEVELOPMENT SUSTAINABILITY FEATURES

An ecology conservation map (sourced from MAGIC) highlights there is one Site of Special Scientific Interest (SSSI) in the vicinity of the site development, Sheepleas in the Surrey Hills.



<u>Figure 13.1 Ecological Sensitivity (Sourced from MAGIC)</u>

13.3 SUMMARY

An Ecology conservation map (sourced from MAGIC) highlights there is one Site of Special Scientific Interest (SSSI) in the vicinity of the development, however the SSSI is 1.5 miles away from the development so will not be affected.

APPENDIX A – FLOOD RISK MAP

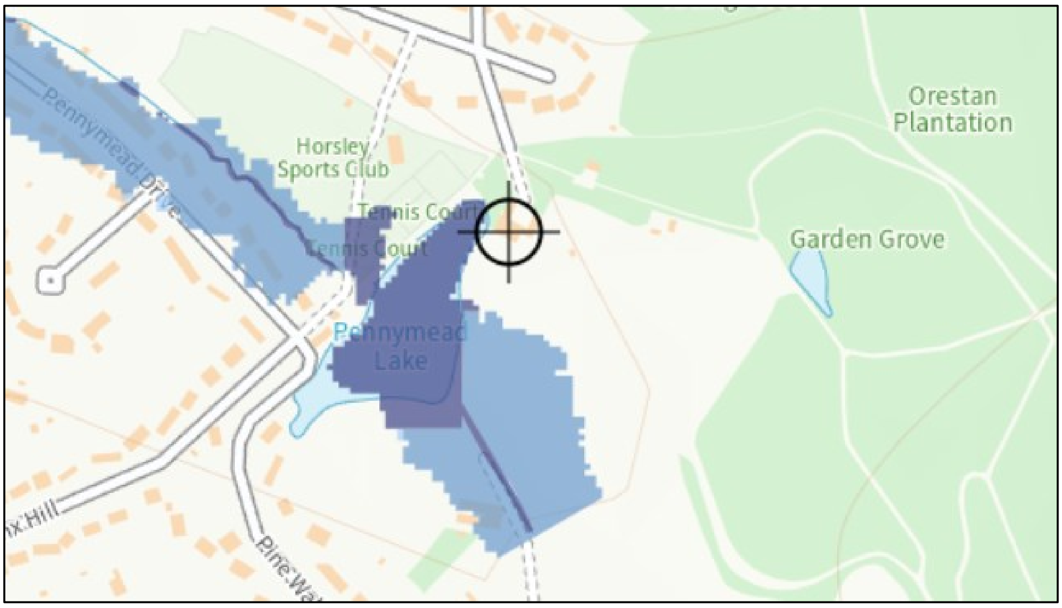


Figure 11.1: Fluvial Flooding (Sourced from Flood Warning Information Service)

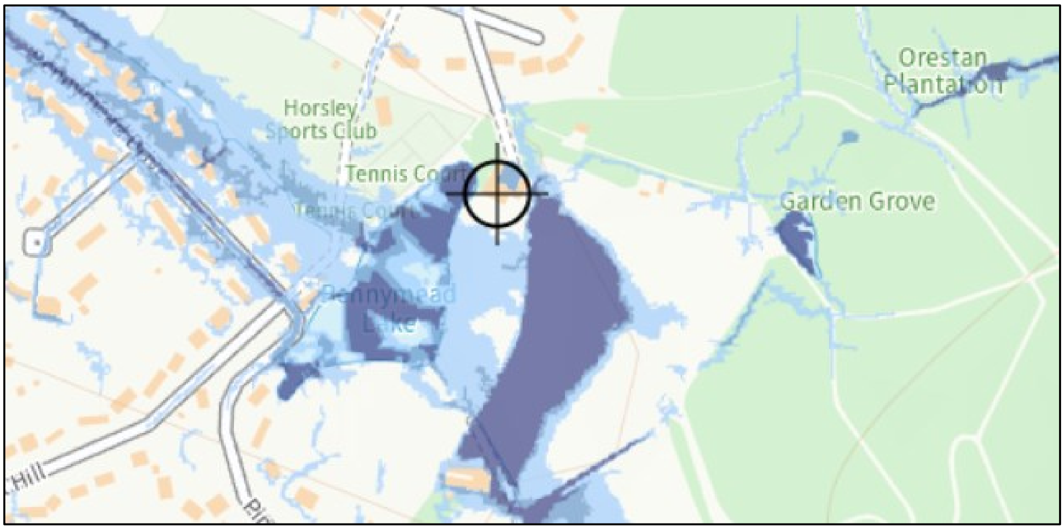


Figure A.2: Reservoir Flooding (Sourced from Flood Warning Information Service)

APPENDIX B – CHP SEARCH

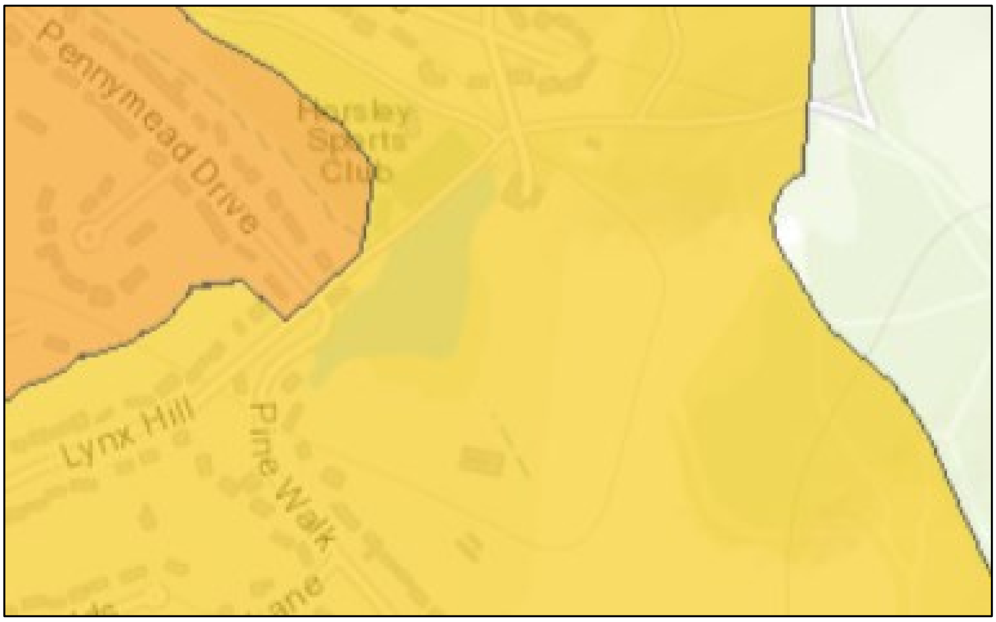


Figure B.1: CHP availability Search Area

Sector Name	Share	Total MWh
Communications and Transport	0.03%	11 MWh
Commercial Offices	0.37%	128 MWh
Domestic	95.22%	33,045 MWh
Education	1.51%	524 MWh
Government Buildings	0%	0 MWh
Hotels	0.94%	327 MWh
Large Industrial	0%	0 MWh
Health	0.22%	78 MWh
Other	0.02%	6 MWh
Small Industrial	0.83%	287 MWh
Prisons	0%	0 MWh
Retail	0.43%	148 MWh
Sport and Leisure	0.4%	138 MWh
Warehouses	0.03%	10 MWh
District Heating	0%	0 MWh
Total heat load in Area		**34,702 MWh**

Figure B.2: CHP Heat Load Distribution

APPENDIX C – WIND MAP

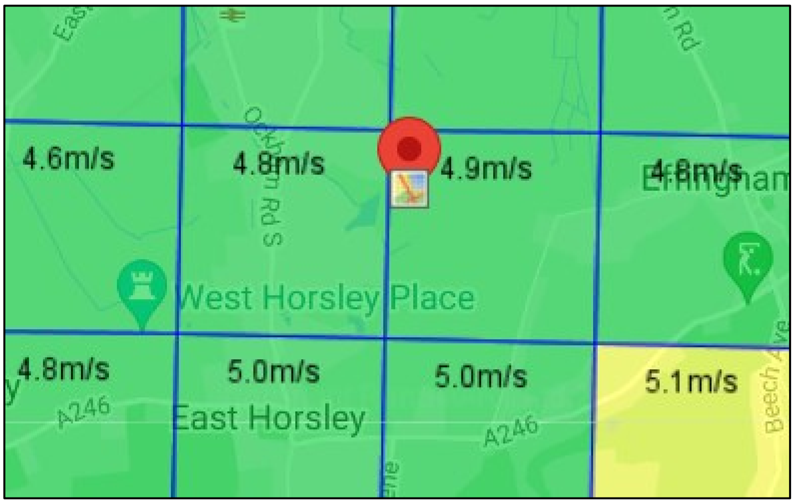


Chart C.1 Wind Velocity Chart for the Development Site

APPENDIX D – ENERGY CALCULATIONS

Baseline

kWh/annum Baseline													
Typical Unit	Area m^2	Quantity	Total Area m^2	DER	TER	Heating	Cooling	Auxillary	Lighting	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
					TER Worksheet	DER Sheet [(Row 307a) ÷ (Row 367a x 0.01)]	DER Sheet Row 321	DER Sheet (Row 313 + 331)	DER Sheet Row 332	DER Sheet [(Row 310a) ÷ (Row 367a x 0.01)]			
Innisfree House	920	1	920	8.10	8.10	537640.2689	0	6579.8697	997.4469	41974.17787	587191.7633	7452	7.45
Total	**920**	**1**	**920**								**587,191.76**	**7,452.00**	**7.45**

Passive

kWh/annum Baseline + Passive/Energy Efficiency Measures													
Typical Unit	Area m^2	Quantity	Total Area m^2	DER	TER	Heating	Cooling	Auxillary	Lighting	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
					TER Worksheet	DER Sheet [(Row 307a) ÷ (Row 367a x 0.01)]	DER Sheet Row 321	DER Sheet (Row 313 + 331)	DER Sheet Row 332	DER Sheet [(Row 310a) ÷ (Row 367a x 0.01)]			
Innisfree House	920	1	920	6.49	8.10	405361.5754	0	6418.4897	997.4469	41974.17787	454751.6899	5970.80	5.97
Total	**920**	**1**	**920**								**454,751.69**	**5,970.80**	**5.97**

WSHP + PV

kWh/annum Baseline + Passive/Energy Efficiency Measures + ASHP													
Typical Unit	Area m^2	Quantity	Total Area m^2	DER	TER	Heating	Cooling	Auxillary	Lighting	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
					TER Worksheet	DER Sheet [(Row 307a) ÷ (Row 367a x 0.01)]	DER Sheet Row 321	DER Sheet (Row 313 + 331)	DER Sheet Row 332	DER Sheet [(Row 310a) ÷ (Row 367a x 0.01)]			
Innisfree House	920	1	920	-0.03	8.10	10102.30451	1250.5982	6262.3758	997.4469	1528.611851	10,732.81	-27.60	-0.03
Total	**920**	**1**	**920**								**10,732.81**	**-27.60**	**-0.03**

APPENDIX E – SAMPLE SAP REPORT

Full SAP Calculation Printout

elmhurst energy

Property Reference	Innisfree, East Horsley	Issued on Date	30/01/2024
Assessment Reference	Be Green	Prop Type Ref	
Property			

SAP Rating	93 A	DER	-0.03	TER	8.10
Environmental	100 A	% DER < TER			100.37
CO_2 Emissions (t/year)	0	DFEE	43.35	TFEE	49.09
Compliance Check	See BREL	% DFEE < TFEE			11.69
% DPER < TPER	102.06	DPER	-0.92	TPER	44.72

