Energy and Sustainability Statement

RIBA Stage 2-3

Elstree Land

FOR THE SITE AT:

The Green
Twickenham
TW2 5AG
London Borough of Richmond upon Thames

SRE

Version	Revision	Date	Author	Reviewer	Project Manager
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2	A	22/08/2024	Elsa Withnell	Manas Bane	Elsa Withnell
2	B	29/08/2024	Elsa Withnell	-	Elsa Withnell

The outline figures and specification within this document are indicative as modelling has not yet been undertaken. Please contact SRE should you have any questions, or should you wish further modelling to be undertaken.

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1.0 Executive Summary

This Energy and Sustainability Statement has been written to demonstrate the measures incorporated into the design of the 5 no. dwellings, consisting of 4 no. new and 1 no. conversion, at The Green, Twickenham (the Proposed Development) which will deliver lower energy and water use and reduced carbon dioxide (CO_2e) emissions compared with a Building Regulations 2021 Part L compliant design. This Proposed Development is seeking to create and deliver a scheme which enhances both the townscape and the built character of the neighbourhood, delivering a truly sustainable development for the location.

The Proposed Development has been designed incorporating strategies regarding both Energy and Sustainability; each of which tackle local planning policy and general sustainability ambitions. Through these design strategies and accompanying measures, the Proposed Development will comply with and exceed *Building Regulations Part L V1* as well as exceed the measures required for meeting the *Future Homes Standard* (FHS).

Figure 1 - Elevation of Proposed Development (dha Architecture)

Proposed Energy Strategy

The energy strategy has been developed by following the Energy Hierarchy of Lean, Clean, Green and Seen as created by the Greater London Authority (GLA) in line with the *Richmond Local Plan*. The proposed energy strategy includes Lean passive and active design measures and Green low to zero carbon (LZC) technologies to reduce the global warming potential (GWP) and carbon dioxide equivalent (CO_2e) emissions as far as practical and viable in line with *Building Regulations 2021 Part L V1*.

The proposed energy strategy for the Proposed Development is summarised below:

- Enhanced building fabric in line with *2021 Building Regulations Part L V1*
- Exceptional level of build quality with high air tightness
- High performance triple low emissivity (low-E) glazing
- High thermal mass construction due to traditional masonry which, subject to finishes, will help to control internal temperature and thermal comfort
- An effective cooling strategy
- High efficiency light-emitting diode (LED) lighting
- High efficiency air-to-water air source heat pump (ASHP) systems to provide heating through underfloor and radiators where applicable in addition to domestic hot water (DHW) for the 4 no. new units
- Roof mounted solar photovoltaic (PV) panels for the 4 no. new units

	Energy Hierarchy Category	CO_2e Emissions (t/yr)	Improvement (%)	Improvement over Baseline (%)
Site-wide	Baseline	3.71		
	Lean	2.49	32.74	32.74
	Clean	2.49	0.00	46.08
	Green	0.79	68.27	78.81

Table 1 – Summary of regulated CO_2e savings for the Proposed Development

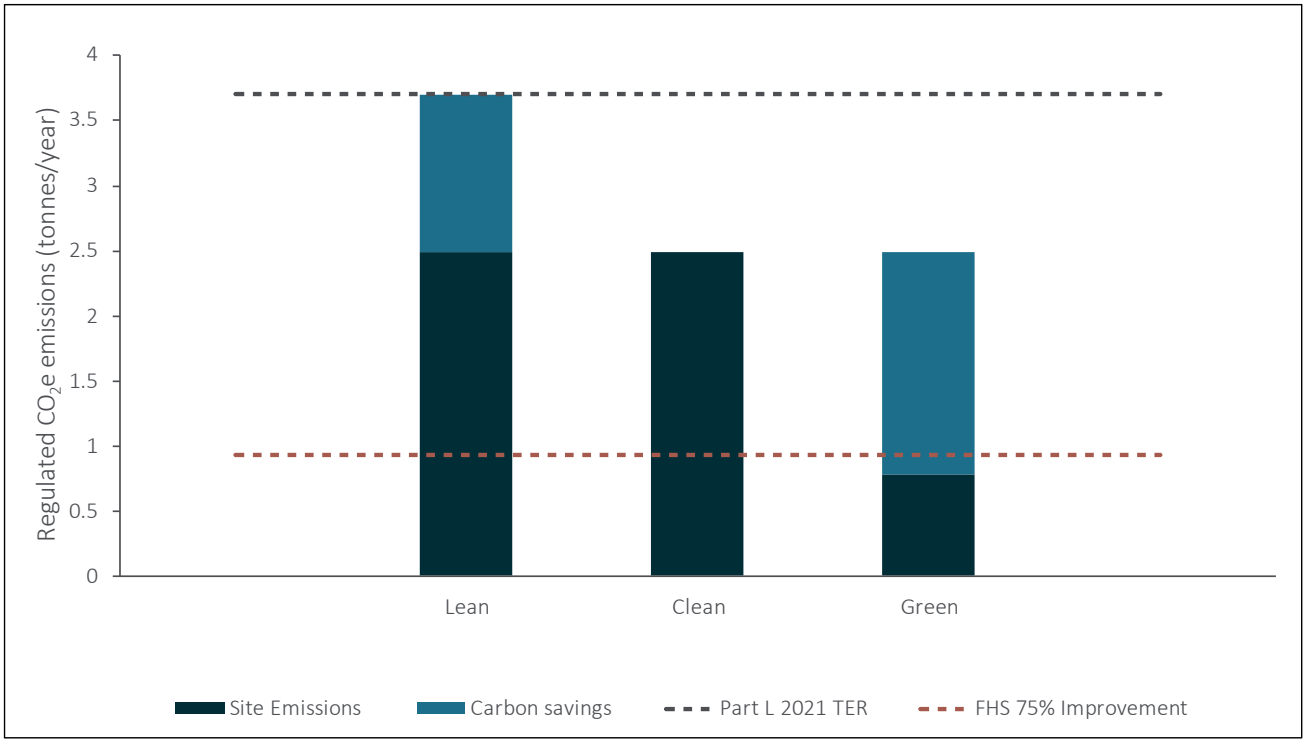


Figure 2 – Energy hierarchy CO_2e site wide emissions reduction graph

Proposed Sustainability Strategy

Through incorporation of sustainability principles, the Proposed Development adopts numerous good practices resulting in positive design and construction methodology. This sustainability strategy will be implemented across the residential spaces. These measures ensure all policy requirements are met with the following notable proposed implementations:

- Air pollution contributions will be negligible on site through operation through use of non-emitting technologies of ASHPs for DHW and space heating. Air pollution is further minimised on a national scale reducing electricity usage through solar PV on site.
- Noise pollution measures have been taken by ensuring minimal disturbance to the occupants through enhanced fabric design and high levels of build quality present seen in very good air tightness levels. Neighbours and surrounding properties will also be relatively unaffected given the technologies installed will be housed in noise dampening containment.

- The site is currently found to be at very low risk of flooding from surface water and rivers and the Proposed Development will not exacerbate this for the site or immediate surrounding area. Sustainable Drainage Systems (SuDS) will be incorporated if found to be needed through further analysis.
- Biodiversity will be protected as much as possible during construction of the Proposed Development with careful consideration given to the local landscape. A biodiversity net gain (BNG) will be ensured and achieved through:
    - Ensuring the highest value habitats are retained
    - Enhancing the existing habitats through appropriate planting of native species where possible
    - Incorporating SuDS
- Construction waste will follow the waste hierarchy minimising landfill contributions.
- Reduction of internal water use has been achieved through use of fittings with a low capacity or flow restrictors in line with the requirement of <105 l/person/day for internal use.
- Bicycle storage is incorporated into the design through garden spaces and readily accessible public transport is available.
- Implementation of sustainable construction techniques and materials, inclusive design, site management and procurement procedures.

Introduction & Key Local Policies

2.0 Introduction

This Energy and Sustainability Statement has been written by SRE on behalf of Elstree Land (the Client) to support the planning permission for the residential developments at The Green (the Proposed Development). The proposed site plan is shown in

Figure 3.

To meet local planning policy and building regulations, the measures incorporated and explained within this statement are categorised into two sections namely:

- Energy – where operational carbon emission reduction is addressed and,
- Sustainability – where measures influencing the overall sustainability of the development are discussed.

The site is located on the corner of The Green and May Road in Twickenham, situated right next to Twickenham Green; a park and events site, and comfortably nestled within the Greater London area. The immediate surrounding area is suburban, with recreational opportunity and amenities nearby.

The existing buildings on-site which consists of office, workshop and storage space are to be demolished (bar the retained flat), freeing up the site in favour of the new residential development. This shall be carried out in accordance with sustainable practices of resource and waste management discussed in more detail in Section 4.6.

2.1 The Proposed Development

This site is located at The Green, Twickenham in the jurisdiction of the Greater London Authority (GLA) and the London Borough of Richmond upon Thames and will be replacing some dilapidated existing residential buildings. The location is planned for demolition in favour of the new dwellings which will provide far superior quality of living to the future occupants and excellent sustainability measures for the local area. One of the existing buildings is deemed suitable to be retained and will be refurbished in line with green aspirations.

Figure 3 – Site Plan of Proposed Development (dha architecture)

Please refer to Appendix A for further architectural details of the Proposed Development.

2.2 Planning Policy

The site is located within Richmond and Greater London and therefore the relevant planning policy contained in the *Richmond Local Plan*, summarised in Table 2, is applicable to the site.