Assessor Details	Mr. Sushil Pathak	Assessor ID	Z621-0001
Client			

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

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)			Volume (m3)	
Ground floor		460.0000	(1b)	x	3.2200 (2b)	=	1481.2000	(1b) - (3b)
First floor		460.0000	(1c)	x	2.9100 (2c)	=	1338.6000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	920.0000							(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	2819.8000	(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		1.0000	(17)
Infiltration rate		0.0500	(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) =	0.0500	(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	0.0638	0.0625	0.0613	0.0550	0.0537	0.0475	0.0475	0.0463	0.0500	0.0537	0.0563	0.0588	(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) =	73.8000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.1948	0.1935	0.1923	0.1860	0.1847	0.1785	0.1785	0.1773	0.1810	0.1847	0.1872	0.1898	(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 = 0.80)			441.1300	0.7752	341.9612			(27)
Glazed Door			12.6000	0.8000	10.0800			(26a)
Normal Door			9.4000	1.0000	9.4000			(26)
Heatloss Floor 1			460.0000	0.1000	46.0000	110.0000	50600.0000	(28a)
Ground Floor External Wall	432.8000	260.3900	172.4100	0.1400	24.1374	190.0000	32757.9000	(29a)
First Floor External Wall	448.3200	202.7400	245.5800	0.1400	34.3812	190.0000	46660.2000	(29a)
External Roof	460.0000		460.0000	0.1100	50.6000	9.0000	4140.0000	(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		516.5598			(33)
Internal Wall 1			493.7400			9.0000	4443.6600	(32c)
Internal Floor 1			460.0000			18.0000	8280.0000	(32d)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	146881.7600	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		159.6541	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	157.4600	0.3000	47.2380	
E3 Sill	157.4600	0.0200	3.1492	
E4 Jamb	162.2800	0.0160	2.5965	
E5 Ground floor (normal)	148.7300	0.0530	7.8827	
E6 Intermediate floor within a dwelling	148.7300	0.0010	0.1487	
E16 Corner (normal)	49.0400	0.0380	1.8635	
E17 Corner (inverted - internal area greater than external area)	24.5200	-0.0750	-1.8390	
E10 Eaves (insulation at ceiling level)	233.5200	0.1200	28.0224	
E12 Gable (insulation at ceiling level)	56.9600	0.2500	14.2400	
E13 Gable (insulation at rafter level)	68.2400	0.2500	17.0600	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				120.3620 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	636.9219 (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	181.2215	180.0583	178.8952	173.0793	171.9162	166.1003	166.1003	164.9372	168.4267	171.9162	174.2425	176.5688	(38)
Heat transfer coeff	818.1434	816.9802	815.8170	810.0012	808.8380	803.0222	803.0222	801.8590	805.3485	808.8380	811.1644	813.4907	(39)
Average = Sum(39)m / 12 =												809.7104	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8893	0.8880	0.8868	0.8804	0.8792	0.8729	0.8729	0.8716	0.8754	0.8792	0.8817	0.8842	(40)
HLP (average)												0.8801	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												3.9379	(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	109.6601	108.0315	105.7381	101.5094	98.3431	94.8321	92.9356	95.2130	97.6926	101.4495	105.7653	109.2894	(42b)
Hot water usage for other uses	57.8509	55.7472	53.6435	51.5399	49.4362	47.3325	47.3325	49.4362	51.5399	53.6435	55.7472	57.8509	(42c)
Average daily hot water use (litres/day)												154.2639	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	167.5110	163.7787	159.3816	153.0493	147.7793	142.1646	140.2682	144.6492	149.2325	155.0931	161.5125	167.1403	(44)
Energy conte	265.2965	233.2187	244.9637	209.5169	198.9393	174.8080	169.6422	179.1059	184.0186	210.4598	230.1041	261.7013	(45)
Energy content (annual)										Total = Sum(45)m =		2561.7751	
Distribution loss (46)m = 0.15 x (45)m	39.7945	34.9828	36.7445	31.4275	29.8409	26.2212	25.4463	26.8659	27.6028	31.5690	34.5156	39.2552	(46)
Water storage loss:													
Store volume												1000.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.4600	(48)
Temperature factor from Table 2b												0.7800	(49)
Enter (49) or (54) in (55)												1.1388	(55)
Total storage loss	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(56)
If cylinder contains dedicated solar storage	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
								Total per year (kWh/year) = Sum(64)m =				3251.3331	(64)
12Total per year (kWh/year)												3251	(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	135.0632	119.8633	128.3026	115.0052	112.9995	103.4645	103.2582	106.4049	106.5270	116.8301	121.8504	133.8678	(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	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	436.6935	483.4820	436.6935	451.2499	436.6935	451.2499	436.6935	436.6935	451.2499	436.6935	451.2499	436.6935	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	865.7936	874.7779	852.1379	803.9401	743.0990	685.9170	647.7159	638.7316	661.3716	709.5694	770.4105	827.5925	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)	181.5366	178.3680	172.4497	159.7294	151.8810	143.7006	138.7879	143.0173	147.9542	157.0296	169.2367	179.9299	(72)
Total internal gains	1566.0927	1618.6969	1543.3500	1496.9883	1413.7424	1362.9365	1305.2662	1300.5114	1342.6446	1385.3615	1472.9660	1526.2848	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	115.2500	11.2829	0.3600	0.0000	0.7700	360.4595	(75)
Southeast	123.6100	36.7938	0.3600	0.0000	0.7700	1260.7293	(77)
Southwest	122.1800	36.7938	0.3600	0.0000	0.7700	1246.1444	(79)

Northwest	80.0900	11.2829	0.3600	0.0000	0.7700	250.4920	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	3117.8253	5513.7430	8083.1715	10918.9337	13054.7816	13323.1193	12693.9516	11045.0563	9056.4739	6239.1965	3771.3921	2644.2953	(83)
Total gains	4683.9179	7132.4398	9626.5215	12415.9220	14468.5241	14686.0557	13999.2178	12345.5677	10399.1186	7624.5579	5244.3581	4170.5801	(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	49.8696	49.9406	50.0118	50.3709	50.4433	50.8087	50.8087	50.8824	50.6619	50.4433	50.2987	50.1548	
alpha	4.3246	4.3294	4.3341	4.3581	4.3629	4.3872	4.3872	4.3922	4.3775	4.3629	4.3532	4.3437	
util living area	0.9936	0.9664	0.8857	0.7068	0.5051	0.3477	0.2519	0.2977	0.5178	0.8512	0.9806	0.9960	(86)
MIT	19.4258	19.9056	20.4224	20.8204	20.9624	20.9941	20.9989	20.9977	20.9697	20.6632	19.9262	19.3355	(87)
Th 2	20.1766	20.1777	20.1788	20.1842	20.1852	20.1906	20.1906	20.1917	20.1885	20.1852	20.1831	20.1809	(88)
util rest of house	0.9922	0.9600	0.8672	0.6728	0.4645	0.3045	0.2058	0.2459	0.4621	0.8203	0.9759	0.9951	(89)
MIT 2	18.7190	19.1928	19.6873	20.0463	20.1604	20.1876	20.1902	20.1909	20.1713	19.9226	19.2210	18.6324	(90)
Living area fraction									fLA = Living area / (4) =			0.1024	(91)
MIT	18.7913	19.2657	19.7625	20.1255	20.2425	20.2702	20.2730	20.2735	20.2530	19.9984	19.2932	18.7043	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7913	19.2657	19.7625	20.1255	20.2425	20.2702	20.2730	20.2735	20.2530	19.9984	19.2932	18.7043	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9890	0.9512	0.8567	0.6702	0.4674	0.3088	0.2105	0.2511	0.4666	0.8123	0.9693	0.9929	(94)
Useful gains	4632.4936	6784.0456	8247.1891	8321.1538	6763.1179	4534.7988	2947.0120	3100.5483	4852.2950	6193.5508	5083.3292	4141.0245	(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	11855.9849	11736.5303	10819.7855	9092.6879	6909.4772	4553.2774	2949.5225	3105.9722	4955.3104	7601.8128	9890.6935	11799.1392	(97)
Space heating kWh	5374.2775	3328.0697	1914.0117	555.5045	108.8914	0.0000	0.0000	0.0000	0.0000	1047.7469	3461.3023	5697.6373	(98a)
Space heating requirement - total per year (kWh/year)												21487.4413	
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	5374.2775	3328.0697	1914.0117	555.5045	108.8914	0.0000	0.0000	0.0000	0.0000	1047.7469	3461.3023	5697.6373	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												21487.4413	
Space heating per m2										(98c) / (4) =		23.3559	(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	7548.4085	5942.3641	6094.1285	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9838	0.9921	0.9860	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	7425.9308	5895.2570	6008.8954	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	16929.9869	16136.5912	14215.9184	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	6842.9204	7619.5526	6106.0251	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		0.9728	(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	1664.2429	1853.1249	1485.0251	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												5002.3929	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Geothermal-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0500	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0500	(305a)
Distribution loss factor (Table 12c) for community heating system	1.5000	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	5374.2775	3328.0697	1914.0117	555.5045	108.8914	0.0000	0.0000	0.0000	0.0000	1047.7469	3461.3023	5697.6373	(98)
Space heat from Geothermal = (98) x 1.00 x 1.05 x 1.50													
307a	8464.4871	5241.7098	3014.5685	874.9196	171.5039	0.0000	0.0000	0.0000	0.0000	1650.2014	5451.5511	8973.7788	
Space heating requirement	8464.4871	5241.7098	3014.5685	874.9196	171.5039	0.0000	0.0000	0.0000	0.0000	1650.2014	5451.5511	8973.7788	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Annual water heating requirement	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
Water heat from Geothermal = (64) x 1.00 x 1.05 x 1.50													
310a	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	
Water heating fuel	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	(310)
Cooling System Energy Efficiency Ratio												4.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	416.0607	463.2812	371.2563	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	503.1299	454.4399	503.1299	486.8999	503.1299	486.8999	503.1299	503.1299	486.8999	503.1299	486.8999	503.1299	(331)
Lighting	123.5906	99.1490	89.2727	65.4050	50.5207	41.2758	46.0867	59.9052	77.8109	102.0921	115.3128	127.0256	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-855.3092	-939.6664	-1006.7756	-805.9568	-661.5888	-570.3878	-581.1824	-656.0203	-763.8507	-932.2154	-862.0799	-773.4890	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)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	(334a)

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Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)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 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)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 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)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 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)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 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                         33842.7201 (307)
Space heating fuel - secondary                                                                                                     0.0000 (309)
Water heating fuel - community heating                                                                                          5120.8497 (310)
Efficiency of water heater                                                                                                         0.0000 (311)
Electricity used for heat distribution                                                                                           338.4272 (313)
Space cooling fuel                                                                                                              1250.5982 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.7220)
   mechanical ventilation fans (SFP =       1.7220)                                                                             5923.9486 (330a)
Total electricity for the above, kWh/year                                                                                       5923.9486 (331)
Electricity for lighting (calculated in Appendix L)                                                                              997.4469 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                  -9408.5224 (333)
Wind generation                                                                                                                    0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                             0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                                     0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                         -0.0000 (336)
Energy used                                                                                                                        0.0000 (337)
Total delivered energy for all uses                                                                                            37727.0411 (338)


---------------------------------------------------------------------------------------------------
12b. Carbon dioxide emissions - Community heating scheme
---------------------------------------------------------------------------------------------------
                                                                                       Energy      Emission factor          Emissions
                                                                                     kWh/year          kg CO2/kWh       kg CO2/year
Efficiency of heat source Geothermal                                                                                     335.0000 (367)
Space and Water heating from Geothermal                                             11630.9164              0.0110       111.1253 (367)
Electrical energy for heat distribution (space & water)                               338.4272              0.0000        60.5945 (372)
Overall CO2 factor for heat network                                                                                        0.0048 (386)
Total CO2 associated with community systems                                                                              188.5346 (373)
Space and water heating                                                                                                  188.5346 (376)
Space cooling                                                                        1250.5982              0.1143       142.9322 (377)
Pumps, fans and electric keep-hot                                                    5923.9486              0.1387       821.7247 (378)
Energy for lighting                                                                   997.4469              0.1443       143.9624 (379)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                -9408.5224              0.1413     -1329.0362
PV Unit electricity exported                                                            0.0000              0.0000         0.0000
Total                                                                                                                  -1329.0362 (380)
Total CO2, kg/year                                                                                                       -31.8822 (383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                                           -0.0300 (384)


---------------------------------------------------------------------------------------------------
13b. Primary energy - Community heating scheme
---------------------------------------------------------------------------------------------------
                                                                                       Energy Primary energy factor     Primary energy
                                                                                     kWh/year          kg CO2/kWh          kWh/year
Efficiency of heat source Geothermal                                                                                     335.0000 (467a)
Space and Water heating from Geothermal                                             11630.9164              0.0510       515.2175 (467)
Electrical energy for heat distribution (space & water)                               338.4272              0.0000       613.8963 (472)
Overall CO2 factor for heat network                                                                                        0.0310 (486)
Total CO2 associated with community systems                                                                             1207.0730 (473)
Space and water heating                                                                                                 1207.0730 (476)
Space cooling                                                                        1250.5982              1.4212      1777.3551 (477)
Pumps, fans and electric keep-hot                                                    5923.9486              1.5128      8961.7495 (478)
Energy for lighting                                                                   997.4469              1.5338      1529.9174 (479)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                -9408.5224              1.5224    -14323.6359
PV Unit electricity exported                                                            0.0000              0.0000         0.0000
Total                                                                                                                 -14323.6359 (480)
Total Primary energy kWh/year                                                                                           -847.5408 (483)
Dwelling Primary energy Rate (DPER)                                                                                       -0.9200 (484)


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


---------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
---------------------------------------------------------------------------------------------------
                                                                                         Area         Storey height              Volume
                                                                                         (m2)                   (m)                (m3)
Ground floor                                                                      460.0000 (1b)    x     3.2200 (2b)    =   1481.2000 (1b) - (3b)
First floor                                                                       460.0000 (1c)    x     2.9100 (2c)    =   1338.6000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)              920.0000                                                         (4)
Dwelling volume                                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =   2819.8000 (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) =	0.0142	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			5.0000	(17)
Infiltration rate			0.2642	(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) =	0.2642	(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	0.3368	0.3302	0.3236	0.2906	0.2840	0.2510	0.2510	0.2444	0.2642	0.2840	0.2972	0.3104	(22b)
Effective ac	0.5567	0.5545	0.5524	0.5422	0.5403	0.5315	0.5315	0.5299	0.5349	0.5403	0.5442	0.5482	(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			9.4000	1.0000	9.4000			(26)
TER Semi-glazed door			12.6000	1.0000	12.6000			(26a)
TER Opening Type (Uw = 1.20)			207.9300	1.1450	238.0878			(27)
Heatloss Floor 1			460.0000	0.1300	59.8000			(28a)
Ground Floor External Wall	432.8000	134.3800	298.4200	0.1800	53.7156			(29a)
First Floor External Wall	448.3200	95.5500	352.7700	0.1800	63.4986			(29a)
External Roof	460.0000		460.0000	0.1100	50.6000			(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		487.7020			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K			159.6541	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	157.4600	0.0500	7.8730
E3 Sill	157.4600	0.0500	7.8730
E4 Jamb	162.2800	0.0500	8.1140
E5 Ground floor (normal)	148.7300	0.1600	23.7968
E6 Intermediate floor within a dwelling	148.7300	0.0000	0.0000
E16 Corner (normal)	49.0400	0.0900	4.4136
E17 Corner (inverted – internal area greater than external area)	24.5200	-0.0900	-2.2068
E10 Eaves (insulation at ceiling level)	233.5200	0.0600	14.0112
E12 Gable (insulation at ceiling level)	56.9600	0.0600	3.4176
E13 Gable (insulation at rafter level)	68.2400	0.0800	5.4592