Planning Policy	Requirement
Richmond Local Plan 2018	*Policy LP15: Biodiversity* A. The Council will protect and enhance the borough's biodiversity, in particular, but not exclusively, the sites designated for their biodiversity and nature conservation value, including the connectivity between habitats. Weighted priority in terms of their importance will be afforded to protected species and priority species and habitats including National Nature Reserves, Sites of Special Scientific Interest (SSSI) and Other Sites of Nature Importance as set out in the *Biodiversity Strategy for England*, and the *London and Richmond upon Thames Biodiversity Action Plans*. This will be achieved by: 1. protecting biodiversity in, and adjacent to, the borough's designated sites for biodiversity and nature conservation importance (including buffer zones), as well as other existing habitats and features of biodiversity value; 2. supporting enhancements to biodiversity; 3. incorporating and creating new habitats or biodiversity features, including trees, into development sites and into the design of buildings themselves where appropriate; major developments are required to deliver net gain for biodiversity, through incorporation of ecological enhancements, wherever possible; 4. ensuring new biodiversity features or habitats connect to the wider ecological and green infrastructure networks and complement surrounding habitats; 5. enhancing wildlife corridors for the movement of species, including river corridors, where opportunities arise; and 6. maximising the provision of soft landscaping, including trees, shrubs and other vegetation that support the borough-wide Biodiversity Action Plan. B. Where development would impact on species or a habitat, especially where identified in the relevant *Biodiversity Action Plan* at London or local level, or the *Biodiversity Strategy for England*, the potential harm should: 1. firstly be avoided (the applicant has to demonstrate that there is no alternative site with less harmful impacts), 2. secondly be adequately mitigated; or as a last resort, appropriately compensated for.
	Policy LP 20: Climate Change Adaptation A. The Council will promote and encourage development to be fully resilient to the future impacts of climate change in order to minimise vulnerability of people and property. B. New development, in their layout, design, construction, materials, landscaping and operation, should minimise the effects of overheating as well as minimise energy consumption in accordance with the following cooling hierarchy: 1. minimise internal heat generation through energy efficient design

Richmond Local Plan 2018	2. reduce the amount of heat entering a building in summer through shading, reducing solar reflectance, fenestration, insulation and green roofs and walls 3. manage the heat within the building through exposed internal thermal mass and high ceilings 4. passive ventilation 5. mechanical ventilation 6. active cooling systems (ensuring they are the lowest carbon options). C. Opportunities to adapt existing buildings, places and spaces to the likely effects of climate change should be maximised and will be supported.
	Policy LP21: Flood Risk and Sustainable Drainage *A.* All developments should avoid, or minimise, contributing to all sources of flooding, including fluvial, tidal, surface water, groundwater and flooding from sewers, taking account of climate change and without increasing flood risk elsewhere. Development will be guided to areas of lower risk by applying the *'Sequential Test*' as set out in national policy guidance, and where necessary, the *'Exception Test*' will be applied. B. The Council will require the use of Sustainable Drainage Systems (SuDS) in all development proposals. Applicants will have to demonstrate that their proposal complies with the following: 1. A reduction in surface water discharge to greenfield run-off rates wherever feasible. 2. Where greenfield run-off rates are not feasible, this will need to be demonstrated by the applicant, and in such instances, the minimum requirement is to achieve at least a 50% attenuation of the site's surface water runoff at peak times based on the levels existing prior to the development.
	Policy LP22: Sustainable Design and Construction A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following: 1. Development of 1 dwelling unit or more will be required to complete the *Sustainable Construction Checklist Supplementary Planning Document (SPD)*. A completed Checklist has to be submitted as part of the planning application. 2. Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).
The London Plan (2021)	Policy SI 1: Improving air quality Development plans, through relevant strategic, site-specific and area based policies, should seek opportunities to identify and deliver further improvements to air quality

	and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality. Development proposals should not lead to further deterioration of existing poor air quality, create any new areas that exceed air quality limits and create unacceptable risk of high levels of exposure to poor air quality. As a minimum, development proposals must be at least Air Quality Neutral. Policy SI 2: Minimising Greenhouse Gas Emissions Major developments should be net zero-carbon in accordance with the energy hierarchy. A minimum on-site reduction of 35% with at least 10% through energy efficiency (Lean) measures alone for residential developments, and 15% for non-residential developments. Initially, non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35% improvement. This is because the new Part L baseline now includes low carbon heating for non-residential developments but not for residential developments. However, planning applicants will still be expected to follow the energy hierarchy to maximise carbon savings before offsetting is considered.[1] If zero-carbon cannot be met onsite, a shortfall should be provided either through a cash lieu contribution to the borough or off-site provided that an alternative proposal is identified, and delivery is certain. Policy SI 4: Managing Heat Risk Limit internal heat gain through the cooling hierarchy Policy SI 5: Water Infrastructure Development proposals should minimise the use of mains water in line with the Operational Requirement of the Building Regulations (Residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption).

Table 2 - Summary of local planning policy requirements

2.3 Applicability to Proposed Development

The planning documents outline the requirements and strategy for this borough. In order to demonstrate measurable alignment with these policies, energy and sustainability measures are required as outlined within this statement.

In accordance with the energy and sustainability aspirations set by the *Richmond Local Plan* the following standards are proposed to be met:

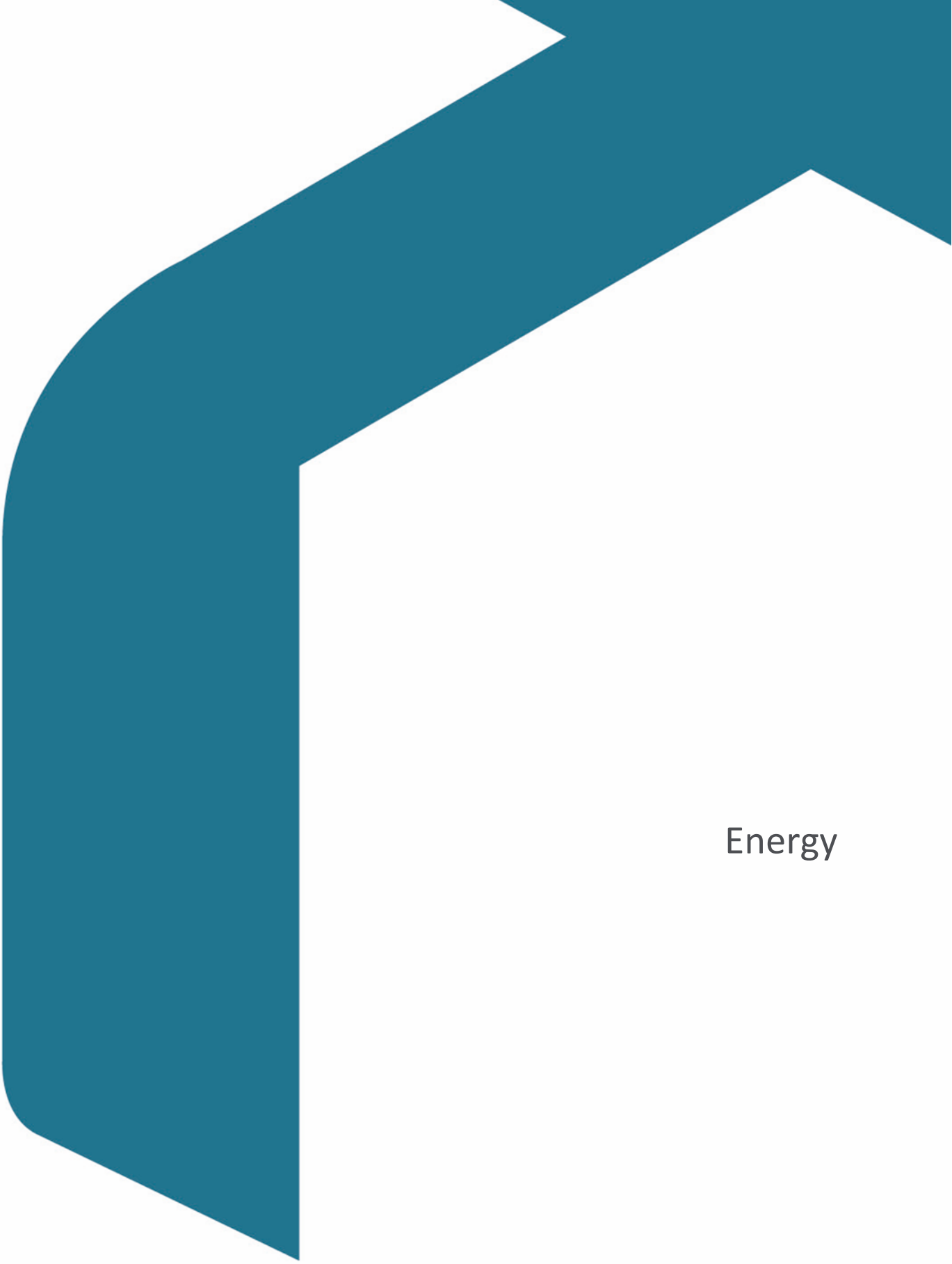
- Biodiversity must be protected and enhanced where possible,
- Follow the cooling hierarchy to be future proofed against climate change and to minimise the risk of overheating,

[1] Part L 2021 and the Energy Assessment Guidance 2022 – cover note
https://www.london.gov.uk/sites/default/files/energy_assessment_guidance_cover_note_june_2022_july_update.pdf

- SuDs should be implemented if required by site geology,
- Reduce internal mains water consumption to <105 litres/person/day.

The Proposed Development will aspire to exceed the on-site requirements as set out in the local planning documentation through the provision of a robustly sustainable, energy efficient development. This will be shown through the additional improvements that will allow the developments to reach the *Future Homes Standard* (FHS):

- Strategy designed in accordance with the Lean, Clean, Green and Seen energy hierarchy,
- Lean passive measures through a fabric first approach ensuring excellent insulation and air tightness through high quality construction materials and methodology,
- Maximise carbon savings through active energy efficiency measures,
- Low-to-zero carbon (LZC) technologies including photovoltaic (PV) panels, air source heat pumps (ASHPs) and wastewater heat recovery (WWHR) systems,
- Incorporate measures of the cooling hierarchy within the Proposed Development,
- Reduce emissions resulting from construction and lifetime usage of building.



Energy

3.0 Energy

The energy strategy has been developed by following the Energy Hierarchy of Lean, Clean, Green and Seen[2], as shown in Figure 4.

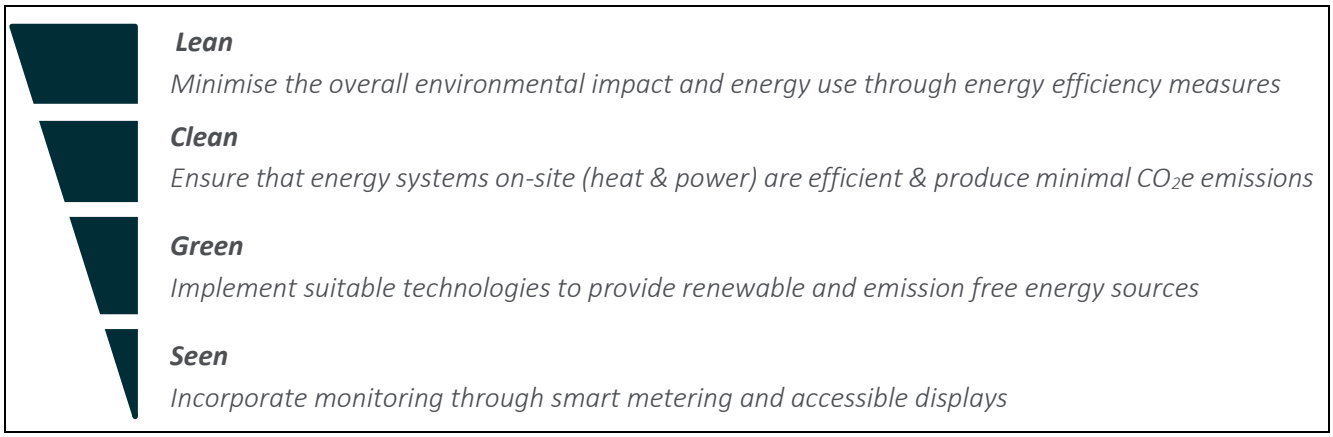


Figure 4 - The Energy Hierarchy

CO_2e Conversion Factors in Table 3 below have been taken from *2021 Building Regulations*. However, within the *Elmhurst Design Standard Assessment Procedure (SAP) 10* software, the CO_2e conversion factor for electricity varies over the course of the year due to the changing mix of inputs to the electricity grid, i.e., increased PV generation in the summer months.

Energy Source	CO_2e Conversion Factor ($kgCO_2e/kWh$)
Electricity (mains)	0.136[3]
Electricity (offset)	-0.136[2]
Gas (mains)	0.210

Table 3 – CO_2e conversion factors by energy source

The energy modelling for the Proposed Development has been calculated using *SAP 10* software in accordance with *2021 Building Regulation Part L V1*. This has involved assessment of a sample unit. This unit has been selected to maximise the variation of performance with a focus on establishing worst case instance. The result from this unit has been multiplied by the number of instances to obtain a conservative approximation of performance for the Proposed Development.

The Target Emission Rates (TERs) from the Green scenario provide the energy baseline and are the exact size and shape of the corresponding units in the Proposed Development. The Baseline uses notional U-values and heating specifications outlined in *2021 Building Regulations Approved Document Part L V1* and the *Domestic Building Services Compliance Guide*. The Baseline CO_2e emissions are shown in Table 4.

[2] Standard approach informed by regional UK policies (GLA)
[3]This value is not directly used, but rather represents the average of the month-to-month values used.

	Energy Hierarchy Category	CO_2e Emissions (t/yr)
Site-wide	Baseline	3.71

Table 4 - Baseline values for CO2e emissions

3.1 LEAN – Demand Reduction

The Proposed Development follows a fabric first approach, creating a high-performance building envelope. This is done through the Lean scenario that uses passive and active design measures to reduce CO_2e emissions. See results shown in Table 5.

	Energy Hierarchy Category	CO_2e Emissions (t/yr)	Improvement over Baseline (%)
Site-wide	Baseline	3.71	
	Lean	2.49	32.74

Table 5 – Lean CO_2e emissions and fabric improvement over Baseline in accordance with the GLA emissions spreadsheet

As can be observed, the Lean strategy alone meets the emissions rate targets (DER) passing with 32.74% over the target emission rate. This is calculated using the GLA emissions spreadsheet which removes the renewable solar PV system from the notional target (against which this is compared). This allows for the Lean improvements to be more accurately calculated to determine the fabrics quality.

An overall sustainable and balanced solution will still be achieved with the DER factors being addressed through the later discussed Green strategy.

A fabric-first approach has been taken with a prioritisation of passive solutions. These are outlined in a detailed breakdown of all these measures below.

All measures applied after the Lean scenario will be compared directly with the baseline CO_2e emissions to show improvement against a 2021 Building Regulations compliant design.

3.1.1 Passive Design Measures

The Proposed Development has been positioned within the site to maximise usable space while retaining a positive public interface in line with the area's aesthetics. The building orientation and fenestration design has aimed to maximise solar gain where possible within the site boundaries. All glazed areas of the building will have elements of shading provided by the building form or internal curtains or blinds.

Natural ventilation will be provided through openable windows to provide purge ventilation which is help address any potential overheating risks *(Part O)* and ventilation *(Part F)* requirements. Thermal gains are further managed through use of low emissivity (low-E) glazing controlling summer gains and a low U-value managing critical thermal losses.

The construction method is expected to be a traditional masonry structure. As discussed, a fabric first approach will be followed for both the new and existing elements with high levels of insulation through external elements, with a low infiltration rate. Proposed U-values for the new element are summarised in Table 6, with construction details provided in Appendix B. The existing elements will meet and exceed the requirements of Table 4.3 in Approved Document Part L V1.

Element	Proposed U-value (W/m^2K)
External Walls	0.14
Pitched Roof	0.10
Flat Roof	0.11
Ground Floor	0.10
Windows	0.80 ($G_{centre\ of\ glass}$-value = 0.40)
External Doors	1.00
Additional Elements	**Detail Measures**
Air Tightness @ 50 Pa	3.00 ($m^3/h.m^2$)
Thermal Bridge	• BRE Thermal Construction details used where viable • Table K1 Default throughout remaining

Table 6 – Fabric energy efficiencies

The high-quality design of the Proposed Development reduces the energy demand of the building, thus reducing the associated CO_2e emissions and the operational costs to the building occupants and users.

3.1.2 Active Design Measures

The Proposed Development will utilise 100% low energy light emitting diode (LED) lighting, improving upon the requirements of *Building Regulations Part L V1*. All external lighting in the development will be positioned to avoid excessive light pollution and be supported by passive infrared (PIR)/daylight sensor and time controls.

In modern air-tight buildings, careful consideration needs to be given to ensure moisture is removed and ventilation standards are met to ensure a healthy standard of internal air. As the Proposed Development has been designed using an Air Source Heat Pump (ASHP) mechanical ventilation with heat recovery (MVHR) is combined within the heating strategy. This active system will work within all wet rooms to remove pollutants and excess moisture. This with operable windows will allow for fresh air to circulate to the building occupants.

As the intended solution for both space heating and DHW is a green technology, a gas boiler has been used indicatively in the Lean scenario for the purpose of comparison. It should be noted that the gas boiler is not being implemented. Further details of the chosen heating strategy can be found in Section 3.3.

Details of the final systems used are provided in the specification sheet in Appendix B.

3.1.3 Cooling

The cooling hierarchy has been used to ensure that passive building design has been optimised to reduce the potential for overheating within the Proposed Development; the design measures proposed are outlined in Table 7.

Cooling Hierarchy	Potential Design Measures
Minimising internal heat generation through energy efficient design	Heat distribution infrastructure will be designed to minimise pipe lengths, adopt pipe configurations to minimise heat loss and be adequately insulated. Low energy lighting throughout with minimal heat output. High specification hot water cylinder installed with low heat loss.
Reducing the amount of heat entering the building in summer	Low-E glass windows and internal blinds are to be provided to minimise solar gain. All new elements are to be well insulated with a high level of air tightness which will reduce heat entering the building.
Use of thermal mass and high ceilings to manage the heat within the building	The impact of high thermal massing from the envelope is expected to help ensure temperature mediation due to thermal lag.
Passive Ventilation	Operable windows will be provided to all habitable rooms and positioned to maximise cross ventilation where room geometry allows.
Mechanical Ventilation	MVHR is proposed within the building to reduce overheating potential.

Table 7 – Design measures following the cooling hierarchy

An Overheating Analysis will be carried out at detailed design stage to demonstrate compliance with *CIBSE TM59* and requirements set out in *Part O.*

3.1.4 Wastewater Heat Recovery (WWHR) Systems

WWHR systems are completely energy neutral and recover some of the heat held in the wastewater from showers. They rely on the wastewater flowing through a counter flow heat exchanger that pre-warms the cold water feed to a shower mixer, heating source or an unvented hot water cylinder. For heat to be recovered, there must be a simultaneous flow of wastewater and cold water through the heat exchanger and hence they can only recover wastewater from a shower and not, for example, a bath.

It is estimated that up to 79% of DHW is used for showering within the home[4]. Currently in the UK, the proposed SAP 10.2 suggests 40-60% depending on house type, but this is based on old data which is being revisited for SAP 11.

[4] Methodology for Ecodesign of Energy-related Products (MEErP) Preparatory Study on Taps and Showers, 2014, p86

Within a well-insulated home, the Coefficient of Performance (COP) for a Heat Pump (HP) can be very high. However, it has been reported that for DHW the COP drops on average to 2.06[5]. With showering being such a large part of this demand, by ensuring that WWHR is installed as a complementary technology to HPs, a large load reduction can be achieved.

3.2 CLEAN – Heating Infrastructure

There is currently no existing or proposed district heating schemes located near the Proposed Development, thus this has been discounted from the scheme. The heating systems proposed for the site are not considered to be wet systems either, and therefore could not utilise District Heating even if one were to become available. No further improvement over the Lean scenario have been recorded.

3.3 GREEN – Low Carbon and Renewable Energy

The addition of Green technologies can provide a significant reduction in CO_2e emissions and enable the Proposed Development to reach high levels of energy efficiency. An ASHP has been proposed as a part of the Green strategy combined with a solar PV array for the 4 no. new units, outlined in Appendix B. The net result of implementing this results in substantial improvement over the Baseline CO_2e emissions as shown in Table 8.

	Energy Hierarchy Category	CO_2e Emissions (t/yr)	Improvement over Baseline (%)
Site-wide	Baseline	3.71	
	Green	0.79	78.81

Table 8 – Green CO_2e emissions and improvement over Baseline

3.3.1 Air Source Heat Pumps (ASHP)

The use of heat pumps (HPs) is often the most direct method of reducing CO_2e emissions for a Proposed Development with minimal change in the aesthetics or the way in which a building is designed. Often a "straight swap," alternative for a gas system boiler, the use of HPs has the potential to provide significant offset in CO_2e emissions.

All HP systems consume electricity to operate – the Coefficient of Performance (CoP) of the system is the ratio of heat energy emitted to electrical energy consumed. Generally, a CoP of 3 or 4 can be achieved, meaning 3 or 4 units of thermal energy are produced for each unit of electricity consumed.

HPs are best at delivering low-grade heat efficiently, and therefore HP systems alone are generally relatively inefficient in providing DHW. These systems are often fitted with an additional electrical immersion booster for high temperature heating maximising the efficiency of the overall system. To achieve the most out of the HP system, space heating will be provided through underfloor heating which requires lower temperature water due to the increased emitter area in comparison to radiators. Further heating for DHW will be achieved in tandem between the ASHP and booster optimised by manufacturer design and specification.

[5] UK Green Building Council (UKGBC), Building the Case for Net Zero, Sept 2020, p24

While an ASHP is typically known to generate some noise, this is not considered to be a significant issue. The Proposed Development is based in a suburban area such that it will have a negligible impact on neighbours and the fabric of the development is expected to be high enough such that minimal sound disturbance will be present. If required, acoustic dampening enclosures can be installed.

To align the proposed energy aspirations, ASHP systems have been proposed in all dwellings as a 'Green' LZC technology.

3.3.2 Photovoltaics (PV)

PV panels convert energy from daylight into direct electrical current (DC) that is then converted to alternating electrical current (AC) via an inverter, or a series of inverters subject to the size of the array. The panels are generally roof mounted and provide electrical generation which can either be utilised directly on-site (or nearby) by HPs, lighting and other electrical equipment, stored in batteries, or exported back to the National Grid using export meters.

Noise will not be an issue – A PV array does not feature moving parts and is silent during operation.

The installation of PV is proposed in order to offset electrical demand within the Proposed Development with any excess being fed back into the National Grid.

The current proposal is to install a solar PV array of 3 no. 400W monocrystalline panels (~1.9m² in area) per dwelling, equivalent to a 1.20kWp array. These have a pitch angle of 30° as per the closest SAP 10 pitch option. With this low area requirement of PV, there is more than adequate roof space throughout the Proposed Development without impacting on the aesthetic appearance of the properties nor encompassing the entire roof space. Details of the proposed PV installation is detailed in Table 9 and Figure 5.

Proposed Array per Dwelling (kWp)	Approximate no. Panels @400W	Active Area (m^2)	Pitch (degrees)	Orientation
1.20	3	5.70	30	South

Table 9 - Proposed PV Array summary

Figure 5 - Roof plan showing proposed PV array indicated in orange

3.4 SEEN – In-use Monitoring

It is recommended that the Proposed Development will be supplied with Smart Meters (where available from the utility supplier) with associated internal energy displays. This will further improve energy efficiency by allowing building occupants to observe their energy use in 'real time' and manage it more effectively.