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		72.7516	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	560.4536	(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	518.0556	516.0058	513.9965	504.5591	502.7934	494.5737	494.5737	493.0515	497.7398	502.7934	506.3654	510.0998	(38)
Heat transfer coeff	1078.5092	1076.4594	1074.4501	1065.0127	1063.2470	1055.0273	1055.0273	1053.5051	1058.1934	1063.2470	1066.8190	1070.5534	(39)
Average = Sum(39)m / 12 =												1065.0042	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1723	1.1701	1.1679	1.1576	1.1557	1.1468	1.1468	1.1451	1.1502	1.1557	1.1596	1.1636	(40)
HLP (average)												1.1576	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												3.9379	(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	104.1771	102.6299	100.4512	96.4340	93.4259	90.0905	88.2888	90.4523	92.8080	96.3771	100.4770	103.8249	(42b)
Hot water usage for other uses	54.9583	52.9599	50.9614	48.9629	46.9644	44.9659	44.9659	46.9644	48.9629	50.9614	52.9599	54.9583	(42c)
Average daily hot water use (litres/day)												146.5507	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	159.1355	155.5898	151.4126	145.3969	140.3903	135.0564	133.2548	137.4167	141.7709	147.3384	153.4369	158.7833	(44)
Energy conte	252.0317	221.5578	232.7155	199.0410	188.9924	166.0676	161.1601	170.1506	174.8177	199.9369	218.5989	248.6162	(45)
Energy content (annual)										Total = Sum(45)m =		2433.6864	
Distribution loss (46)m = 0.15 x (45)m	37.8048	33.2337	34.9073	29.8562	28.3489	24.9101	24.1740	25.5226	26.2227	29.9905	32.7898	37.2924	(46)
Water storage loss:													
Store volume												1000.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												4.5050	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												2.4327	(55)
Total storage loss	75.4137	68.1156	75.4137	72.9810	75.4137	72.9810	75.4137	75.4137	72.9810	75.4137	72.9810	75.4137	(56)
If cylinder contains dedicated solar storage	75.4137	68.1156	75.4137	72.9810	75.4137	72.9810	75.4137	75.4137	72.9810	75.4137	72.9810	75.4137	(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	350.7078	310.6846	331.3916	294.5340	287.6685	261.5606	259.8362	268.8267	270.3107	298.6130	314.0919	347.2923	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	350.7078	310.6846	331.3916	294.5340	287.6685	261.5606	259.8362	268.8267	270.3107	298.6130	314.0919	347.2923	(64)

Total per year (kWh/year) = Sum(64)m = 3595.5179 (64)

12Total per year (kWh/year) 3596 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	162.7414	144.9694	156.3188	142.5755	141.7808	131.6119	132.5266	135.5160	134.5213	145.4199	149.0785	161.6058	(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	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	436.6142	483.3943	436.6142	451.1680	436.6142	451.1680	436.6142	436.6142	451.1680	436.6142	451.1680	436.6142	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	865.7936	874.7779	852.1379	803.9401	743.0990	685.9170	647.7159	638.7316	661.3716	709.5694	770.4105	827.5925	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)	218.7385	215.7283	210.1059	198.0216	190.5656	182.7943	178.1272	182.1451	186.8351	195.4568	207.0535	217.2121	(72)
Total internal gains	1606.2153	1658.9694	1583.9269	1538.1987	1455.3478	1401.9482	1344.5262	1339.5599	1381.4437	1426.7094	1513.7010	1566.4878	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	54.3300	11.2829	0.6300	0.7000	0.7700	187.3414	(75)
Southeast	58.2600	36.7938	0.6300	0.7000	0.7700	655.1147	(77)
Southwest	57.6100	36.7938	0.6300	0.7000	0.7700	647.8056	(79)
Northwest	37.7300	11.2829	0.6300	0.7000	0.7700	130.1011	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	1620.3629	2865.5188	4200.7998	5674.4376	6784.3288	6923.7447	6596.7934	5739.9500	4706.5888	3242.5234	1960.0231	1374.2678	(83)
Total gains	3226.5781	4524.4883	5784.7268	7212.6363	8239.6767	8325.6929	7941.3196	7079.5100	6088.0325	4669.2328	3473.7241	2940.7556	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	37.8305	37.9025	37.9734	38.3099	38.3735	38.6724	38.6724	38.7283	38.5567	38.3735	38.2450	38.1116	
alpha	3.5220	3.5268	3.5316	3.5540	3.5582	3.5782	3.5782	3.5819	3.5704	3.5582	3.5497	3.5408	
util living area	0.9981	0.9935	0.9808	0.9397	0.8457	0.6936	0.5457	0.6171	0.8461	0.9726	0.9956	0.9986	(86)
MIT	18.6010	18.9169	19.3915	20.0055	20.5244	20.8404	20.9496	20.9220	20.6492	19.9386	19.1498	18.5538	(87)
Th 2	19.9422	19.9440	19.9458	19.9541	19.9556	19.9628	19.9628	19.9642	19.9600	19.9556	19.9525	19.9492	(88)
util rest of house	0.9976	0.9919	0.9760	0.9239	0.8046	0.6137	0.4326	0.5032	0.7883	0.9628	0.9943	0.9983	(89)
MIT 2	17.1010	17.5062	18.1119	18.8868	19.5067	19.8479	19.9392	19.9238	19.6667	18.8162	17.8107	17.0447	(90)

Living area fraction fLA = Living area / (4) = 0.1024 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	17.2545	17.6506	18.2429	19.0013	19.6108	19.9495	20.0426	20.0260	19.7672	18.9311	17.9478	17.1992	(92)

Temperature adjustment 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	17.2545	17.6506	18.2429	19.0013	19.6108	19.9495	20.0426	20.0260	19.7672	18.9311	17.9478	17.1992	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9956	0.9865	0.9645	0.9050	0.7886	0.6125	0.4418	0.5106	0.7753	0.9488	0.9902	0.9968	(94)
Useful gains	3212.3386	4463.5412	5579.2811	6527.7479	6497.6872	5099.7794	3508.6953	3614.9114	4719.9536	4430.1224	3439.6497	2931.3045	(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	13971.5643	13725.5402	12617.1855	10758.0350	8411.1694	5643.8452	3632.0891	3820.0257	5997.0455	8857.9817	11572.6115	13916.3166	(97)
Space heating kWh	8004.8639	6224.0633	5236.2009	3045.8067	1423.6308	0.0000	0.0000	0.0000	0.0000	3294.3273	5855.7326	8172.8490	(98a)

Space heating requirement - total per year (kWh/year) 41257.4744

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)

Solar heating contribution - total per year (kWh/year) 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating kWh	8004.8639	6224.0633	5236.2009	3045.8067	1423.6308	0.0000	0.0000	0.0000	0.0000	3294.3273	5855.7326	8172.8490	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 41257.4744

Space heating per m2 (98c) / (4) = 44.8451 (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													
	8004.8639	6224.0633	5236.2009	3045.8067	1423.6308	0.0000	0.0000	0.0000	0.0000	3294.3273	5855.7326	8172.8490	(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)													
	8672.6586	6743.2972	5673.0237	3299.8989	1542.3952	0.0000	0.0000	0.0000	0.0000	3569.1520	6344.2390	8854.6576	(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													
	350.7078	310.6846	331.3916	294.5340	287.6685	261.5606	259.8362	268.8267	270.3107	298.6130	314.0919	347.2923	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.3816	88.3264	88.2079	87.9256	87.1478	79.8000	79.8000	79.8000	79.8000	87.9754	88.2931	88.3936	(217)
Fuel for water heating, kWh/month													
	396.8108	351.7461	375.6939	334.9809	330.0926	327.7702	325.6092	336.8756	338.7352	339.4279	355.7379	392.8929	(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	90.7198	72.7788	65.5292	48.0095	37.0839	30.2979	33.8292	43.9725	57.1159	74.9392	84.6436	93.2412	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-300.5941	-371.7723	-468.9227	-459.7393	-444.1930	-395.9418	-389.1902	-389.6023	-387.8075	-386.2437	-310.2167	-266.2205	(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	-372.9365	-746.5084	-1420.0169	-2048.1944	-2632.9055	-2620.4311	-2591.0984	-2228.6168	-1680.6214	-1039.1475	-487.5872	-298.1444	(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	44699.3222	(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	4206.3732	(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)	732.1609	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-22736.6525	(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	26987.2038	(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	44699.3222	0.2100	9386.8577	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4206.3732	0.2100	883.3384	(264)
Space and water heating			10270.1960	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	732.1609	0.1443	105.6734	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4570.4441	0.1376	-629.0287	
PV Unit electricity exported	-18166.2084	0.1271	-2309.2691	
Total			-2938.2978	(269)
Total CO2, kg/year			7449.5009	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			8.1000	(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	44699.3222	1.1300	50510.2341	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4206.3732	1.1300	4753.2017	(278)
Space and water heating			55263.4358	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	732.1609	1.5338	1123.0128	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4570.4441	1.5088	-6895.9692	
PV Unit electricity exported	-18166.2084	0.4667	-8477.5261	
Total			-15373.4953	(283)
Total Primary energy kWh/year			41143.0541	(286)
Target Primary Energy Rate (TPER)			44.7200	(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)	
Ground floor	460.0000 (1b)	x	3.2200 (2b)	=	1481.2000	(1b) - (3b)
First floor	460.0000 (1c)	x	2.9100 (2c)	=	1338.6000	(1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 920.0000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 2819.8000 (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) =	0.0142	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.0000	(17)
Infiltration rate		0.0642	(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) =	0.0642	(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	0.0818	0.0802	0.0786	0.0706	0.0690	0.0610	0.0610	0.0594	0.0642	0.0690	0.0722	0.0754	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5033	0.5032	0.5031	0.5025	0.5024	0.5019	0.5019	0.5018	0.5021	0.5024	0.5026	0.5028	(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 = 0.80)			441.1300	0.7752	341.9612			(27)
Glazed Door			12.6000	0.8000	10.0800			(26a)
Normal Door			9.4000	1.0000	9.4000			(26)
Heatloss Floor 1			460.0000	0.1000	46.0000	110.0000	50600.0000	(28a)
Ground Floor External Wall	432.8000	260.3900	172.4100	0.1400	24.1374	190.0000	32757.9000	(29a)
First Floor External Wall	448.3200	202.7400	245.5800	0.1400	34.3812	190.0000	46660.2000	(29a)
External Roof	460.0000		460.0000	0.1100	50.6000	9.0000	4140.0000	(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	516.5598			(33)
Internal Wall 1			493.7400			9.0000	4443.6600	(32c)
Internal Floor 1			460.0000			18.0000	8280.0000	(32d)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 146881.7600 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 159.6541 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	157.4600	0.3000	47.2380
E3 Sill	157.4600	0.0200	3.1492
E4 Jamb	162.2800	0.0160	2.5965
E5 Ground floor (normal)	148.7300	0.0530	7.8827
E6 Intermediate floor within a dwelling	148.7300	0.0010	0.1487
E16 Corner (normal)	49.0400	0.0380	1.8635
E17 Corner (inverted - internal area greater than external area)	24.5200	-0.0750	-1.8390
E10 Eaves (insulation at ceiling level)	233.5200	0.1200	28.0224
E12 Gable (insulation at ceiling level)	56.9600	0.2500	14.2400
E13 Gable (insulation at rafter level)	68.2400	0.2500	17.0600

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 120.3620 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 636.9219 (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	468.3830	468.2620	468.1434	467.5863	467.4821	466.9969	466.9969	466.9071	467.1838	467.4821	467.6929	467.9134	(38)
Heat transfer coeff	1105.3048	1105.1838	1105.0652	1104.5082	1104.4040	1103.9188	1103.9188	1103.8289	1104.1057	1104.4040	1104.6148	1104.8352	(39)