3.5 Energy Conclusions

The Proposed Development has considered energy efficiency at every stage of the design and will deliver energy demand reduction measures along with LZC technologies in order to reduce energy demand and associated CO_2e emissions resulting from the Proposed Development's operation.

The calculations undertaken demonstrate that the Proposed Development will successfully exceed *Building Regulations Part L V1* compliance, policy set by the Richmond Borough Council and meet or exceed the requirements set out by the *FHS*.

In delivering the Green energy strategy, each dwelling within the Proposed Development will reach a high EPC B vastly exceeding all requirements including those for Future Home Standards. This is achieved through:

- Enhanced building fabric in line with *2021 Building Regulations Part L V1*
- High level of build quality with high air tightness
- High performance double low emissivity (low-E) glazing
- An effective cooling strategy following the cooling hierarchy and achieving compliance with Part O
- High efficiency light emitting diode (LED) lighting
- Air Source Heat Pumps (ASHP) for domestic hot water (DHW) and space heating for 4 no. new units
- Mechanical ventilation with heat recovery (MVHR)
- Wastewater heat recovery (WWHR) systems and

- Onsite renewable electricity generation from photovoltaic (PV) arrays.

The Proposed Development will achieve a site-wide improvement of 78.81% over Baseline through the use of both Lean and Green measures as shown in Table 10 and Figure 6.

	Energy Hierarchy Category	CO_2e Emissions (t/yr)	Improvement (%)	Improvement over Baseline (%)
Site-wide	Baseline	3.71		
	Lean	2.49	32.74	32.74
	Clean	2.49	0.00	46.08
	Green	0.79	68.27	78.81

Table 10 - Summary of site wide CO_2e emissions

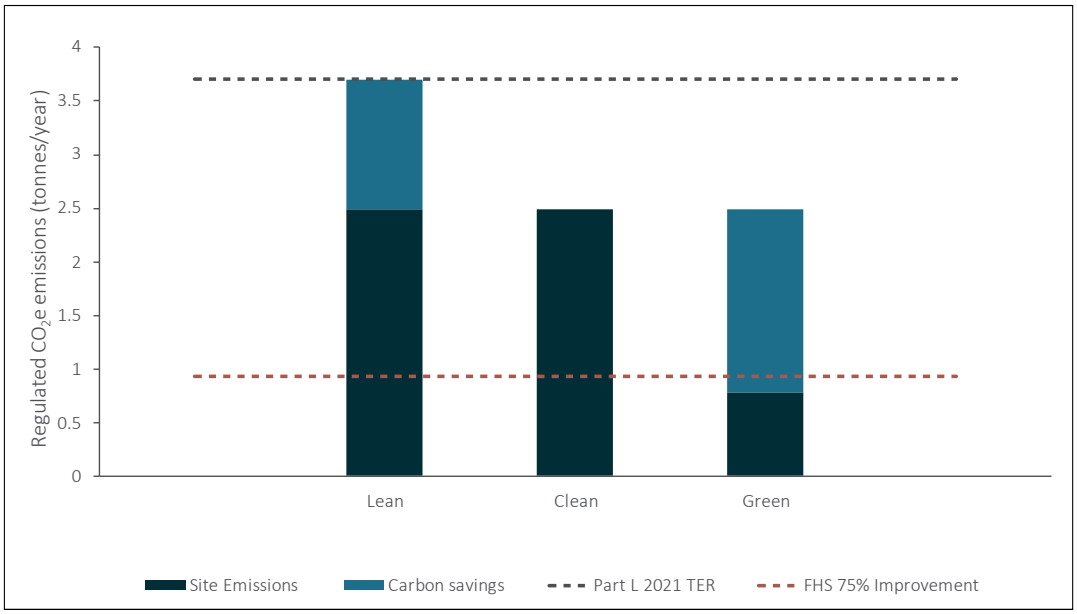


Figure 6 - Summary of site wide CO_2e savings

Sustainability

4.0 Sustainability

Sustainable Development - "meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development: Our Common Future[6]).

The planning system focuses on three objectives to achieve a sustainable development: economic, social, and environmental. These objectives mutually support each other and have been adapted in this statement to meet the objectives of the *Richmond Local Plan*. This planning framework asks that developments make the best use of resources, increase the sustainability of the local communities and are adaptable to climate change. Careful considerations have been taken to ensure the Proposed Development meets these expectations.

4.1 Climate Change

The year 2023 was the warmest year since global records began in 1850, with global temperatures reaching 1.18 °C above the century average.[7] According to the UK Meteorological Office, there is a 98% chance that the next warmest year will be within five years, with there being a two-in-three chance that global average temperature will exceed 1.5°C above pre-industrial levels. [8] Projected annual emissions are only expected to rise, with global temperatures following the same trendline.

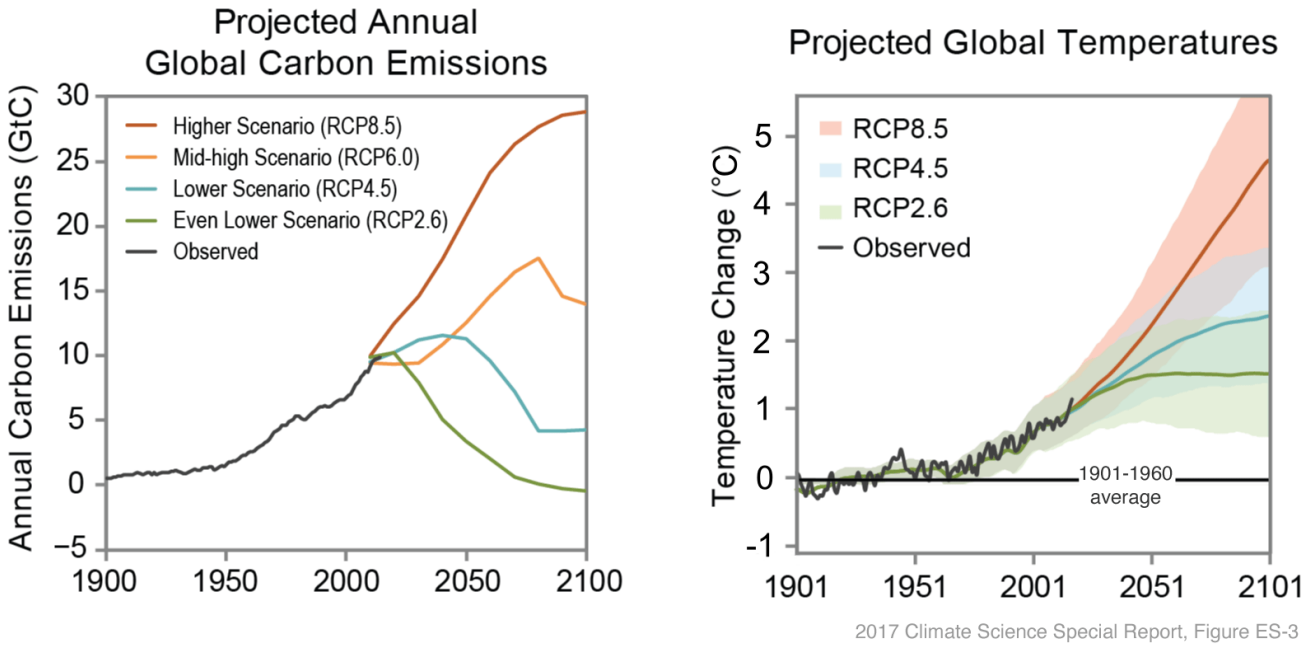


Figure 7 - Project global emissions and temperatures

The UK built environment is one of the largest contributors to greenhouse gas (GHG) emissions, contributing approximately 25% to the total share of UK GHG emissions according to the UK Green Building Council[9]. For a sustainable future, a clear pathway to reducing emissions in our homes is no longer a choice, but a requirement.

[6] https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf
[7] Annual 2023 Global Climate Report | National Centers for Environmental Information (NCEI) (noaa.gov)
[8] New global temperature records on the horizon - Met Office
[9] https://ukgbc.org/our-work/climate-change-mitigation/

4.2 Pollution

Twickenham is located within the London Borough of Richmond's Air Quality Management Area (AQMA). There are exceedances of Nitrogen Oxide (NO_x) emissions and Particulate Matter (PM_{10}), as shown in Figure 8 and Figure 9 respectively.

As the proposed site is located within an area of poor air quality and an AQMA, it is imperative that the Proposed Development has minimal influence and/or impact on the air quality of the location.

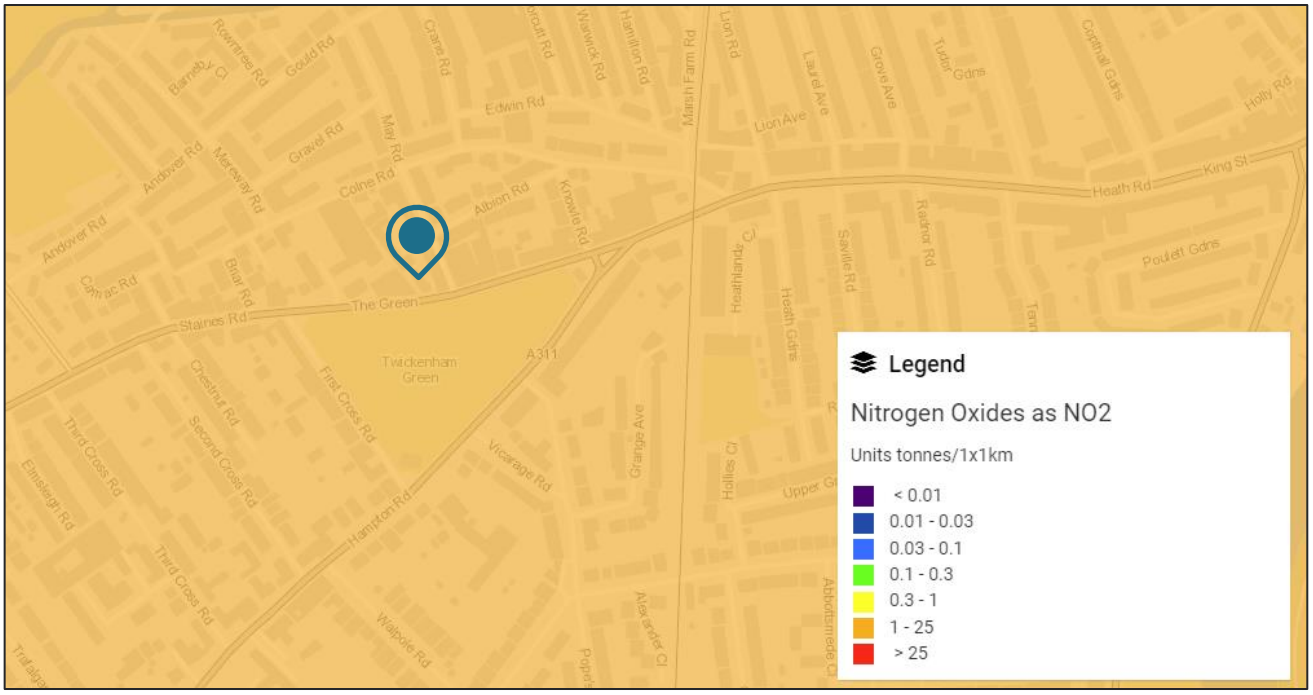


Figure 8 – UK Air Pollution Map showing pollution from NO_x as NO_2 (UK Emissions Interactive Map (beis.gov.uk)

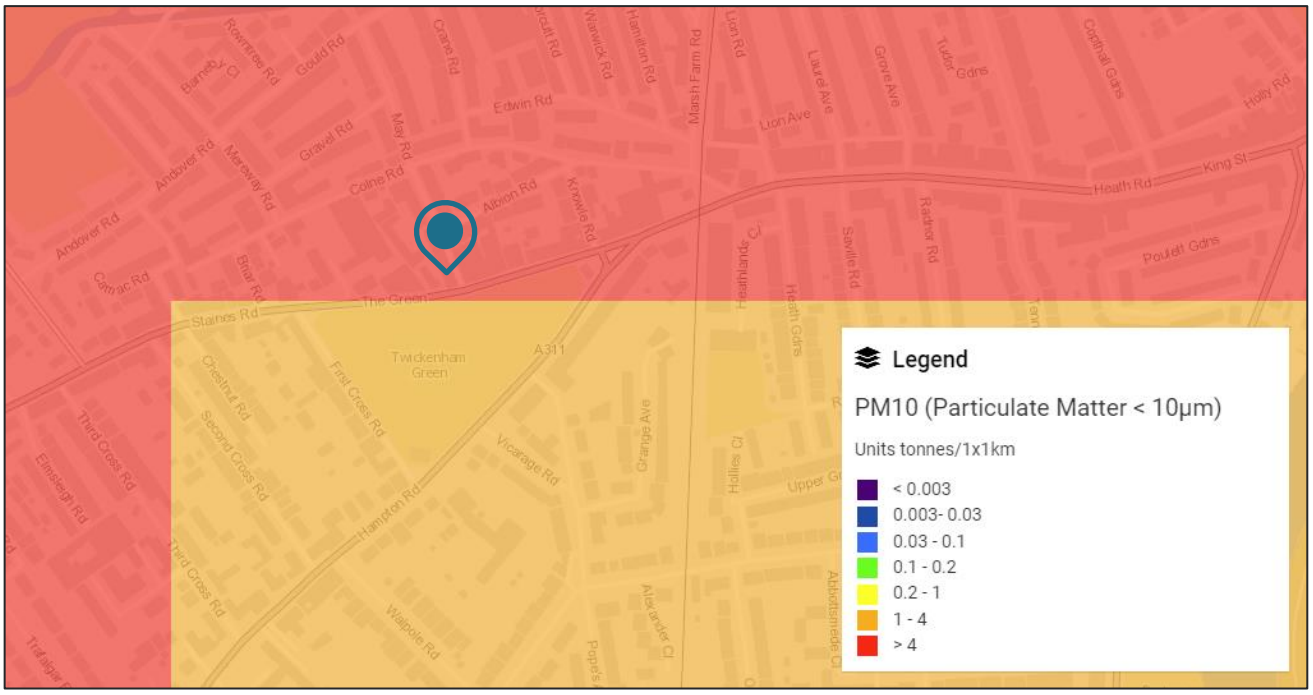


Figure 9 – UK Air Pollution Map showing pollution from PM_{10} (UK Emissions Interactive Map (beis.gov.uk)

The Proposed Development will limit its contribution to local air pollution where possible through the following:

- Opting for ASHPs, that emit no on-site NO_x or CO_2e emissions, for space heating and DHW,
- A reduction in volatile organic compounds (VOCs) from finishes and furnishings,
- Careful placement of heating, ventilation and air condition (HVAC) equipment.

A primary contributor to poor air quality is from vehicle emissions, this is discussed and tackled in detail in Section 4.3.

4.2.1 Noise and Vibration

Noise and Vibration are two other pollutants that must be considered and effectively tackled. The Proposed Development will be replacing an existing building while retaining one for refurbishment. This is due to the following:

- A fabric first design; ensuring high levels of insulation and excellent airtightness,
- Quiet internal plant equipment used and positioned inside each dwelling to minimise noise disturbance,
- Acoustic attenuation measures to any external plant that is deemed likely to cause noise disturbance,
- Encouragement to use more sustainable modes of transport.

During the construction phase, quieter equipment and machinery will be employed and monitored. Additional measures including acoustic screening will be implemented if necessary. Construction traffic generates high levels of noise pollution; vehicles travelling to site will therefore be managed, along with the working hours and activities conducted onsite.

4.2.2 Light

The site layout and designs of the Proposed Development has maximised internal daylight levels taking into consideration a range of design and specification requirements, these include the following:

- Sensitivity of sightlines to neighbouring properties and engagement to the public space,
- All occupied rooms will have suitable areas of glazing to provide natural daylight that meet or exceed national space standards,
- Use of light-coloured curtains or roller blinds will be encouraged to enable glare control and privacy.
- Low energy fittings and daylight controls,
- Security lighting to be PIR and daylight/timer controlled.

These measures will ensure light pollution will be minimised where possible ensuring little to no detriment to the local populus and any negative impacts on local wildlife.

4.3 Transport

Sustainable Transport – "Any efficient, safe and accessible means of transport with overall low impact on the environment, including walking and cycling, ultra-low and zero emission vehicles, car sharing and public transport." (National Planning Policy Framework 2021[10]).

[10] https://www.gov.uk/government/publications/national-planning-policy-framework--2

The Proposed Development makes a concerted effort to facilitate and encourage sustainable transport options for the occupants and visitors both in its intended siting and adopted design strategies.

4.3.1 Public Transport

The siting of the Proposed Development has multiple opportunities for use of public transport in the form of buses and rail options, both within walking distance. It is circa 0.4 miles from Strawberry Hill Railway Station taking about 9 minutes to walk to and circa 0.02 miles from Twickenham Green Bus, directly across the road. Destinations include but are not limited to London, Greater London and surrounding areas.

There are also multiple taxi companies operating around Twickenham, such as Enterprise Car Club, a 6 minute walk to the east.

4.3.2 Parking and Electric Vehicle (EV) Support

The Proposed Development does not include any car parking. On street car parking may be available however, it is unlikely to be available for every unit due to the constraints of the location. EV support will be explored.

4.3.3 Car Rental

There is a car rental service provided by Enterprise Car and Van Club. This company is located on Lion Road, which is 0.2 miles from the Proposed Development.

4.3.4 Bicycle Storage

The provision of adequate, accessible, and convenient bicycle storage is key to supporting the long-term adoption of active travel solutions, such as cycling and multimodal transport. The Proposed Development will provide sufficient bicycle storage facilities in the form of covered spaces for each residential unit, located in small private gardens.

These will be secure and used to encourage the use of a bicycle for shorter, local journeys. This will reduce the need for residents to travel by public transport and individual cars, thus reducing the carbon dioxide and nitrous oxide emissions associated with transportation for this development.

4.4 Flood Risk

Investigation into the location of the site reveals that it is located in a very low flood risk zone from rivers and the sea and has a low risk of surface water flooding as seen in Figure 10 and Figure 11.

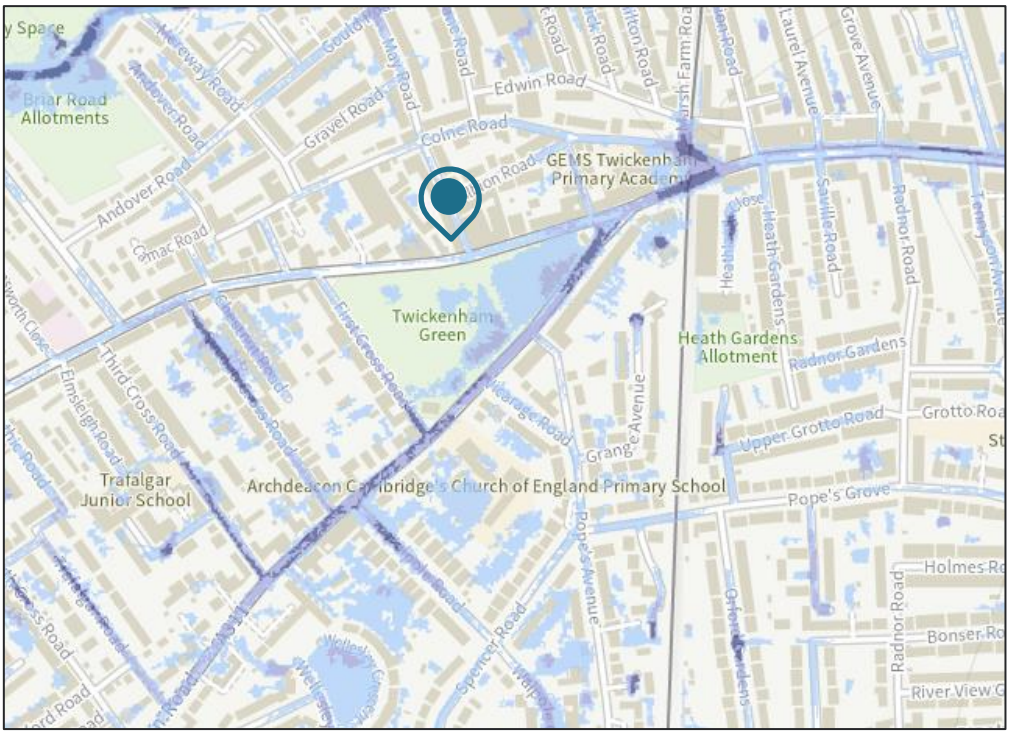


Figure 10 - Flood Map showing flooding from surface water (https://www.gov.uk/check-long-term-flood-risk)

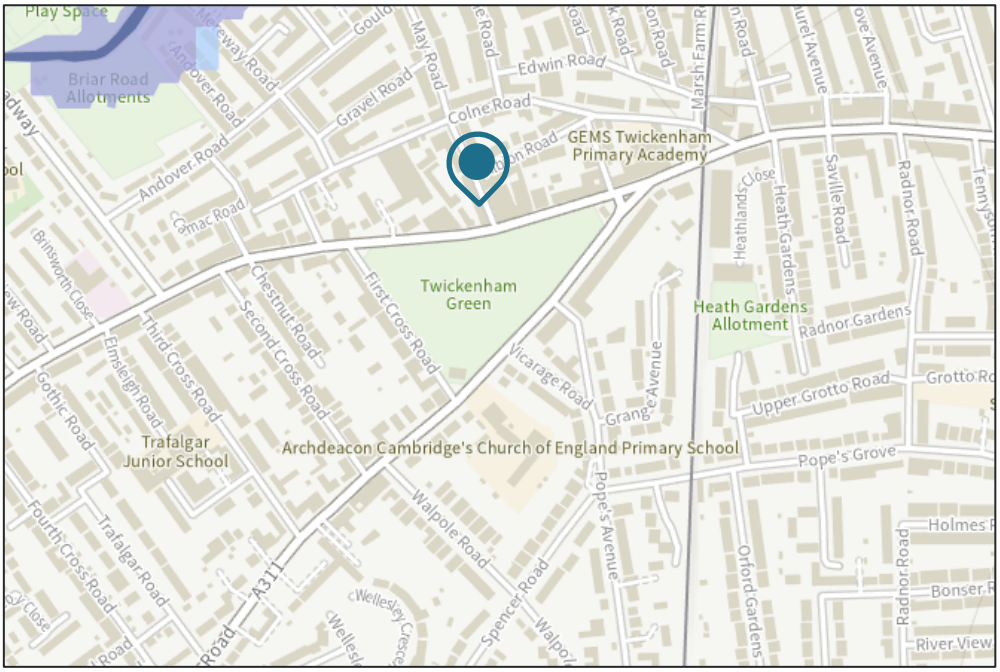


Figure 11 - Flood Map showing flooding from rivers and the sea (https://www.gov.uk/check-long-term-flood-risk)

While flood risk is not considered to be an issue, if required any further risk will be minimised through the incorporation of sustainable urban drainage systems (SuDs).