Average = Sum(39)m / 12 = 1104.5077

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2014	1.2013	1.2012	1.2006	1.2004	1.1999	1.1999	1.1998	1.2001	1.2004	1.2007	1.2009	(40)
HLP (average)												1.2006	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.9379 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	38.9321	38.3539	37.5396	36.0384	34.9142	33.6677	32.9944	33.8030	34.6833	36.0171	37.5493	38.8004	(42b)
Hot water usage for other uses													
	54.9583	52.9599	50.9614	48.9629	46.9644	44.9659	44.9659	46.9644	48.9629	50.9614	52.9599	54.9583	(42c)
Average daily hot water use (litres/day)												86.0583	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	93.8904	91.3137	88.5010	85.0013	81.8786	78.6337	77.9604	80.7674	83.6462	86.9785	90.5091	93.7588	(44)
Energy conte	148.6994	130.0295	136.0228	116.3625	110.2244	96.6893	94.2863	100.0069	103.1441	118.0290	128.9469	146.8036	(45)
Energy content (annual)										Total = Sum(45)m =		1429.2446	
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													
	126.3945	110.5251	115.6194	98.9081	93.6907	82.1859	80.1434	85.0058	87.6725	100.3246	109.6048	124.7831	(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													
	126.3945	110.5251	115.6194	98.9081	93.6907	82.1859	80.1434	85.0058	87.6725	100.3246	109.6048	124.7831	(64)
								Total per year (kWh/year) = Sum(64)m =				1214.8579	(64)
12Total per year (kWh/year)												1215	(64)
Electric shower(s)													
	72.2722	64.3951	70.3170	67.1027	68.3618	65.2106	67.3842	68.3618	67.1027	70.3170	68.9948	72.2722	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							822.0923	(64a)
Heat gains from water heating, kWh/month													
	49.6667	43.7301	46.4841	41.5027	40.5131	36.8491	36.8819	38.3419	38.6938	42.6604	44.6499	49.2638	(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	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	196.8965	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	436.6935	483.4820	436.6935	451.2499	436.6935	451.2499	436.6935	436.6935	451.2499	436.6935	451.2499	436.6935	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	865.7936	874.7779	852.1379	803.9401	743.0990	685.9170	647.7159	638.7316	661.3716	709.5694	770.4105	827.5925	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	42.6897	(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)													
	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)													
	66.7563	65.0745	62.4786	57.6426	54.4531	51.1793	49.5724	51.5348	53.7414	57.3393	62.0138	66.2148	(72)
Total internal gains													
	1451.3123	1505.4033	1433.3789	1394.9016	1316.3146	1270.4151	1216.0507	1209.0289	1248.4318	1285.6711	1365.7431	1412.5697	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	115.2500	11.2829	0.3600	0.0000	0.7700	360.4595	(75)
Southeast	123.6100	36.7938	0.3600	0.0000	0.7700	1260.7293	(77)
Southwest	122.1800	36.7938	0.3600	0.0000	0.7700	1246.1444	(79)
Northwest	80.0900	11.2829	0.3600	0.0000	0.7700	250.4920	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	3117.8253	5513.7430	8083.1715	10918.9337	13054.7816	13323.1193	12693.9516	11045.0563	9056.4739	6239.1965	3771.3921	2644.2953	(83)
Total gains	4569.1376	7019.1463	9516.5504	12313.8352	14371.0962	14593.5344	13910.0024	12254.0852	10304.9058	7524.8676	5137.1352	4056.8650	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	36.9133	36.9174	36.9213	36.9400	36.9434	36.9597	36.9597	36.9627	36.9534	36.9434	36.9364	36.9290	
alpha	3.4609	3.4612	3.4614	3.4627	3.4629	3.4640	3.4640	3.4642	3.4636	3.4629	3.4624	3.4619	
util living area													
	0.9940	0.9754	0.9259	0.8066	0.6327	0.4631	0.3432	0.4027	0.6478	0.9060	0.9849	0.9960	(86)
MIT	18.7593	19.2374	19.8386	20.4472	20.8101	20.9505	20.9866	20.9769	20.8482	20.2482	19.3421	18.6617	(87)
Th 2	19.9189	19.9190	19.9191	19.9196	19.9196	19.9201	19.9201	19.9201	19.9199	19.9196	19.9195	19.9193	(88)
util rest of house													
	0.9926	0.9700	0.9105	0.7714	0.5773	0.3920	0.2616	0.3130	0.5715	0.8793	0.9808	0.9950	(89)
MIT 2	17.8695	18.3426	18.9265	19.4892	19.7937	19.8955	19.9158	19.9121	19.8335	19.3276	18.4504	17.7726	(90)
Living area fraction									fLA = Living area / (4) =			0.1024	(91)
MIT	17.9606	18.4342	19.0198	19.5872	19.8978	20.0035	20.0254	20.0211	19.9374	19.4218	18.5417	17.8637	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.9606	18.4342	19.0198	19.5872	19.8978	20.0035	20.0254	20.0211	19.9374	19.4218	18.5417	17.8637	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9888	0.9599	0.8947	0.7592	0.5761	0.3976	0.2697	0.3216	0.5729	0.8640	0.9732	0.9922	(94)
Useful gains	4517.9920	6737.9560	8514.3041	9349.1829	8278.7745	5803.0106	3751.0399	3941.1393	5903.2572	6501.4531	4999.6306	4025.3974	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate W	15099.1022	14957.8068	13835.2489	11804.1300	9053.6455	5965.0208	3781.3555	3997.0847	6445.1080	9742.8654	12638.6730	15096.0969	(97)
Space heating kWh	7872.3460	5523.7397	3958.7829	1767.5620	576.5040	0.0000	0.0000	0.0000	0.0000	2411.6107	5500.1106	8236.6005	(98a)
Space heating requirement - total per year (kWh/year)												35847.2563	
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	7872.3460	5523.7397	3958.7829	1767.5620	576.5040	0.0000	0.0000	0.0000	0.0000	2411.6107	5500.1106	8236.6005	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												35847.2563	
Space heating per m2											(98c) / (4) =	38.9644	(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	10376.8364	8168.9989	8389.0998	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9188	0.9501	0.9258	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	9534.0209	7761.5061	7766.3735	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	16826.9461	16036.0091	14109.6611	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	5250.9062	6156.2303	4719.4060	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	1312.7265	1539.0576	1179.8515	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												4031.6356	(107)
Energy for space heating												38.9644	(99)
Energy for space cooling												4.3822	(108)
Total												43.3466	(109)
Fabric Energy Efficiency (DFEE)												43.3	(109)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	460.0000 (1b)	x	3.2200 (2b)	=	1481.2000 (1b) - (3b)	
First floor	460.0000 (1c)	x	2.9100 (2c)	=	1338.6000 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 920.0000						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		2819.8000	(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) =	0.0142	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2642	(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) =	0.2642	(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	0.3368	0.3302	0.3236	0.2906	0.2840	0.2510	0.2510	0.2444	0.2642	0.2840	0.2972	0.3104	(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	0.5567	0.5545	0.5524	0.5422	0.5403	0.5315	0.5315	0.5299	0.5349	0.5403	0.5442	0.5482	(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			9.4000	1.0000	9.4000			(26)
TER Semi-glazed door			12.6000	1.0000	12.6000			(26a)

```
TER Opening Type (Uw = 1.20)                                                 207.9300        1.1450       238.0878                               (27)
Heatloss Floor 1                                                             460.0000        0.1300        59.8000                               (28a)
Ground Floor External Wall                         432.8000       134.3800   298.4200        0.1800        53.7156                               (29a)
First Floor External Wall                          448.3200        95.5500   352.7700        0.1800        63.4986                               (29a)
External Roof                                      460.0000                  460.0000        0.1100        50.6000                               (30)
Total net area of external elements Aum(A, m2)                              1801.1200                                                            (31)
Fabric heat loss, W/K = Sum (A x U)                                                 (26)...(30) + (32) =   487.7020                              (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                     159.6541 (35)
List of Thermal Bridges
        K1 Element                                                                          Length      Psi-value         Total
        E2 Other lintels (including other steel lintels)                                  157.4600         0.0500         7.8730
        E3 Sill                                                                           157.4600         0.0500         7.8730
        E4 Jamb                                                                           162.2800         0.0500         8.1140
        E5 Ground floor (normal)                                                          148.7300         0.1600        23.7968
        E6 Intermediate floor within a dwelling                                           148.7300         0.0000         0.0000
        E16 Corner (normal)                                                                49.0400         0.0900         4.4136
        E17 Corner (inverted - internal area greater than external area)                   24.5200        -0.0900        -2.2068
        E10 Eaves (insulation at ceiling level)                                           233.5200         0.0600        14.0112
        E12 Gable (insulation at ceiling level)                                            56.9600         0.0600         3.4176
        E13 Gable (insulation at rafter level)                                             68.2400         0.0800         5.4592
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                                             72.7516 (36)
Point Thermal bridges                                                                                                  (36a) =      0.0000
Total fabric heat loss                                                                                     (33) + (36) + (36a) =   560.4536 (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        518.0556   516.0058   513.9965   504.5591   502.7934   494.5737   494.5737   493.0515   497.7398   502.7934   506.3654   510.0998 (38)
Heat transfer coeff
            1078.5092  1076.4594  1074.4501  1065.0127  1063.2470  1055.0273  1055.0273  1053.5051  1058.1934  1063.2470  1066.8190  1070.5534 (39)
Average = Sum(39)m / 12 =                                                                                                            1065.0042

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP                1.1723     1.1701     1.1679     1.1576     1.1557     1.1468     1.1468     1.1451     1.1502     1.1557     1.1596     1.1636 (40)
HLP (average)                                                                                                                            1.1576
Days in mont           31         28         31         30         31         30         31         31         30         31         30         31


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4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                        3.9379 (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
                38.9321    38.3539    37.5396    36.0384    34.9142    33.6677    32.9944    33.8030    34.6833    36.0171    37.5493    38.8004 (42b)
Hot water usage for other uses
                54.9583    52.9599    50.9614    48.9629    46.9644    44.9659    44.9659    46.9644    48.9629    50.9614    52.9599    54.9583 (42c)
Average daily hot water use (litres/day)                                                                                                86.0583 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
                93.8904    91.3137    88.5010    85.0013    81.8786    78.6337    77.9604    80.7674    83.6462    86.9785    90.5091    93.7588 (44)
Energy conte   148.6994   130.0295   136.0228   116.3625   110.2244    96.6893    94.2863   100.0069   103.1441   118.0290   128.9469   146.8036 (45)
Energy content (annual)                                                                                     Total = Sum(45)m =    1429.2446
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
               126.3945   110.5251   115.6194    98.9081    93.6907    82.1859    80.1434    85.0058    87.6725   100.3246   109.6048   124.7831 (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
               126.3945   110.5251   115.6194    98.9081    93.6907    82.1859    80.1434    85.0058    87.6725   100.3246   109.6048   124.7831 (64)
                                                                                       Total per year (kWh/year) = Sum(64)m =    1214.8579 (64)
12Total per year (kWh/year)                                                                                                           1215 (64)
Electric shower(s)
                72.2722    64.3951    70.3170    67.1027    68.3618    65.2106    67.3842    68.3618    67.1027    70.3170    68.9948    72.2722 (64a)
                                                    Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    822.0923 (64a)
Heat gains from water heating, kWh/month
                49.6667    43.7301    46.4841    41.5027    40.5131    36.8491    36.8819    38.3419    38.6938    42.6604    44.6499    49.2638 (65)


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5. Internal gains (see Table 5 and 5a)
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Metabolic gains (Table 5), Watts
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m          196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965   196.8965 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
               436.6142   483.3943   436.6142   451.1680   436.6142   451.1680   436.6142   436.6142   451.1680   436.6142   451.1680   436.6142 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               865.7936   874.7779   852.1379   803.9401   743.0990   685.9170   647.7159   638.7316   661.3716   709.5694   770.4105   827.5925 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897    42.6897 (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)
              -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172  -157.5172 (71)
Water heating gains (Table 5)
                66.7563    65.0745    62.4786    57.6426    54.4531    51.1793    49.5724    51.5348    53.7414    57.3393    62.0138    66.2148 (72)
Total internal gains
              1451.2331  1505.3156  1433.2997  1394.8197  1316.2353  1270.3333  1215.9715  1208.9497  1248.3500  1285.5919  1365.6612  1412.4905 (73)


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6. Solar gains
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[Jan]                                          Area        Solar flux               g                 FF             Access                Gains
                                                 m2          Table 6a   Specific data      Specific data             factor                    W
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		W/m2	or Table 6b	or Table 6c	Table 6d		
Northeast	54.3300	11.2829	0.6300	0.7000	0.7700	187.3414	(75)
Southeast	58.2600	36.7938	0.6300	0.7000	0.7700	655.1147	(77)
Southwest	57.6100	36.7938	0.6300	0.7000	0.7700	647.8056	(79)
Northwest	37.7300	11.2829	0.6300	0.7000	0.7700	130.1011	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	1620.3629	2865.5188	4200.7998	5674.4376	6784.3288	6923.7447	6596.7934	5739.9500	4706.5888	3242.5234	1960.0231	1374.2678	(83)
Total gains	3071.5960	4370.8345	5634.0995	7069.2573	8100.5642	8194.0780	7812.7649	6948.8997	5954.9387	4528.1153	3325.6844	2786.7584	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	37.8305	37.9025	37.9734	38.3099	38.3735	38.6724	38.6724	38.7283	38.5567	38.3735	38.2450	38.1116	
alpha	3.5220	3.5268	3.5316	3.5540	3.5582	3.5782	3.5782	3.5819	3.5704	3.5582	3.5497	3.5408	
util living area	0.9984	0.9942	0.9822	0.9429	0.8511	0.7006	0.5529	0.6256	0.8531	0.9749	0.9961	0.9989	(86)
MIT	18.5760	18.8926	19.3688	19.9871	20.5123	20.8349	20.9474	20.9185	20.6376	19.9179	19.1261	18.5289	(87)
Th 2	19.9422	19.9440	19.9458	19.9541	19.9556	19.9628	19.9628	19.9642	19.9600	19.9556	19.9525	19.9492	(88)
util rest of house	0.9980	0.9928	0.9778	0.9277	0.8108	0.6209	0.4390	0.5112	0.7967	0.9659	0.9950	0.9986	(89)
MIT 2	17.7031	18.0201	18.4944	19.1051	19.5957	19.8698	19.9435	19.9311	19.7225	19.0478	18.2598	17.6608	(90)
Living area fraction										fLA = Living area / (4) =		0.1024	(91)
MIT	17.7925	18.1094	18.5839	19.1954	19.6895	19.9686	20.0463	20.0322	19.8161	19.1369	18.3485	17.7497	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.7925	18.1094	18.5839	19.1954	19.6895	19.9686	20.0463	20.0322	19.8161	19.1369	18.3485	17.7497	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9967	0.9891	0.9696	0.9136	0.7988	0.6214	0.4488	0.5194	0.7873	0.9559	0.9924	0.9977	(94)
Useful gains	3061.4692	4323.3786	5463.0018	6458.7539	6470.5553	5091.9502	3506.1314	3609.5327	4688.1437	4328.6489	3300.3354	2780.2128	(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	14551.7427	14219.3787	12983.5852	10964.7319	8494.8402	5663.9865	3635.9483	3826.5249	6048.7916	9076.7925	12000.1102	14505.6647	(97)
Space heating kWh	8548.7635	6650.1120	5595.3140	3244.3041	1506.0679	0.0000	0.0000	0.0000	0.0000	3532.6188	6263.8378	8723.7362	(98a)
Space heating requirement - total per year (kWh/year)												44064.7544	
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	8548.7635	6650.1120	5595.3140	3244.3041	1506.0679	0.0000	0.0000	0.0000	0.0000	3532.6188	6263.8378	8723.7362	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												44064.7544	
Space heating per m2											(98c) / (4) =	47.8965	(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	9917.2566	7807.2020	8006.6390	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.7579	0.8300	0.7769	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	7516.0115	6480.0804	6220.5359	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	9347.1507	8909.4530	7908.8778	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	1318.4202	1807.4532	1256.1264	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	329.6051	451.8633	314.0316	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												1095.4999	(107)
Energy for space heating												47.8965	(99)
Energy for space cooling												1.1908	(108)
Total												49.0872	(109)
Fabric Energy Efficiency (TFEE)												49.1	(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)	
Ground floor		460.0000	(1b)	x	3.2200	(2b)	=	1481.2000	(1b) - (3b)
First floor		460.0000	(1c)	x	2.9100	(2c)	=	1338.6000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	920.0000								(4)
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =			2819.8000	(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		1.0000	(17)
Infiltration rate		0.0500	(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) =	0.0500	(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	0.0638	0.0625	0.0613	0.0550	0.0537	0.0475	0.0475	0.0463	0.0500	0.0537	0.0563	0.0588	(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) =	73.8000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.1948	0.1935	0.1923	0.1860	0.1847	0.1785	0.1785	0.1773	0.1810	0.1847	0.1872	0.1898	(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 = 0.80)			441.1300	0.7752	341.9612			(27)
Glazed Door			12.6000	0.8000	10.0800			(26a)
Normal Door			9.4000	1.0000	9.4000			(26)
Heatloss Floor 1			460.0000	0.1000	46.0000	110.0000	50600.0000	(28a)
Ground Floor External Wall	432.8000	260.3900	172.4100	0.1400	24.1374	190.0000	32757.9000	(29a)
First Floor External Wall	448.3200	202.7400	245.5800	0.1400	34.3812	190.0000	46660.2000	(29a)
External Roof	460.0000		460.0000	0.1100	50.6000	9.0000	4140.0000	(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	516.5598			(33)
Internal Wall 1			493.7400			9.0000	4443.6600	(32c)
Internal Floor 1			460.0000			18.0000	8280.0000	(32d)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	146881.7600	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		159.6541	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	157.4600	0.3000	47.2380
E3 Sill	157.4600	0.0200	3.1492
E4 Jamb	162.2800	0.0160	2.5965
E5 Ground floor (normal)	148.7300	0.0530	7.8827
E6 Intermediate floor within a dwelling	148.7300	0.0010	0.1487
E16 Corner (normal)	49.0400	0.0380	1.8635
E17 Corner (inverted – internal area greater than external area)	24.5200	-0.0750	-1.8390
E10 Eaves (insulation at ceiling level)	233.5200	0.1200	28.0224
E12 Gable (insulation at ceiling level)	56.9600	0.2500	14.2400
E13 Gable (insulation at rafter level)	68.2400	0.2500	17.0600

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		120.3620	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	636.9219	(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	181.2215	180.0583	178.8952	173.0793	171.9162	166.1003	166.1003	164.9372	168.4267	171.9162	174.2425	176.5688	(38)
Heat transfer coeff	818.1434	816.9802	815.8170	810.0012	808.8380	803.0222	803.0222	801.8590	805.3485	808.8380	811.1644	813.4907	(39)
Average = Sum(39)m / 12 =												809.7104	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8893	0.8880	0.8868	0.8804	0.8792	0.8729	0.8729	0.8716	0.8754	0.8792	0.8817	0.8842	(40)
HLP (average)												0.8801	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.9379 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	109.6601	108.0315	105.7381	101.5094	98.3431	94.8321	92.9356	95.2130	97.6926	101.4495	105.7653	109.2894	(42b)
Hot water usage for other uses	57.8509	55.7472	53.6435	51.5399	49.4362	47.3325	47.3325	49.4362	51.5399	53.6435	55.7472	57.8509	(42c)
Average daily hot water use (litres/day)												154.2639	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	167.5110	163.7787	159.3816	153.0493	147.7793	142.1646	140.2682	144.6492	149.2325	155.0931	161.5125	167.1403	(44)
Energy conte	265.2965	233.2187	244.9637	209.5169	198.9393	174.8080	169.6422	179.1059	184.0186	210.4598	230.1041	261.7013	(45)
Energy content (annual)										Total = Sum(45)m =		2561.7751	
Distribution loss (46)m = 0.15 x (45)m	39.7945	34.9828	36.7445	31.4275	29.8409	26.2212	25.4463	26.8659	27.6028	31.5690	34.5156	39.2552	(46)

Water storage loss:

Store volume	1000.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.4600	(48)

Temperature factor from Table 2b 0.7800 (49)