4.4.1 Sustainable Urban Drainage Systems (SuDS)

SuDS are intended to manage risks associated with flooding and can reduce pollution, and enhance biodiversity, improving the quality of the surrounding environment. They are designed to intercept and attenuate rainfall during an event and slow down the flow of surface run-off before it joins watercourses, by allowing infiltration of the water into the ground which temporarily stores the water and reduces the hydrograph peak and associated flood risk.

4.5 Biodiversity

Biodiversity is defined as the variety of life forms within an ecosystem and their interactions, up to the global scale. The construction process disrupts flora and fauna, potentially leading to a loss of biodiversity. It is therefore important to consider biodiversity on-site wherever possible both during and post construction minimising any potential impact. A biodiversity net gain (BNG) is intended to be achieved through:

- Ensuring the highest value habitats are retained and maintained around the site,
- Enhancing the existing habitats through appropriate planting, of native species where possible, incorporated throughout the site design including:
    - Species rich native hedgerows, trees and shrubs
    - Vegetated gardens
    - Enhanced acid/neutral grasslands
    - Trees along the streets in the urban area

4.6 Resource Efficiency

Water and resources used shall be minimised through implementation of sustainable technologies and design. Furthermore, the Proposed Development will aim to make efficient use of materials, minimising construction and demolition waste and maximising recycling/re-use of materials produced throughout the construction phase, low-impact materials will also be incorporated where appropriate.

4.6.1 Consideration for Re-Use

Minimisation of demolition waste can be achieved through re-use and adoption of existing structures. Reusing materials onsite will reduce the embodied CO_2e (ECO_2e) of the Proposed Development through the 'reuse' of the energy that exists in that material, having arisen from its production. Transportation of new material to the site will be reduced, reducing the CO_2e and NO_x emissions associated with transportation and material manufacture.

4.6.2 Waste Management

The Proposed Development will aim to make efficient use of materials, minimising waste and maximising reuse and recycling of materials produced throughout the construction phase.

A comprehensive Construction Management Plan will be implemented from the outset of site works and will follow the principles of the Waste Hierarchy (shown in Figure 12).

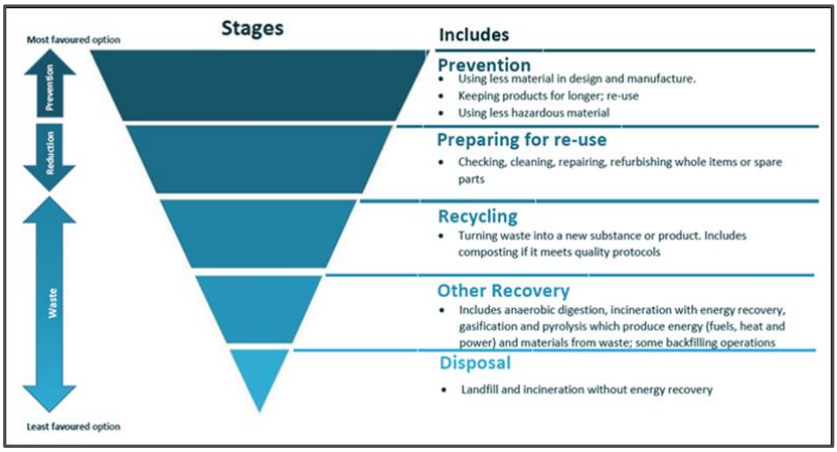


Figure 12 - The Waste Management Hierarchy

The construction and demolition waste generated as part of the redevelopment will be segregated and monitored as per best practice. Suitable materials will be recycled as part of this process, either to be reused on site if feasible or introduced back into the supply chain through recycling by a Licensed Contractor.

Any new materials should be locally sourced if possible so that transportation to site will be managed in the most efficient way possible. This will reduce the total CO_2e emissions associated with transportation and material manufacture.

Nominal construction waste should be sent to landfill or for incineration unless this is unavoidable due to the materials found on the existing site.

4.6.3 Resource Management

Policies will be put in place for management of site impacts such as air and water pollution in line with industry best practice. Monitoring and reporting on CO_2e emissions and water use from site related activities will take place in line with national benchmarks.

4.6.4 Materials

The Proposed Development is to use high quality, low impact materials in order to minimise the overall impact on the environment as far as possible. This will be done through:

- As the form of construction is anticipated to be concrete foundation and floor slab with a traditional masonry structure, the Proposed Development will follow the UK concrete *Standards BS 8500 (Part 1 and Part 2)* (which are currently being updated) and aspire to use new ternary blend cements utilising limestone powder.
- Steel is predominantly manufactured by either of two process routes, namely the primary or basic oxygen steel-making route (BF-BOF) and the secondary, electric arc furnace (EAF) route. Typically, the EAF steel-making process has an ECO_2e of around 20% that of BF-BOF steelmaking and also utilises up to 100% recycled content, compared to BF-BOF, which incorporates up to 30% recycled content. Specifying EAF steel will significantly lower the ECO_2e of the Proposed Development.
- All timber and timber-based products used on-site will be legally sourced from a reputable forest certification scheme, such as Forest Stewardship Council (FSC) with appropriate Chain of Custody certification to confirm this.

All other materials sourced from suppliers who have an accredited Environmental Management System (EMS) certified through *ISO 14001* or the *Eco-Management and Audit Scheme (EMAS)* ensuring that any environmental impacts caused are managed and reduced. BES 6001 certification should also be considered to ensure products have been made with constituent materials that have been responsibly sourced.

As standard industry best-practice, all insulation on the site will have a GWP of <5. Other ozone depletion materials will be avoided where feasible, including high VOC content paints and sealants, further minimising the Proposed Development's effect on global climate change.

4.7 Water

Water usage will be minimised:

- Water consumption less than 110 litres per person per day in line with *Building Regulations Approved Document Part G,* including 5 litres for external use.
- Water usage will be minimised through the use of efficient appliances and reduced flow showers and taps with restrictors installed as appropriate.

The specification outlined below is indicative of one or a similar equivalent that the Proposed Development will follow:

- Water closets (WCs): 4.5/3.0 litre effective dual flush volume
- Hand wash basin taps: 5.0 litres/min
- Kitchenette taps: 5.0 litres/min
- Showers: 6.0 litres/min
- Baths: 160 litres
- Domestic sized dishwashers (if installed) 1.25 litres/place setting
- Domestic sized washing machines (if installed) 8.17 litres/kg dry load.#

4.8 Sustainability Conclusions

Through a considered approach to sustainability in the early design stages, the Proposed Development will reduce its impact on the environment at both construction and operational stages and will provide a sustainable dwelling that responds positively to its surroundings, and local and regional policy.

The net result of the sustainability measures implemented will aim to meet and exceed the targets set out by planning policy through the following:

- Air pollution contributions will be negligible on site and minimised on a national scale through use of an ASHP for space heating and DHW. Further reduced through the use of solar PV.
- Noise pollution reduction measures will be considered by minimising air infiltration and enhanced fabric.
- Flooding is considered to be a low risk for the site. SuDS will be implemented if required based on site conditions determined through later design stages.
- The Proposed Development will enhance the biodiversity of the area.
- Waste management will be ensured following the waste hierarchy in accordance with local policy.
- Implementation of sustainable construction techniques and materials, inclusive design, site management and procurement procedures in accordance with local policy.
- Internal water use will be controlled in alignment with *Part G* requirements.

Appendices

Appendix A – Proposed Site Plan

Appendix B – SAP Specification Sheet

The Green, Twickenham

BRegs LV1 2021 (with 2023 amendments) | Planning Authority: London Borough of Richmond-upon-Thames | V1 Rev A

Unit	Floors	External Wall	Flat Roof	Slope Roof	Plane Roof	Ground Floor	Windows	External Door	Air Permeability	MVHR	Space Heating	DHW Heating	H/W Cylinder	PV Allocation	EPC	DER v TER Improvement	DFEE vs TFEE Improvement	DPER vs TPER Improvement
Type	(#)	U Value	U Value	U Value	U Value	U Value	U Value	U Value	m³/m².hr	Y/N	Type	Type	(litres)	(# Panels)	(Rating)	%	%	%
Sample Unit	2	0.14	0.11	0.10	0.10	0.11	0.80	1.00	3.00	Y	ASHP	ASHP	300.00	3	90-B	78.81	2.27	49.51

Fabric Elements

Element	U Values	Description
External Wall	0.14	102.5mm brick, nominal air space (10mm), 150mm Unilin CavityTherm PIR (0.021W/mK) or similar approved, 100mm inner leaf blockwork, 12.5mm plasterboard on dabs.
Flat Roof *(Above GFL and FFL)*	0.11	Waterproof membrane, 200mm Unilin FR-ALU or similar PIR insulation (0.022W/mK), vapour control layer, 225mm RC, unventilated air cavity, 15mm plasterboard ceiling.
Slope Roof *(Room-in-roof angled ceiling)*	0.10	Waterproof membrane, glass fibre insulation (0.040W/mK) to achieve U-value (est. 400mm), vapour control layer, 12.5mm plasterboard ceiling.
Plane Roof *(Room-in-roof horizontal ceiling)*	0.10	Roof finish to architectural specification, vapour control layer, unventilated air cavity, 20mm 0.022W/mK), 50mm screed.
Ground Floor *(slab on ground)*	0.11	150mm RC surface bed, vapour control layer, 140mm PIR insulation (0.022W/mK), 50mm screed.
Vertical Windows *(Glazed windows and glazed doors)*	0.80	Triple Low-E glazing. Centre of glass g-value = 0.40. Frame factor indicatively assumed 0.70.
Rooflights and Roof Windows *(On flat roofs above ground and first floor)*	0.80	Triple Low-E glazing. Centre of glass g-value = 0.40. Frame factor indicatively assumed 0.70.
External Solid Door *(Front Door)*	1.00	Insulated door to meet designated U-value. Assumed by SRE.
Construction Details (PSI values)	-	BRE Thermal Construction details used where viable. Independently Assessed where impact is significant. Table K1 Default where impact is minor. See thermal bridge specification for further details.