Enter (49) or (54) in (55) 1.1388 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(56)
If cylinder contains dedicated solar storage	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)

Total per year (kWh/year) = Sum(64)m = 3251.3331 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	135.0632	119.8633	128.3026	115.0052	112.9995	103.4645	103.2582	106.4049	106.5270	116.8301	121.8504	133.8678	(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	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	141.1989	125.4116	101.9916	77.2142	57.7185	48.7284	52.6528	68.4401	91.8601	116.6375	136.1332	145.1233	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1292.2293	1305.6386	1271.8476	1199.9106	1109.1030	1023.7567	966.7401	953.3308	987.1218	1059.0588	1149.8664	1235.2127	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)	181.5366	178.3680	172.4497	159.7294	151.8810	143.7006	138.7879	143.0173	147.9542	157.0296	169.2367	179.9299	(72)
Total internal gains	1756.2890	1750.7424	1687.6130	1578.1783	1460.0267	1357.5098	1299.5049	1306.1123	1368.2602	1474.0501	1596.5604	1701.5900	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	115.2500	11.2829	0.3600	0.0000	0.7700	360.4595	(75)
Southeast	123.6100	36.7938	0.3600	0.0000	0.7700	1260.7293	(77)
Southwest	122.1800	36.7938	0.3600	0.0000	0.7700	1246.1444	(79)
Northwest	80.0900	11.2829	0.3600	0.0000	0.7700	250.4920	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	3117.8253	5513.7430	8083.1715	10918.9337	13054.7816	13323.1193	12693.9516	11045.0563	9056.4739	6239.1965	3771.3921	2644.2953	(83)
Total gains	4874.1142	7264.4853	9770.7845	12497.1119	14514.8083	14680.6291	13993.4565	12351.1686	10424.7341	7713.2465	5367.9525	4345.8853	(84)

7. Mean internal temperature (heating season)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	49.8696	49.9406	50.0118	50.3709	50.4433	50.8087	50.8087	50.8824	50.6619	50.4433	50.2987	50.1548	
alpha	4.3246	4.3294	4.3341	4.3581	4.3629	4.3872	4.3872	4.3922	4.3775	4.3629	4.3532	4.3437	
util living area	0.9925	0.9642	0.8811	0.7037	0.5036	0.3478	0.2520	0.2976	0.5166	0.8470	0.9789	0.9953	(86)
MIT	19.4579	19.9252	20.4370	20.8236	20.9628	20.9941	20.9989	20.9977	20.9700	20.6708	19.9458	19.3655	(87)
Th 2	20.1766	20.1777	20.1788	20.1842	20.1852	20.1906	20.1906	20.1917	20.1885	20.1852	20.1831	20.1809	(88)
util rest of house	0.9909	0.9575	0.8622	0.6696	0.4632	0.3046	0.2059	0.2458	0.4610	0.8156	0.9739	0.9943	(89)
MIT 2	18.7509	19.2118	19.7006	20.0488	20.1607	20.1876	20.1902	20.1909	20.1714	19.9291	19.2402	18.6622	(90)

Living area fraction fLA = Living area / (4) = 0.1024 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	18.8233	19.2848	19.7760	20.1281	20.2428	20.2702	20.2730	20.2735	20.2532	20.0050	19.3125	18.7342	(92)

Temperature adjustment 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	18.8233	19.2848	19.7760	20.1281	20.2428	20.2702	20.2730	20.2735	20.2532	20.0050	19.3125	18.7342	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9874	0.9484	0.8518	0.6671	0.4661	0.3089	0.2106	0.2510	0.4656	0.8079	0.9669	0.9918	(94)
Useful gains	4812.6299	6889.9772	8323.0860	8336.8954	6764.9857	4534.7680	2947.0071	3100.5597	4853.3138	6231.1871	5190.5176	4310.1478	(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	11882.1025	11752.1164	10830.7700	9094.8021	6909.7156	4553.2735	2949.5219	3105.9737	4955.4405	7607.1362	9906.3087	11823.4608	(97)
Space heating kWh	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98a)

Space heating requirement - total per year (kWh/year) 21055.1147

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)

Solar heating contribution - total per year (kWh/year) 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating kWh	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 21055.1147
Space heating per m2 (98c) / (4) = 22.8860 (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	7548.4085	5942.3641	6094.1285	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9838	0.9921	0.9860	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	7425.9308	5895.2570	6008.8954	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	16929.9869	16136.5912	14215.9184	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	6842.9204	7619.5526	6106.0251	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9728	(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	1664.2429	1853.1249	1485.0251	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												5002.3929	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Geothermal-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0500	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0500	(305a)
Distribution loss factor (Table 12c) for community heating system	1.5000	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98)
Space heat from Geothermal = (98) x 1.00 x 1.05 x 1.50													
307a	8284.0080	5146.0882	2938.5041	859.4662	169.5946	0.0000	0.0000	0.0000	0.0000	1612.3372	5347.7072	8804.1002	
Space heating requirement	8284.0080	5146.0882	2938.5041	859.4662	169.5946	0.0000	0.0000	0.0000	0.0000	1612.3372	5347.7072	8804.1002	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Annual water heating requirement	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
Water heat from Geothermal = (64) x 1.00 x 1.05 x 1.50													
310a	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	
Water heating fuel	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	(310)
Cooling System Energy Efficiency Ratio												4.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	416.0607	463.2812	371.2563	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	503.1299	454.4399	503.1299	486.8999	503.1299	486.8999	503.1299	503.1299	486.8999	503.1299	486.8999	503.1299	(331)
Lighting	123.5906	99.1490	89.2727	65.4050	50.5207	41.2758	46.0867	59.9052	77.8109	102.0921	115.3128	127.0256	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-855.3092	-939.6664	-1006.7756	-805.9568	-661.5888	-570.3878	-581.1824	-656.0203	-763.8507	-932.2154	-862.0799	-773.4890	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)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	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)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	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)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	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)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	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)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	(335b)

Annual totals kWh/year

Space heating fuel - community heating	33161.8056	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	5120.8497	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	331.6181	(313)
Space cooling fuel	1250.5982	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.7220)

mechanical ventilation fans (SFP = 1.7220)	5923.9486	(330a)
Total electricity for the above, kWh/year	5923.9486	(331)
Electricity for lighting (calculated in Appendix L)	997.4469	(332)

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

PV generation	-9408.5224	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	37046.1266	(338)

10b. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Geothermal	33161.8056	3.1100	1031.3322	(340a)
Space heating total			1031.3322	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Geothermal	5120.8497	3.1100	159.2584	(342a)
Water heating total			159.2584	(342)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(347a)
Space cooling	1250.5982	16.4900	206.2236	(348)
Pumps, fans and electric keep-hot	5923.9486	16.4900	976.8591	(349)
Energy for lighting	997.4469	16.4900	164.4790	(350)
Additional standing charges			92.0000	(351)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9408.5224	16.4900	-1551.4653	
PV Unit electricity exported	0.0000	5.5900	0.0000	

Total		-1551.4653 (352)
Total energy cost		1078.6870 (355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600 (356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.4024 (357)
SAP value		93.4769
SAP rating (Section 12)		93 (358)
SAP band		A

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Geothermal			335.0000 (367)
Space and Water heating from Geothermal	11427.6583	0.0110	108.8895 (367)
Electrical energy for heat distribution (space & water)	331.6181	0.0000	59.5215 (372)
Overall CO2 factor for heat network			0.0048 (386)
Total CO2 associated with community systems			185.2257 (373)
Space and water heating			185.2257 (376)
Space cooling	1250.5982	0.1143	142.9322 (377)
Pumps, fans and electric keep-hot	5923.9486	0.1387	821.7247 (378)
Energy for lighting	997.4469	0.1443	143.9624 (379)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-9408.5224	0.1413	-1329.0362
PV Unit electricity exported	0.0000	0.0000	0.0000
Total			-1329.0362 (380)
Total CO2, kg/year			-35.1911 (383)
CO2 emissions per m2			-0.0400 (384)
EI value			100.0489 (384a)
EI rating			100 (385)
EI band			A

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	460.0000 (1b)	x	3.2200 (2b)	=	1481.2000 (1b) - (3b)
First floor	460.0000 (1c)	x	2.9100 (2c)	=	1338.6000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 920.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	2819.8000 (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		1.0000 (17)
Infiltration rate		0.0500 (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) =	0.0500 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.2000	5.2000	5.0000	4.4000	4.3000	3.9000	3.7000	3.7000	4.1000	4.6000	4.8000	4.7000	(22)
Wind factor	1.3000	1.3000	1.2500	1.1000	1.0750	0.9750	0.9250	0.9250	1.0250	1.1500	1.2000	1.1750	(22a)
Adj infilt rate	0.0650	0.0650	0.0625	0.0550	0.0537	0.0488	0.0463	0.0463	0.0512	0.0575	0.0600	0.0588	(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) =	73.8000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.1960	0.1960	0.1935	0.1860	0.1847	0.1798	0.1773	0.1773	0.1822	0.1885	0.1910	0.1898	(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 = 0.80)			441.1300	0.7752	341.9612			(27)
Glazed Door			12.6000	0.8000	10.0800			(26a)
Normal Door			9.4000	1.0000	9.4000			(26)
Heatloss Floor 1			460.0000	0.1000	46.0000	110.0000	50600.0000	(28a)
Ground Floor External Wall	432.8000	260.3900	172.4100	0.1400	24.1374	190.0000	32757.9000	(29a)
First Floor External Wall	448.3200	202.7400	245.5800	0.1400	34.3812	190.0000	46660.2000	(29a)
External Roof	460.0000		460.0000	0.1100	50.6000	9.0000	4140.0000	(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	516.5598			(33)
Internal Wall 1			493.7400			9.0000	4443.6600	(32c)
Internal Floor 1			460.0000			18.0000	8280.0000	(32d)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 146881.7600 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 159.6541 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	157.4600	0.3000	47.2380
E3 Sill	157.4600	0.0200	3.1492
E4 Jamb	162.2800	0.0160	2.5965
E5 Ground floor (normal)	148.7300	0.0530	7.8827
E6 Intermediate floor within a dwelling	148.7300	0.0010	0.1487
E16 Corner (normal)	49.0400	0.0380	1.8635
E17 Corner (inverted – internal area greater than external area)	24.5200	-0.0750	-1.8390
E10 Eaves (insulation at ceiling level)	233.5200	0.1200	28.0224
E12 Gable (insulation at ceiling level)	56.9600	0.2500	14.2400
E13 Gable (insulation at rafter level)	68.2400	0.2500	17.0600

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 120.3620 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 636.9219 (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	182.3847	182.3847	180.0583	173.0793	171.9162	167.2635	164.9372	164.9372	169.5898	175.4057	177.7320	176.5688	(38)
Heat transfer coeff	819.3065	819.3065	816.9802	810.0012	808.8380	804.1853	801.8590	801.8590	806.5117	812.3275	814.6539	813.4907	(39)
Average = Sum(39)m / 12 =												810.7766	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8906	0.8906	0.8880	0.8804	0.8792	0.8741	0.8716	0.8716	0.8766	0.8830	0.8855	0.8842	(40)
HLP (average)												0.8813	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.9379 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	109.6601	108.0315	105.7381	101.5094	98.3431	94.8321	92.9356	95.2130	97.6926	101.4495	105.7653	109.2894	(42b)
Hot water usage for other uses	57.8509	55.7472	53.6435	51.5399	49.4362	47.3325	47.3325	49.4362	51.5399	53.6435	55.7472	57.8509	(42c)

Average daily hot water use (litres/day) 154.2639 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	167.5110	163.7787	159.3816	153.0493	147.7793	142.1646	140.2682	144.6492	149.2325	155.0931	161.5125	167.1403	(44)
Energy conte	265.2965	233.2187	244.9637	209.5169	198.9393	174.8080	169.6422	179.1059	184.0186	210.4598	230.1041	261.7013	(45)

Energy content (annual) Total = Sum(45)m = 2561.7751

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	39.7945	34.9828	36.7445	31.4275	29.8409	26.2212	25.4463	26.8659	27.6028	31.5690	34.5156	39.2552	(46)

Water storage loss:

Store volume 1000.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.4600 (48)

Temperature factor from Table 2b 0.7800 (49)

Enter (49) or (54) in (55) 1.1388 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(56)
If cylinder contains dedicated solar storage	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)

Total per year (kWh/year) = Sum(64)m = 3251.3331 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	135.0632	119.8633	128.3026	115.0052	112.9995	103.4645	103.2582	106.4049	106.5270	116.8301	121.8504	133.8678	(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	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	141.1989	125.4116	101.9916	77.2142	57.7185	48.7284	52.6528	68.4401	91.8601	116.6375	136.1332	145.1233	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1292.2293	1305.6386	1271.8476	1199.9106	1109.1030	1023.7567	966.7401	953.3308	987.1218	1059.0588	1149.8664	1235.2127	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)

Water heating gains (Table 5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	181.5366	178.3680	172.4497	159.7294	151.8810	143.7006	138.7879	143.0173	147.9542	157.0296	169.2367	179.9299	(72)
Total internal gains	1756.2890	1750.7424	1687.6130	1578.1783	1460.0267	1357.5098	1299.5049	1306.1123	1368.2602	1474.0501	1596.5604	1701.5900	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	115.2500	10.0309	0.3600	0.0000	0.7700	320.4609	(75)
Southeast	123.6100	33.4622	0.3600	0.0000	0.7700	1146.5729	(77)
Southwest	122.1800	33.4622	0.3600	0.0000	0.7700	1133.3086	(79)
Northwest	80.0900	10.0309	0.3600	0.0000	0.7700	222.6960	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	2823.0384	5320.7766	8137.1427	11554.4468	13686.0244	13585.1418	13099.6744	11072.6940	9030.8801	5980.3053	3507.9564	2449.4933	(83)
Total gains	4579.3274	7071.5190	9824.7558	13132.6250	15146.0511	14942.6516	14399.1792	12378.8062	10399.1403	7454.3553	5104.5168	4151.0833	(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	49.7988	49.7988	49.9406	50.3709	50.4433	50.7352	50.8824	50.8824	50.5888	50.2266	50.0832	50.1548	
alpha	4.3199	4.3199	4.3294	4.3581	4.3629	4.3823	4.3922	4.3922	4.3726	4.3484	4.3389	4.3437	
util living area	0.9946	0.9712	0.8975	0.7180	0.5310	0.4143	0.3377	0.3972	0.6009	0.8868	0.9845	0.9965	(86)
MIT	19.3484	19.8097	20.3420	20.7930	20.9496	20.9856	20.9950	20.9904	20.9360	20.5504	19.8271	19.2613	(87)
Th 2	20.1755	20.1755	20.1777	20.1842	20.1852	20.1896	20.1917	20.1917	20.1874	20.1820	20.1798	20.1809	(88)
util rest of house	0.9935	0.9659	0.8814	0.6869	0.4933	0.3729	0.2937	0.3470	0.5504	0.8628	0.9809	0.9958	(89)
MIT 2	18.6410	19.0966	19.6095	20.0213	20.1502	20.1810	20.1893	20.1868	20.1463	19.8174	19.1206	18.5582	(90)
Living area fraction									fLA = Living area / (4) =			0.1024	(91)
MIT	18.7134	19.1696	19.6845	20.1003	20.2320	20.2634	20.2717	20.2691	20.2271	19.8924	19.1929	18.6302	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7134	19.1696	19.6845	20.1003	20.2320	20.2634	20.2717	20.2691	20.2271	19.8924	19.1929	18.6302	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9907	0.9576	0.8704	0.6835	0.4955	0.3767	0.2981	0.3519	0.5529	0.8531	0.9751	0.9938	(94)
Useful gains	4536.7783	6771.9316	8551.9227	8976.5665	7505.4902	5629.2102	4292.3034	4355.6421	5750.0219	6359.0064	4977.3705	4125.2204	(95)
Ext temp.	3.9000	4.3000	5.6000	7.9000	10.7000	13.2000	14.9000	14.8000	12.8000	9.7000	6.6000	3.7000	(96)
Heat loss rate W	12136.7165	12182.7561	11506.7654	9882.2820	7709.8741	5680.2861	4307.3853	4385.4471	5990.0595	8279.5615	10258.8623	12145.5897	(97)
Space heating kWh	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98a)
Space heating requirement - total per year (kWh/year)												23491.7296	
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	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												23491.7296	
Space heating per m2											(98c) / (4) =	25.5345	(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.	3.9000	4.3000	5.6000	7.9000	10.7000	13.2000	14.9000	14.8000	12.8000	9.7000	6.6000	3.7000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	8685.2017	7296.9170	7377.1029	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9748	0.9847	0.9724	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	8465.9773	7185.2432	7173.7686	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	17236.2470	16610.8126	14248.2221	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	6314.5942	7012.6236	5263.3934	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9728	(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	1535.7505	1705.5158	1280.0916	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												4521.3579	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Geothermal-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0500	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0500	(305a)
Distribution loss factor (Table 12c) for community heating system	1.5000	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98)
Space heat from Geothermal = (98) x 1.00 x 1.05 x 1.50													
307a	8905.6075	5726.8166	3462.4848	1027.0813	239.4970	0.0000	0.0000	0.0000	0.0000	2250.5065	5989.2117	9398.2687	
Space heating requirement	8905.6075	5726.8166	3462.4848	1027.0813	239.4970	0.0000	0.0000	0.0000	0.0000	2250.5065	5989.2117	9398.2687	(307)

Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) 0.0000 (308)

Space heating fuel for secondary/supplementary system

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)
Water heating													
Annual water heating requirement													
	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
Water heat from Geothermal = (64) x 1.00 x 1.05 x 1.50													
310a	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	
Water heating fuel													
	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	(310)
Cooling System Energy Efficiency Ratio												4.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	383.9376	426.3789	320.0229	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	503.1299	454.4399	503.1299	486.8999	503.1299	486.8999	503.1299	503.1299	486.8999	503.1299	486.8999	503.1299	(331)
Lighting	123.5906	99.1490	89.2727	65.4050	50.5207	41.2758	46.0867	59.9052	77.8109	102.0921	115.3128	127.0256	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-812.4773	-933.1904	-1006.2351	-779.2296	-633.2200	-558.7076	-562.9648	-654.8727	-765.8378	-932.9504	-837.8009	-739.7350	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)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	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)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	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)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	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)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	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)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	(335b)

Annual totals kWh/year		
Space heating fuel - community heating	36999.4742	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	5120.8497	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	369.9947	(313)
Space cooling fuel	1130.3395	(321)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.7220)		
mechanical ventilation fans (SFP = 1.7220)	5923.9486	(330a)
Total electricity for the above, kWh/year	5923.9486	(331)
Electricity for lighting (calculated in Appendix L)	997.4469	(332)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-9217.2214	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	40954.8374	(338)

10b. Fuel costs - using BEDF prices (535)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Geothermal	36999.4742	5.2900	1957.2722	(340a)
Space heating total			1957.2722	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Geothermal	5120.8497	5.2900	270.8929	(342a)
Water heating total			270.8929	(342)
Energy for instantaneous electric shower(s)	0.0000	25.1600	0.0000	(347a)
Space cooling	1130.3395	25.1600	284.3934	(348)
Pumps, fans and electric keep-hot	5923.9486	25.1600	1490.4655	(349)
Energy for lighting	997.4469	25.1600	250.9576	(350)
Additional standing charges			102.0000	(351)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9217.2214	25.1600	-2319.0529	
PV Unit electricity exported	0.0000	5.8100	0.0000	
Total			-2319.0529	(352)
Total energy cost			2036.9287	(355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Geothermal			335.0000	(367)
Space and Water heating from Geothermal	12573.2310	0.0110	121.4908	(367)
Electrical energy for heat distribution (space & water)	369.9947	0.0000	65.4026	(372)
Overall CO2 factor for heat network			0.0048	(386)
Total CO2 associated with community systems			203.7081	(373)
Space and water heating			203.7081	(376)
Space cooling	1130.3395	0.1143	129.2431	(377)
Pumps, fans and electric keep-hot	5923.9486	0.1387	821.7247	(378)
Energy for lighting	997.4469	0.1443	143.9624	(379)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9217.2214	0.1411	-1300.9910	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1300.9910	(380)
Total CO2, kg/year			-2.3527	(383)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Geothermal			335.0000	(467a)
Space and Water heating from Geothermal	12573.2310	0.0510	563.2756	(467)
Electrical energy for heat distribution (space & water)	369.9947	0.0000	663.2674	(472)
Overall CO2 factor for heat network			0.0310	(486)
Total CO2 associated with community systems			1304.5022	(473)
Space and water heating			1304.5022	(476)
Space cooling	1130.3395	1.4214	1606.6408	(477)