Building Systems

Element	Description
Air Permeability	Blower door air pressure test to be performed and designed to achieve 3.00m³/m²hr @50Pa or superior.
Mechanical Ventilation	MVHR system of Nuaire MRXBOXAB-ECO2 or similar approved.
Lighting	Low energy lighting with an efficacy of 85 lm/W or superior to be installed throughout.
Space Heating and Domestic Hot Water	Modelled as Valiant AroTherm 8kW air source heat pump system (1 per unit). Combined space heating and domestic hot water.
Heating Controls	Time and temperature zone control by arrangement.
Heat Emitters	Radiators.
Showers and Baths	Quantities as per plan. Showers modelled as 8l/min. Baths assumed not to have shower over.
Hot Water Cylinder	300L with a heat loss of 1.34kWh/day or better.
Wastewater Heat Recovery System	Recoup Easyfit+ type B or similar approved to each shower.
Renewables	3x 400Wp panels per unit.
Notes	All specs are indicative to achieve required targets and are TBC.

Sign Off of details	Name	PP M Maclean	Date	22.08.2024	On behalf of the contractor/client:	Name		Date	
	Sign	(on behalf of SRE)				Sign			

Appendix C – GLA Emissions Reporting Spreadsheet

Residential

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for residential buildings

	Carbon Dioxide Emissions for residential buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2021 of the Building Regulations Compliant Development	3.7	
After energy demand reduction (be lean)	2.5	
After heat network connection (be clean)	2.5	
After renewable energy (be green)	0.8	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for residential buildings

	Regulated residential carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	1.2	33%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	1.7	46%
Cumulative on site savings	**2.9**	**79%**
Annual savings from off-set payment	0.8	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**24**	-
Cash in-lieu contribution (£)	**2,237**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development

SITE-WIDE

	Total regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Part L 2021 baseline	3.7		
Be lean	2.5	1.2	33%
Be clean	2.5	0.0	0%
Be green	0.8	1.7	46%
Total Savings	-	2.9	79%
	-	**CO_2 savings off-set (Tonnes CO_2)**	-
Off-set	-	**23.6**	-

	Target Fabric Energy Efficiency (kWh/m²)	Dwelling Fabric Energy Efficiency (kWh/m²)	Improvement (%)
Development total	31.28	0.00	100%

Appendix D – SAP Reports

Building Regulations England Part L (BREL) Compliance Report

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

Date: Thu 22 Aug 2024 14:32:41

Project Information			
Assessed By	Malcolm Maclean	Building Type	House, Mid-terrace
OCDEA Registration	EES/022689	Assessment Date	2024-08-22

Dwelling Details			
Assessment Type	As designed	Total Floor Area	83 m^2
Site Reference	Unit 4	Plot Reference	Green
Address			

Client Details	
Name	Daniel Bradbury
Company	Elstree Land
Address	7 Grena Gardens, London, TW9 1XP

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

1a Target emission rate and dwelling emission rate		
Fuel for main heating system	Electricity	
Target carbon dioxide emission rate	*10.43 $kgCO_2/m^2$*	
Dwelling carbon dioxide emission rate	2.21 $kgCO_2/m^2$	OK
1b Target primary energy rate and dwelling primary energy		
Target primary energy	*54.33 kWh_{PE}/m^2*	
Dwelling primary energy	27.43 kWh_{PE}/m^2	OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency		
Target fabric energy efficiency	*31.3 kWh/m^2*	
Dwelling fabric energy efficiency	30.4 kWh/m^2	OK

2a Fabric U-values				
Element	***Maximum permitted average U-Value [W/m^2K]***	**Dwelling average U-Value [W/m^2K]**	**Element with highest individual U-Value**	
External walls	*0.26*	0.14	Walls (1) (0.14)	OK
Party walls	*0.2*	0	Party Wall (1) (0)	**N/A**
Curtain walls	*1.6*	0	N/A	**N/A**
Floors	*0.18*	0.11	Ground Floor (0.11)	OK
Roofs	*0.16*	0.1	Roof (1) (0.1)	OK
Windows, doors, and roof windows	*1.6*	0.83	00_NE Solid Door (1)	OK
Rooflights	*2.2*	N/A	N/A	**N/A**

2b Envelope elements (better than typically expected values are flagged with a subsequent (!))		
Name	**Net area [m^2]**	**U-Value [W/m^2K]**
Exposed wall: Walls (1)	17.399	0.14 **(!)**
Exposed wall: Walls (2)	31.713	0.14 **(!)**
Party wall: Party Wall (1)	41.7	0 **(!)**
Party wall: Party Wall (2)	32.6	0 **(!)**
Ground floor: Ground Floor, Ground Floor	41.34	0.11
Exposed roof: Roof (1)	41.26	0.1 **(!)**

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	**Area [m^2]**	**Orientation**	**Frame factor**	**U-Value [W/m^2K]**
00_SW Glazing, Window	4.896	South West	0.7	0.8 **(!)**
01_SW Glazing, Window	2.337	South West	0.7	0.8 **(!)**
00_NE Glazing, Window	1.4	North East	0.7	0.8 **(!)**
00_NE Solid Door, Solid Door	2.205	North East	N/A	1 **(!)**
01_NE Glazing, Window	1.3	North East	0.7	0.8 **(!)**
01_NE Glazing, Window	1.3	North East	0.7	0.8 **(!)**

2d Thermal bridging (better than typically expected values are flagged with a subsequent (!))
Building part **1 - Main Dwelling**: Thermal bridging calculated from linear thermal transmittances for each junction

Main element	Junction detail	Source	Psi value [W/mK]	Drawing / reference
External wall	E5: Ground floor (normal)	Not government-approved scheme	0.09	BRE 600472
Party wall	P1: Ground floor	Not government-approved scheme	0.161	BRE 600424
External wall	E6: Intermediate floor within a dwelling	Not government-approved scheme	0.001 **(!)**	BRE 600475
Party wall	P2: Intermediate floor within a dwelling	SAP table default	0 **(!)**	
Party wall	P5: Roof (insulation at rafter level)	SAP table default	0.48	
External wall	E12: Gable (insulation at ceiling level)	Not government-approved scheme	0.09	BRE 600479
External wall	E10: Eaves (insulation at ceiling level)	Not government-approved scheme	0.046	BRE 600478
External wall	E1: Steel lintel with perforated steel base plate	Not government-approved scheme	0.001 **(!)**	BRE 600466
External wall	E3: Sill	Not government-approved scheme	0.008 **(!)**	BRE 600469
External wall	E4: Jamb	Not government-approved scheme	0 **(!)**	BRE 600471
External wall	E18: Party wall between dwellings	Not government-approved scheme	0.069	BRE 600484
External wall	E25: Staggered party wall between dwellings	SAP table default	0.24	
External wall	E16: Corner (normal)	Not government-approved scheme	0.038 **(!)**	BRE 600482
External wall	E17: Corner (inverted - internal area greater than external area)	Not government-approved scheme	-0.048	BRE 600483

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

4 Space heating	
Main heating system 1: Heat pump with radiators or underfloor heating - Electricity	
Efficiency	233.0%
Emitter type	Radiators
Flow temperature	55°C
System type	Heat Pump
Manufacturer	Vaillant Group UK Ltd
Model	aroTHERM 8kW
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water	
Cylinder/store - type: Cylinder	
Capacity	300 litres
Declared heat loss	1.34 kWh/day
Primary pipework insulated	Yes
Manufacturer	
Model	
Commissioning	
Waste water heat recovery system 1 - type: Instantaneous	
Efficiency	43.1%
Manufacturer	Dutch Solar Systems BV
Model	Easyfit+

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

7 Lighting		
Minimum permitted light source efficacy	*75 lm/W*	
Lowest light source efficacy	85 lm/W	OK
External lights control	N/A	

8 Mechanical ventilation		
System type: Balanced whole-house mechanical ventilation with heat recovery		
Maximum permitted specific fan power	*1.5 W/(l/s)*	
Specific fan power	0.8 W/(l/s)	OK
Minimum permitted heat recovery efficiency	*73%*	
Heat recovery efficiency	87%	OK
Manufacturer/Model	MRXBOXAB-ECO2, MRXBOXAB-ECO2C	
Commissioning		

9 Local generation	
Technology type: **Photovoltaic system (1)**	
Peak power	1.2 kWp
Orientation	South
Pitch	30°
Overshading	None or very little
Manufacturer	
MCS certificate	

10 Heat networks
N/A

11 Supporting documentary evidence
N/A

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

Full SAP Calculation Printout

Property Reference	Unit 4	Issued on Date	22/08/2024
Assessment Reference	Green	Prop Type Ref	
Property			

SAP Rating	90 B	DER	2.21	TER	10.43
Environmental	98 A	% DER < TER			78.81
CO_2 Emissions (t/year)	0.15	DFEE	30.43	TFEE	31.28
Compliance Check	See BREL	% DFEE < TFEE			2.72
% DPER < TPER	49.51	DPER	27.43	TPER	54.33

Assessor Details	Mr. Malcolm Maclean	Assessor ID	V497-0002
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.1500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(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) =	78.3000 (23c)

Effective ac	0.2711	0.2679	0.2647	0.2488	0.2456	0.2296	0.2296	0.2264	0.2360	0.2456	0.2519	0.2583	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 0.80)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 21281.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)
List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.3600	0.0900	0.9324
P1 Party wall - Ground floor	16.7800	0.1610	2.7016
E6 Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2 Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5 Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12 Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10 Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1 Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3 Sill	7.3000	0.0080	0.0584
E4 Jamb	18.7400	0.0000	0.0000
E18 Party wall between dwellings	15.8000	0.0690	1.0902
E25 Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16 Corner (normal)	16.1000	0.0380	0.6118
E17 Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	18.4537	18.2367	18.0197	16.9347	16.7176	15.6326	15.6326	15.4156	16.0666	16.7176	17.1517	17.5857	(38)
Heat transfer coeff	59.1766	58.9596	58.7425	57.6575	57.4405	56.3555	56.3555	56.1385	56.7895	57.4405	57.8745	58.3085	(39)

Average = Sum(39)m / 12 = 57.6033

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7171	0.7145	0.7119	0.6987	0.6961	0.6829	0.6829	0.6803	0.6882	0.6961	0.7013	0.7066	(40)
HLP (average)												0.6981	
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 2.5089 (42)
Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)

Energy content (annual) Total = Sum(45)m = 2064.8496

Distribution loss (46)m = 0.15 x (45)m												
32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)

Water storage loss:
Store volume 300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.3400 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 0.7236 (55)
Total storage loss

22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(56)

If cylinder contains dedicated solar storage

22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(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

259.8794	229.7385	243.7080	213.2675	206.0853	184.9813	181.9724	189.5527	192.0388	215.0153	229.7239	256.8963	(62)
WWHRS -35.3914	-31.3004	-32.7760	-27.1398	-25.2933	-21.6437	-20.2875	-21.5737	-22.3934	-26.3993	-29.9073	-34.7360	(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