```
Pumps, fans and electric keep-hot                                                                 5923.9486          1.5128          8961.7495 (478)
Energy for lighting                                                                                997.4469          1.5338          1529.9174 (479)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                             -9217.2214          1.5220        -14028.6550
PV Unit electricity exported                                                                         0.0000          0.0000            0.0000
Total                                                                                                                               -14028.6550 (480)
Total Primary energy kWh/year                                                                                                         -625.8452 (483)
```

SAP 10 EPC IMPROVEMENTS

```
Be Green

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

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                    + 0.2        -£  48          -1 kg (30.7%)

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

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

Fuel prices for cost data on this page from database revision number 535 TEST (04 Jan 2024)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, North West England):
                                       Current        Potential      Saving
  Electricity                           £2026       £2026       £0
  Community scheme                      £2330       £2330       £0

  Space heating                         £3550       £3550       £0
  Space cooling                         £284        £284        £0
  Water heating                         £271        £271        £0
  Lighting                              £251        £251        £0
  Generated (PV)                       -£2319      -£2319       £0

  Total cost of fuels                  £2037         £2037         £0
  Total cost of uses                   £2037         £2037         £0
  Delivered energy                     45 kWh/m²     45 kWh/m²     0 kWh/m²
  Carbon dioxide emissions             -0.0 tonnes   -0.0 tonnes   0.0 tonnes
  CO2 emissions per m²                 -0 kg/m²      -0 kg/m²      0 kg/m²
  Primary energy                       -1 kWh/m²     -1 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

---

1. Overall dwelling characteristics

```
                                                                                          Area          Storey height                Volume
                                                                                          (m2)               (m)                      (m3)
Ground floor                                                                          460.0000 (1b)    x      3.2200 (2b)    =   1481.2000 (1b) - (3b)
First floor                                                                           460.0000 (1c)    x      2.9100 (2c)    =   1338.6000 (1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)                  920.0000                                                          (4)
Dwelling volume                                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =   2819.8000 (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                                                                                                          1.0000 (17)
```

```
Infiltration rate                                                                                                            0.0500 (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)  =     0.0500 (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
                 0.0638     0.0625     0.0613     0.0550     0.0537     0.0475     0.0475     0.0463     0.0500     0.0537     0.0563     0.0588 (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) =                                73.8000 (23c)

Effective ac     0.1948     0.1935     0.1923     0.1860     0.1847     0.1785     0.1785     0.1773     0.1810     0.1847     0.1872     0.1898 (25)
```

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3. Heat losses and heat loss parameter

```
Element                                          Gross       Openings         NetArea        U-value         A x U        K-value           A x K
                                                    m2             m2              m2          W/m2K           W/K         kJ/m2K            kJ/K
Window (Uw = 0.80)                                                           441.1300         0.7752      341.9612                              (27)
Glazed Door                                                                   12.6000         0.8000       10.0800                              (26a)
Normal Door                                                                    9.4000         1.0000        9.4000                              (26)
Heatloss Floor 1                                                             460.0000         0.1000       46.0000       110.0000      50600.0000 (28a)
Ground Floor External Wall                    432.8000       260.3900        172.4100         0.1400       24.1374       190.0000      32757.9000 (29a)
First Floor External Wall                     448.3200       202.7400        245.5800         0.1400       34.3812       190.0000      46660.2000 (29a)
External Roof                                 460.0000                       460.0000         0.1100       50.6000         9.0000       4140.0000 (30)
Total net area of external elements Aum(A, m2)                              1801.1200                                                   (31)
Fabric heat loss, W/K = Sum (A x U)                                     (26)...(30) + (32) =   516.5598                                 (33)
Internal Wall 1                                                              493.7400                                    9.0000       4443.6600 (32c)
Internal Floor 1                                                             460.0000                                   18.0000       8280.0000 (32d)

Heat capacity Cm = Sum(A x k)                                                        (28)...(30) + (32) + (32a)...(32e) = 146881.7600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                         159.6541 (35)
List of Thermal Bridges
        K1 Element                                                                          Length       Psi-value          Total
        E2 Other lintels (including other steel lintels)                                  157.4600          0.3000        47.2380
        E3 Sill                                                                           157.4600          0.0200         3.1492
        E4 Jamb                                                                           162.2800          0.0160         2.5965
        E5 Ground floor (normal)                                                          148.7300          0.0530         7.8827
        E6 Intermediate floor within a dwelling                                           148.7300          0.0010         0.1487
        E16 Corner (normal)                                                                49.0400          0.0380         1.8635
        E17 Corner (inverted - internal area greater than external area)                  24.5200         -0.0750        -1.8390
        E10 Eaves (insulation at ceiling level)                                           233.5200          0.1200        28.0224
        E12 Gable (insulation at ceiling level)                                            56.9600          0.2500        14.2400
        E13 Gable (insulation at rafter level)                                             68.2400          0.2500        17.0600
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                               120.3620 (36)
Point Thermal bridges                                                                                       (36a) =        0.0000
Total fabric heat loss                                                                        (33) + (36) + (36a) =      636.9219 (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          181.2215   180.0583   178.8952   173.0793   171.9162   166.1003   166.1003   164.9372   168.4267   171.9162   174.2425   176.5688 (38)
Heat transfer coeff
               818.1434   816.9802   815.8170   810.0012   808.8380   803.0222   803.0222   801.8590   805.3485   808.8380   811.1644   813.4907 (39)
Average = Sum(39)m / 12 =                                                                                                809.7104

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP              0.8893     0.8880     0.8868     0.8804     0.8792     0.8729     0.8729     0.8716     0.8754     0.8792     0.8817     0.8842 (40)
HLP (average)                                                                                                             0.8801
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                                                                                                         3.9379 (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
               109.6601   108.0315   105.7381   101.5094    98.3431    94.8321    92.9356    95.2130    97.6926   101.4495   105.7653   109.2894 (42b)
Hot water usage for other uses
                57.8509    55.7472    53.6435    51.5399    49.4362    47.3325    47.3325    49.4362    51.5399    53.6435    55.7472    57.8509 (42c)
Average daily hot water use (litres/day)                                                                                154.2639 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
               167.5110   163.7787   159.3816   153.0493   147.7793   142.1646   140.2682   144.6492   149.2325   155.0931   161.5125   167.1403 (44)
Energy conte   265.2965   233.2187   244.9637   209.5169   198.9393   174.8080   169.6422   179.1059   184.0186   210.4598   230.1041   261.7013 (45)
Energy content (annual)                                                                           Total = Sum(45)m =    2561.7751
Distribution loss  (46)m = 0.15 x (45)m
                39.7945    34.9828    36.7445    31.4275    29.8409    26.2212    25.4463    26.8659    27.6028    31.5690    34.5156    39.2552 (46)
Water storage loss:
Store volume                                                                                                            1000.0000 (47)
a) If  manufacturer declared loss factor is known  (kWh/day):                                                              1.4600 (48)
  Temperature factor from Table 2b                                                                                         0.7800 (49)
Enter (49) or (54) in (55)                                                                                                 1.1388 (55)
Total storage loss
                35.3028    31.8864    35.3028    34.1640    35.3028    34.1640    35.3028    35.3028    34.1640    35.3028    34.1640    35.3028 (56)
If cylinder contains dedicated solar storage
                35.3028    31.8864    35.3028    34.1640    35.3028    34.1640    35.3028    35.3028    34.1640    35.3028    34.1640    35.3028 (57)
Primary loss    23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
               323.8617   286.1163   303.5289   266.1929   257.5045   231.4840   228.2074   237.6711   240.6946   269.0250   286.7801   320.2665 (62)
WWHRS           0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63a)
PV diverter    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000    -0.0000 (63b)
Solar input     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63c)
FGHRS           0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63d)
Output from w/h
               323.8617   286.1163   303.5289   266.1929   257.5045   231.4840   228.2074   237.6711   240.6946   269.0250   286.7801   320.2665 (64)
                                                                                Total per year (kWh/year) = Sum(64)m =  3251.3331 (64)
Electric shower(s)
```

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	135.0632	119.8633	128.3026	115.0052	112.9995	103.4645	103.2582	106.4049	106.5270	116.8301	121.8504	133.8678	(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	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	141.1989	125.4116	101.9916	77.2142	57.7185	48.7284	52.6528	68.4401	91.8601	116.6375	136.1332	145.1233	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1292.2293	1305.6386	1271.8476	1199.9106	1109.1030	1023.7567	966.7401	953.3308	987.1218	1059.0588	1149.8664	1235.2127	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)	181.5366	178.3680	172.4497	159.7294	151.8810	143.7006	138.7879	143.0173	147.9542	157.0296	169.2367	179.9299	(72)
Total internal gains	1756.2890	1750.7424	1687.6130	1578.1783	1460.0267	1357.5098	1299.5049	1306.1123	1368.2602	1474.0501	1596.5604	1701.5900	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	115.2500	11.2829	0.3600	0.0000	0.7700	360.4595	(75)
Southeast	123.6100	36.7938	0.3600	0.0000	0.7700	1260.7293	(77)
Southwest	122.1800	36.7938	0.3600	0.0000	0.7700	1246.1444	(79)
Northwest	80.0900	11.2829	0.3600	0.0000	0.7700	250.4920	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	3117.8253	5513.7430	8083.1715	10918.9337	13054.7816	13323.1193	12693.9516	11045.0563	9056.4739	6239.1965	3771.3921	2644.2953	(83)
Total gains	4874.1142	7264.4853	9770.7845	12497.1119	14514.8083	14680.6291	13993.4565	12351.1686	10424.7341	7713.2465	5367.9525	4345.8853	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	49.8696	49.9406	50.0118	50.3709	50.4433	50.8087	50.8087	50.8824	50.6619	50.4433	50.2987	50.1548	
alpha	4.3246	4.3294	4.3341	4.3581	4.3629	4.3872	4.3872	4.3922	4.3775	4.3629	4.3532	4.3437	
util living area	0.9925	0.9642	0.8811	0.7037	0.5036	0.3478	0.2520	0.2976	0.5166	0.8470	0.9789	0.9953	(86)
MIT	19.4579	19.9252	20.4370	20.8236	20.9628	20.9941	20.9989	20.9977	20.9700	20.6708	19.9458	19.3655	(87)
Th 2	20.1766	20.1777	20.1788	20.1842	20.1852	20.1906	20.1906	20.1917	20.1885	20.1852	20.1831	20.1809	(88)
util rest of house	0.9909	0.9575	0.8622	0.6696	0.4632	0.3046	0.2059	0.2458	0.4610	0.8156	0.9739	0.9943	(89)
MIT 2	18.7509	19.2118	19.7006	20.0488	20.1607	20.1876	20.1902	20.1909	20.1714	19.9291	19.2402	18.6622	(90)
Living area fraction									fLA = Living area / (4) =			0.1024	(91)
MIT	18.8233	19.2848	19.7760	20.1281	20.2428	20.2702	20.2730	20.2735	20.2532	20.0050	19.3125	18.7342	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.8233	19.2848	19.7760	20.1281	20.2428	20.2702	20.2730	20.2735	20.2532	20.0050	19.3125	18.7342	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9874	0.9484	0.8518	0.6671	0.4661	0.3089	0.2106	0.2510	0.4656	0.8079	0.9669	0.9918	(94)
Useful gains	4812.6299	6889.9772	8323.0860	8336.8954	6764.9857	4534.7680	2947.0071	3100.5597	4853.3138	6231.1871	5190.5176	4310.1478	(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	11882.1025	11752.1164	10830.7700	9094.8021	6909.7156	4553.2735	2949.5219	3105.9737	4955.4405	7607.1362	9906.3087	11823.4608	(97)
Space heating kWh	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98a)
Space heating requirement - total per year (kWh/year)												21055.1147	
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	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												21055.1147	
Space heating per m2											(98c) / (4) =	22.8860	(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	7548.4085	5942.3641	6094.1285	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9838	0.9921	0.9860	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	7425.9308	5895.2570	6008.8954	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	16929.9869	16136.5912	14215.9184	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	6842.9204	7619.5526	6106.0251	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9728	(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	1664.2429	1853.1249	1485.0251	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling requirement	5002.3929	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Geothermal-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0500	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0500	(305a)
Distribution loss factor (Table 12c) for community heating system	1.5000	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

Space heating requirement	5259.6876	3267.3576	1865.7169	545.6928	107.6791	0.0000	0.0000	0.0000	0.0000	1023.7061	3395.3696	5589.9049	(98)
Space heat from Geothermal = (98) x 1.00 x 1.05 x 1.50													
307a	8284.0080	5146.0882	2938.5041	859.4662	169.5946	0.0000	0.0000	0.0000	0.0000	1612.3372	5347.7072	8804.1002	
Space heating requirement	8284.0080	5146.0882	2938.5041	859.4662	169.5946	0.0000	0.0000	0.0000	0.0000	1612.3372	5347.7072	8804.1002	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

Annual water heating requirement	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
Water heat from Geothermal = (64) x 1.00 x 1.05 x 1.50													
310a	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	
Water heating fuel	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	(310)
Cooling System Energy Efficiency Ratio												4.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	416.0607	463.2812	371.2563	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	503.1299	454.4399	503.1299	486.8999	503.1299	486.8999	503.1299	503.1299	486.8999	503.1299	486.8999	503.1299	(331)
Lighting	123.5906	99.1490	89.2727	65.4050	50.5207	41.2758	46.0867	59.9052	77.8109	102.0921	115.3128	127.0256	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-855.3092	-939.6664	-1006.7756	-805.9568	-661.5888	-570.3878	-581.1824	-656.0203	-763.8507	-932.2154	-862.0799	-773.4890	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)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	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)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	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)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	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)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	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)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	(335b)

Annual totals kWh/year

Space heating fuel - community heating	33161.8056	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	5120.8497	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	331.6181	(313)
Space cooling fuel	1250.5982	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.7220)

mechanical ventilation fans (SFP = 1.7220)	5923.9486	(330a)
Total electricity for the above, kWh/year	5923.9486	(331)
Electricity for lighting (calculated in Appendix L)	997.4469	(332)

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

PV generation	-9408.5224	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	37046.1266	(338)

10b. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Geothermal	33161.8056	3.1100	1031.3322	(340a)
Space heating total			1031.3322	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Geothermal	5120.8497	3.1100	159.2584	(342a)
Water heating total			159.2584	(342)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(347a)
Space cooling	1250.5982	16.4900	206.2236	(348)
Pumps, fans and electric keep-hot	5923.9486	16.4900	976.8591	(349)
Energy for lighting	997.4469	16.4900	164.4790	(350)
Additional standing charges			92.0000	(351)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9408.5224	16.4900	-1551.4653	
PV Unit electricity exported	0.0000	5.5900	0.0000	
Total			-1551.4653	(352)
Total energy cost			1078.6870	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600	(356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.4024	(357)
SAP value		93.4769	
SAP rating (Section 12)		93	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Geothermal			335.0000	(367)
Space and Water heating from Geothermal	11427.6583	0.0110	108.8895	(367)
Electrical energy for heat distribution (space & water)	331.6181	0.0000	59.5215	(372)
Overall CO2 factor for heat network			0.0048	(386)
Total CO2 associated with community systems			185.2257	(373)
Space and water heating			185.2257	(376)
Space cooling	1250.5982	0.1143	142.9322	(377)
Pumps, fans and electric keep-hot	5923.9486	0.1387	821.7247	(378)
Energy for lighting	997.4469	0.1443	143.9624	(379)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9408.5224	0.1413	-1329.0362	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1329.0362	(380)
Total CO2, kg/year			-35.1911	(383)
CO2 emissions per m2			-0.0400	(384)
EI value			100.0489	(384a)
EI rating			100	(385)
EI band			A	

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

1. Overall dwelling characteristics

	Area (m2)			Storey height (m)			Volume (m3)	
Ground floor	460.0000	(1b)	x	3.2200	(2b)	=	1481.2000	(1b) - (3b)
First floor	460.0000	(1c)	x	2.9100	(2c)	=	1338.6000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 920.0000								(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	2819.8000	(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		1.0000	(17)
Infiltration rate		0.0500	(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) =	0.0500	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.2000	5.2000	5.0000	4.4000	4.3000	3.9000	3.7000	3.7000	4.1000	4.6000	4.8000	4.7000	(22)
Wind factor	1.3000	1.3000	1.2500	1.1000	1.0750	0.9750	0.9250	0.9250	1.0250	1.1500	1.2000	1.1750	(22a)
Adj infilt rate	0.0650	0.0650	0.0625	0.0550	0.0537	0.0488	0.0463	0.0463	0.0512	0.0575	0.0600	0.0588	(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) =	73.8000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.1960	0.1960	0.1935	0.1860	0.1847	0.1798	0.1773	0.1773	0.1822	0.1885	0.1910	0.1898	(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 = 0.80)			441.1300	0.7752	341.9612			(27)
Glazed Door			12.6000	0.8000	10.0800			(26a)
Normal Door			9.4000	1.0000	9.4000			(26)
Heatloss Floor 1			460.0000	0.1000	46.0000	110.0000	50600.0000	(28a)
Ground Floor External Wall	432.8000	260.3900	172.4100	0.1400	24.1374	190.0000	32757.9000	(29a)
First Floor External Wall	448.3200	202.7400	245.5800	0.1400	34.3812	190.0000	46660.2000	(29a)
External Roof	460.0000		460.0000	0.1100	50.6000	9.0000	4140.0000	(30)
Total net area of external elements Aum(A, m2)			1801.1200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		516.5598			(33)
Internal Wall 1			493.7400			9.0000	4443.6600	(32c)
Internal Floor 1			460.0000			18.0000	8280.0000	(32d)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	146881.7600	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		159.6541	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)	157.4600	0.3000	47.2380	
E3 Sill	157.4600	0.0200	3.1492	
E4 Jamb	162.2800	0.0160	2.5965	
E5 Ground floor (normal)	148.7300	0.0530	7.8827	
E6 Intermediate floor within a dwelling	148.7300	0.0010	0.1487	
E16 Corner (normal)	49.0400	0.0380	1.8635	
E17 Corner (inverted - internal area greater than external area)	24.5200	-0.0750	-1.8390	
E10 Eaves (insulation at ceiling level)	233.5200	0.1200	28.0224	
E12 Gable (insulation at ceiling level)	56.9600	0.2500	14.2400	
E13 Gable (insulation at rafter level)	68.2400	0.2500	17.0600	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			120.3620	(36)
Point Thermal bridges		(36a) =	0.0000	
Total fabric heat loss		(33) + (36) + (36a) =	636.9219	(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	182.3847	182.3847	180.0583	173.0793	171.9162	167.2635	164.9372	164.9372	169.5898	175.4057	177.7320	176.5688	(38)
Heat transfer coeff	819.3065	819.3065	816.9802	810.0012	808.8380	804.1853	801.8590	801.8590	806.5117	812.3275	814.6539	813.4907	(39)
Average = Sum(39)m / 12 =												810.7766	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8906	0.8906	0.8880	0.8804	0.8792	0.8741	0.8716	0.8716	0.8766	0.8830	0.8855	0.8842	(40)
HLP (average)												0.8813	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												3.9379	(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	109.6601	108.0315	105.7381	101.5094	98.3431	94.8321	92.9356	95.2130	97.6926	101.4495	105.7653	109.2894	(42b)
Hot water usage for other uses	57.8509	55.7472	53.6435	51.5399	49.4362	47.3325	47.3325	49.4362	51.5399	53.6435	55.7472	57.8509	(42c)
Average daily hot water use (litres/day)												154.2639	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	167.5110	163.7787	159.3816	153.0493	147.7793	142.1646	140.2682	144.6492	149.2325	155.0931	161.5125	167.1403	(44)
Energy conte	265.2965	233.2187	244.9637	209.5169	198.9393	174.8080	169.6422	179.1059	184.0186	210.4598	230.1041	261.7013	(45)
Energy content (annual)										Total = Sum(45)m =		2561.7751	
Distribution loss (46)m = 0.15 x (45)m	39.7945	34.9828	36.7445	31.4275	29.8409	26.2212	25.4463	26.8659	27.6028	31.5690	34.5156	39.2552	(46)
Water storage loss:													
Store volume												1000.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.4600	(48)
Temperature factor from Table 2b												0.7800	(49)
Enter (49) or (54) in (55)												1.1388	(55)
Total storage loss	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(56)
If cylinder contains dedicated solar storage	35.3028	31.8864	35.3028	34.1640	35.3028	34.1640	35.3028	35.3028	34.1640	35.3028	34.1640	35.3028	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
								Total per year (kWh/year) = Sum(64)m =				3251.3331	(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	135.0632	119.8633	128.3026	115.0052	112.9995	103.4645	103.2582	106.4049	106.5270	116.8301	121.8504	133.8678	(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	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	236.2758	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	141.1989	125.4116	101.9916	77.2142	57.7185	48.7284	52.6528	68.4401	91.8601	116.6375	136.1332	145.1233	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1292.2293	1305.6386	1271.8476	1199.9106	1109.1030	1023.7567	966.7401	953.3308	987.1218	1059.0588	1149.8664	1235.2127	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	62.5655	(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)	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	-157.5172	(71)
Water heating gains (Table 5)	181.5366	178.3680	172.4497	159.7294	151.8810	143.7006	138.7879	143.0173	147.9542	157.0296	169.2367	179.9299	(72)
Total internal gains	1756.2890	1750.7424	1687.6130	1578.1783	1460.0267	1357.5098	1299.5049	1306.1123	1368.2602	1474.0501	1596.5604	1701.5900	(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	
Northeast	115.2500	10.0309	0.3600	0.0000	0.7700	320.4609	(75)
Southeast	123.6100	33.4622	0.3600	0.0000	0.7700	1146.5729	(77)
Southwest	122.1800	33.4622	0.3600	0.0000	0.7700	1133.3086	(79)
Northwest	80.0900	10.0309	0.3600	0.0000	0.7700	222.6960	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	2823.0384	5320.7766	8137.1427	11554.4468	13686.0244	13585.1418	13099.6744	11072.6940	9030.8801	5980.3053	3507.9564	2449.4933	(83)
Total gains	4579.3274	7071.5190	9824.7558	13132.6250	15146.0511	14942.6516	14399.1792	12378.8062	10399.1403	7454.3553	5104.5168	4151.0833	(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	49.7988	49.7988	49.9406	50.3709	50.4433	50.7352	50.8824	50.8824	50.5888	50.2266	50.0832	50.1548	
alpha	4.3199	4.3199	4.3294	4.3581	4.3629	4.3823	4.3922	4.3922	4.3726	4.3484	4.3389	4.3437	
util living area	0.9946	0.9712	0.8975	0.7180	0.5310	0.4143	0.3377	0.3972	0.6009	0.8868	0.9845	0.9965	(86)
MIT	19.3484	19.8097	20.3420	20.7930	20.9496	20.9856	20.9950	20.9904	20.9360	20.5504	19.8271	19.2613	(87)
Th 2	20.1755	20.1755	20.1777	20.1842	20.1852	20.1896	20.1917	20.1917	20.1874	20.1820	20.1798	20.1809	(88)
util rest of house	0.9935	0.9659	0.8814	0.6869	0.4933	0.3729	0.2937	0.3470	0.5504	0.8628	0.9809	0.9958	(89)
MIT 2	18.6410	19.0966	19.6095	20.0213	20.1502	20.1810	20.1893	20.1868	20.1463	19.8174	19.1206	18.5582	(90)
Living area fraction									fLA = Living area / (4) =			0.1024	(91)
MIT	18.7134	19.1696	19.6845	20.1003	20.2320	20.2634	20.2717	20.2691	20.2271	19.8924	19.1929	18.6302	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7134	19.1696	19.6845	20.1003	20.2320	20.2634	20.2717	20.2691	20.2271	19.8924	19.1929	18.6302	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9907	0.9576	0.8704	0.6835	0.4955	0.3767	0.2981	0.3519	0.5529	0.8531	0.9751	0.9938	(94)
Useful gains	4536.7783	6771.9316	8551.9227	8976.5665	7505.4902	5629.2102	4292.3034	4355.6421	5750.0219	6359.0064	4977.3705	4125.2204	(95)
Ext temp.	3.9000	4.3000	5.6000	7.9000	10.7000	13.2000	14.9000	14.8000	12.8000	9.7000	6.6000	3.7000	(96)
Heat loss rate W	12136.7165	12182.7561	11506.7654	9882.2820	7709.8741	5680.2861	4307.3853	4385.4471	5990.0595	8279.5615	10258.8623	12145.5897	(97)
Space heating kWh	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98a)
Space heating requirement - total per year (kWh/year)												23491.7296	
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	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												23491.7296	
Space heating per m2											(98c) / (4) =	25.5345	(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.	3.9000	4.3000	5.6000	7.9000	10.7000	13.2000	14.9000	14.8000	12.8000	9.7000	6.6000	3.7000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	8685.2017	7296.9170	7377.1029	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9748	0.9847	0.9724	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	8465.9773	7185.2432	7173.7686	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	17236.2470	16610.8126	14248.2221	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	6314.5942	7012.6236	5263.3934	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9728	(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	1535.7505	1705.5158	1280.0916	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												4521.3579	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Geothermal-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0500	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0500	(305a)
Distribution loss factor (Table 12c) for community heating system	1.5000	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	5654.3540	3636.0740	2198.4030	652.1151	152.0616	0.0000	0.0000	0.0000	0.0000	1428.8930	3802.6741	5967.1548	(98)
Space heat from Geothermal = (98) x 1.00 x 1.05 x 1.50													
307a	8905.6075	5726.8166	3462.4848	1027.0813	239.4970	0.0000	0.0000	0.0000	0.0000	2250.5065	5989.2117	9398.2687	
Space heating requirement	8905.6075	5726.8166	3462.4848	1027.0813	239.4970	0.0000	0.0000	0.0000	0.0000	2250.5065	5989.2117	9398.2687	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Annual water heating requirement	323.8617	286.1163	303.5289	266.1929	257.5045	231.4840	228.2074	237.6711	240.6946	269.0250	286.7801	320.2665	(64)
Water heat from Geothermal = (64) x 1.00 x 1.05 x 1.50													
310a	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	
Water heating fuel	510.0822	450.6332	478.0580	419.2538	405.5696	364.5873	359.4266	374.3320	379.0940	423.7144	451.6787	504.4197	(310)
Cooling System Energy Efficiency Ratio												4.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	383.9376	426.3789	320.0229	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	503.1299	454.4399	503.1299	486.8999	503.1299	486.8999	503.1299	503.1299	486.8999	503.1299	486.8999	503.1299	(331)
Lighting	123.5906	99.1490	89.2727	65.4050	50.5207	41.2758	46.0867	59.9052	77.8109	102.0921	115.3128	127.0256	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-812.4773	-933.1904	-1006.2351	-779.2296	-633.2200	-558.7076	-562.9648	-654.8727	-765.8378	-932.9504	-837.8009	-739.7350	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)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	(334a)

Electricity generated by hydro-electric generators (Appendix M) (negative quantity)

(335a)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	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)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	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)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	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)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	(335b)

Annual totals kWh/year		
Space heating fuel - community heating	36999.4742	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	5120.8497	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	369.9947	(313)
Space cooling fuel	1130.3395	(321)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.7220)		
mechanical ventilation fans (SFP = 1.7220)	5923.9486	(330a)
Total electricity for the above, kWh/year	5923.9486	(331)
Electricity for lighting (calculated in Appendix L)	997.4469	(332)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-9217.2214	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	40954.8374	(338)

10b. Fuel costs - using BEDF prices (535)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Geothermal	36999.4742	5.2900	1957.2722	(340a)
Space heating total			1957.2722	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Geothermal	5120.8497	5.2900	270.8929	(342a)
Water heating total			270.8929	(342)
Energy for instantaneous electric shower(s)	0.0000	25.1600	0.0000	(347a)
Space cooling	1130.3395	25.1600	284.3934	(348)
Pumps, fans and electric keep-hot	5923.9486	25.1600	1490.4655	(349)
Energy for lighting	997.4469	25.1600	250.9576	(350)
Additional standing charges			102.0000	(351)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9217.2214	25.1600	-2319.0529	
PV Unit electricity exported	0.0000	5.8100	0.0000	
Total			-2319.0529	(352)
Total energy cost			2036.9287	(355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Geothermal			335.0000	(367)
Space and Water heating from Geothermal	12573.2310	0.0110	121.4908	(367)
Electrical energy for heat distribution (space & water)	369.9947	0.0000	65.4026	(372)
Overall CO2 factor for heat network			0.0048	(386)
Total CO2 associated with community systems			203.7081	(373)
Space and water heating			203.7081	(376)
Space cooling	1130.3395	0.1143	129.2431	(377)
Pumps, fans and electric keep-hot	5923.9486	0.1387	821.7247	(378)
Energy for lighting	997.4469	0.1443	143.9624	(379)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9217.2214	0.1411	-1300.9910	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1300.9910	(380)
Total CO2, kg/year			-2.3527	(383)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Geothermal			335.0000	(467a)
Space and Water heating from Geothermal	12573.2310	0.0510	563.2756	(467)
Electrical energy for heat distribution (space & water)	369.9947	0.0000	663.2674	(472)
Overall CO2 factor for heat network			0.0310	(486)
Total CO2 associated with community systems			1304.5022	(473)
Space and water heating			1304.5022	(476)
Space cooling	1130.3395	1.4214	1606.6408	(477)
Pumps, fans and electric keep-hot	5923.9486	1.5128	8961.7495	(478)
Energy for lighting	997.4469	1.5338	1529.9174	(479)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-9217.2214	1.5220	-14028.6550	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-14028.6550	(480)
Total Primary energy kWh/year			-625.8452	(483)

APPENDIX F – DESIGN EPC

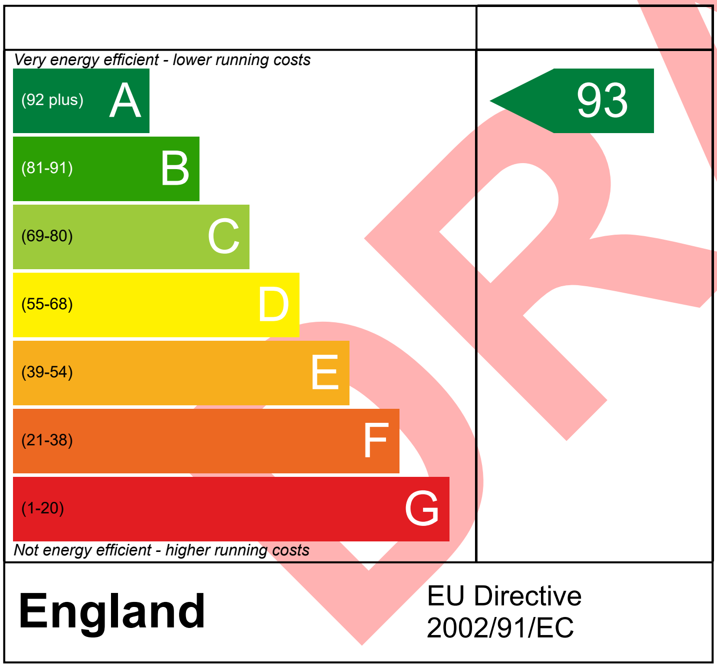
Predicted Energy Assessment

Dwelling type:	House, Detached
Date of assessment:	01/02/2024
Produced by:	Sushil Pathak
Total floor area:	920 m²
DRRN:	

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

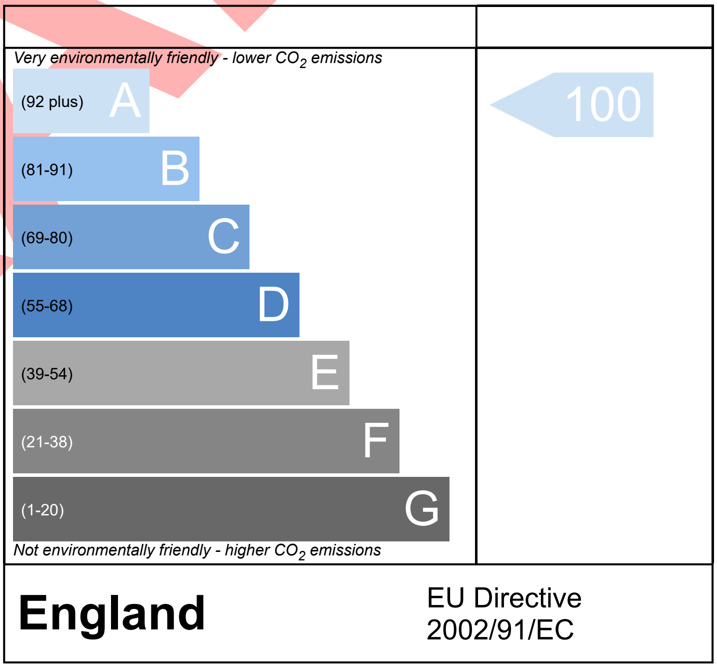
The energy performance has been assessed using the Government approved SAP 10 methodology and is rated in terms of the energy use per square meter of floor area; the energy efficiency is based on fuel costs and the environmental impact is based on carbon dioxide (CO2) emissions.

Energy Efficiency Rating



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

Environmental Impact (CO_2) Rating



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