224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)

Total per year (kWh/year) = Sum(64)m = 2274.0178 (64)
12Total per year (kWh/year) 2274 (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

107.7719	95.6827	102.3949	91.5843	89.8853	82.1791	81.8678	84.3882	84.5258	92.8545	97.0561	106.7800	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	144.8547	142.3850	137.6275	127.2004	120.8136	114.1377	110.0373	113.4250	117.3969	124.8045	134.8001	143.5215	(72)
Total internal gains	556.0626	569.4182	545.2925	526.5589	500.1889	482.8756	464.6659	465.7227	479.7666	495.4807	525.4595	544.8183	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	616.5097	675.2909	697.8786	728.5711	738.2801	724.4447	695.4004	668.7457	649.3442	614.5758	598.3910	596.2057	(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	99.8967	100.2644	100.6348	102.5286	102.9159	104.8973	104.8973	105.3028	104.0957	102.9159	102.1441	101.3838	
alpha	7.6598	7.6843	7.7090	7.8352	7.8611	7.9932	7.9932	8.0202	7.9397	7.8611	7.8096	7.7589	
util living area	0.9897	0.9778	0.9528	0.8667	0.7069	0.4969	0.3565	0.3860	0.5991	0.8742	0.9726	0.9916	(86)
Living	20.4809	20.6030	20.7432	20.9087	20.9830	20.9990	20.9999	20.9999	20.9961	20.9171	20.6936	20.4656	
Non living	19.7267	19.8814	20.0551	20.2553	20.3312	20.3554	20.3559	20.3582	20.3489	20.2691	20.0051	19.7152	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.7344	20.6030	20.7432	20.9087	20.9830	20.9990	20.9999	20.9999	20.9961	20.9171	20.6936	20.5404	(87)
Th 2	20.3257	20.3281	20.3304	20.3420	20.3443	20.3559	20.3559	20.3583	20.3513	20.3443	20.3397	20.3350	(88)
util rest of house	0.9868	0.9718	0.9405	0.8382	0.6625	0.4474	0.3044	0.3322	0.5447	0.8415	0.9642	0.9892	(89)
MIT 2	20.0869	19.8814	20.0551	20.2553	20.3312	20.3554	20.3559	20.3582	20.3489	20.2691	20.0051	19.8269	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	20.2425	20.0548	20.2204	20.4123	20.4878	20.5101	20.5107	20.5124	20.5044	20.4248	20.1706	19.9984	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.2425	20.0548	20.2204	20.4123	20.4878	20.5101	20.5107	20.5124	20.5044	20.4248	20.1706	19.9984	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9863	0.9689	0.9382	0.8414	0.6724	0.4593	0.3169	0.3452	0.5576	0.8459	0.9616	0.9877	(94)
Useful gains	608.0872	654.2660	654.7240	613.0382	496.4531	332.7046	220.3729	230.8355	362.0901	519.8429	575.4331	588.8506	(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	943.4237	893.5193	805.9732	663.7707	504.7776	333.0660	220.3883	230.8654	363.7041	564.3410	756.4543	921.1800	(97)
Space heating kWh	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98a)
Space heating requirement - total per year (kWh/year)												976.2136	
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	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												976.2136	
Space heating per m2											(98c) / (4) =	11.8300	(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 %)	233.0103 (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	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98)
Space heating efficiency (main heating system 1)	233.0103	233.0103	233.0103	233.0103	233.0103	0.0000	0.0000	0.0000	0.0000	233.0103	233.0103	233.0103	(210)
Space heating fuel (main heating system)	107.0727	69.0005	48.2937	15.6763	2.6580	0.0000	0.0000	0.0000	0.0000	14.2082	55.9354	106.1125	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
Efficiency of water heater												172.2755	(216)
(217)m	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	(217)
Fuel for water heating, kWh/month	130.3076	115.1865	122.4388	108.0407	104.9435	94.8119	93.8525	97.5060	98.4733	109.4851	115.9867	128.9564	(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	21.3761	19.3074	21.3761	20.6865	21.3761	20.6865	21.3761	21.3761	20.6865	21.3761	20.6865	21.3761	(231)
Lighting	25.6345	20.5649	18.5164	13.5659	10.4787	8.5612	9.5590	12.4252	16.1391	21.1754	23.9175	26.3469	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-23.8242	-36.1175	-55.6717	-66.5365	-75.5194	-72.0041	-71.1296	-65.1695	-54.9963	-42.5812	-26.8962	-20.2925	(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	-6.2277	-14.0305	-29.7360	-47.9267	-65.8902	-67.0241	-66.0613	-54.6949	-38.8816	-21.5263	-8.7496	-4.8558	(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	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	418.9574	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	172.2755	
Water heating fuel used	1319.9890	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.0000)		
mechanical ventilation fans (SFP = 1.0000)	251.6860	(230a)
Total electricity for the above, kWh/year	251.6860	(231)
Electricity for lighting (calculated in Appendix L)	206.8848	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1036.3436	(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	1161.1735	(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	418.9574	0.1579	66.1493	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1319.9890	0.1408	185.8588	(264)
Space and water heating			252.0081	(265)
Pumps, fans and electric keep-hot	251.6860	0.1387	34.9120	(267)
Energy for lighting	206.8848	0.1443	29.8599	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-610.7389	0.1332	-81.3677	
PV Unit electricity exported	-425.6047	0.1242	-52.8745	
Total			-134.2422	(269)
Total CO2, kg/year			182.5377	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			2.2100	(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	418.9574	1.5845	663.8310	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1319.9890	1.5206	2007.2208	(278)
Space and water heating			2671.0518	(279)
Pumps, fans and electric keep-hot	251.6860	1.5128	380.7506	(281)
Energy for lighting	206.8848	1.5338	317.3269	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-610.7389	1.4923	-911.4137	
PV Unit electricity exported	-425.6047	0.4560	-194.0593	
Total			-1105.4730	(283)
Total Primary energy kWh/year			2263.6562	(286)
Dwelling Primary energy Rate (DPER)			27.4300	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 82.5200						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)

Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.3954	(18)
Number of sides sheltered	2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3361	(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	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(22b)
Effective ac	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	257.8958	(35)

List of Thermal Bridges

K1	Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	9.2251	(36)
Point Thermal bridges	(36a) = 0.0000	
Total fabric heat loss	(33) + (36) + (36a) = 43.0561	(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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.5089	(42)

Hot water usage for mixer showers

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day)	124.3152	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)											Total = Sum(45)m =	2064.8496	
Distribution loss (46)m = 0.15 x (45)m													
	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(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													
	272.8143	241.4215	256.6429	225.7851	219.0201	197.4989	194.9073	202.4875	204.5564	227.9501	242.2415	269.8311	(62)
WWHRS	-30.3034	-26.8005	-28.0640	-23.2381	-21.6571	-18.5321	-17.3709	-18.4722	-19.1740	-22.6041	-25.6077	-29.7422	(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	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)
											Total per year (kWh/year) = Sum(64)m =	2473.5904	(64)
12Total per year (kWh/year)												2474	(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

	118.1197	105.0292	112.7427	101.5983	100.2331	92.1932	92.2156	94.7361	94.5398	103.2024	107.0701	117.1278 (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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)

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

	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)

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

	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)

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

	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)

	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)

Water heating gains (Table 5)

	158.7631	156.2934	151.5359	141.1088	134.7220	128.0461	123.9457	127.3334	131.3053	138.7129	148.7085	157.4299	(72)

Total internal gains

	569.3034	582.2660	558.5333	539.6775	513.4297	492.9941	474.9067	475.9635	489.8852	508.7215	538.5780	558.0591	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	664.5077	749.0156	798.8564	857.8467	888.4234	873.4654	838.3136	795.7248	756.9698	696.2964	653.4451	638.9942	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area	0.9924	0.9839	0.9659	0.9068	0.7785	0.5792	0.4213	0.4620	0.7007	0.9234	0.9827	0.9938	(86)
MIT	20.0480	20.2185	20.4406	20.7244	20.9130	20.9873	20.9983	20.9972	20.9633	20.7325	20.3519	20.0240	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house	0.9900	0.9790	0.9552	0.8794	0.7239	0.5029	0.3363	0.3736	0.6237	0.8948	0.9765	0.9918	(89)
MIT 2	18.9793	19.1963	19.4751	19.8225	20.0242	20.0963	20.1026	20.1040	20.0767	19.8404	19.3754	18.9561	(90)
Living area fraction									fLA = Living area / (4) =			0.2403	(91)
MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9870	0.9746	0.9499	0.8776	0.7332	0.5209	0.3568	0.3949	0.6408	0.8934	0.9722	0.9893	(94)
Useful gains	655.8829	729.9986	758.8479	752.8495	651.3802	455.0210	299.0838	314.1994	485.0352	622.0552	635.2908	632.1436	(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	1244.8793	1208.4953	1094.4183	910.6175	696.1649	460.0655	299.5320	315.0023	501.0044	770.9334	1025.3553	1237.1176	(97)
Space heating kWh	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98a)

Space heating requirement - total per year (kWh/year) 1998.0526

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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 1998.0526

Space heating per m2 (98c) / (4) = 24.2130 (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	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(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)	474.7707	348.3746	270.4923	123.0692	36.0994	0.0000	0.0000	0.0000	0.0000	120.0058	304.2757	487.6497	(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												
	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889 (64)
Efficiency of water heater												79.8000 (216)
(217)m	85.3699	84.9643	84.2581	82.8159	80.9856	79.8000	79.8000	79.8000	79.8000	82.7383	84.6430	85.4477 (217)
Fuel for water heating, kWh/month												
	284.0707	252.6014	271.2842	244.5750	243.7015	224.2691	222.4766	230.5957	232.3087	248.1874	255.9383	280.9777 (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	25.4073	20.3827	18.3523	13.4457	10.3859	8.4853	9.4743	12.3151	15.9961	20.9877	23.7056	26.1135 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-38.4047	-54.0339	-77.5047	-86.9444	-93.5754	-87.2696	-86.1902	-81.4622	-73.0794	-61.7013	-42.1832	-33.2159 (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	-22.0081	-46.2711	-91.9250	-138.0064	-182.4269	-183.2859	-181.1288	-153.3807	-112.4497	-66.1500	-29.3763	-17.4052 (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	2164.7374 (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	2990.9862 (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)	205.0515 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-2039.3789 (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	3407.3963 (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	2164.7374	0.2100	454.5949	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2990.9862	0.2100	628.1071	(264)
Space and water heating			1082.7020	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	205.0515	0.1443	29.5953	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	0.1346	-109.8028	
PV Unit electricity exported	-1223.8140	0.1259	-154.0882	
Total			-263.8909	(269)
Total CO2, kg/year			860.3356	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.4300	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	2164.7374	1.1300	2446.1533	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2990.9862	1.1300	3379.8144	(278)
Space and water heating			5825.9677	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	205.0515	1.5338	314.5148	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	1.4976	-1221.3795	
PV Unit electricity exported	-1223.8140	0.4622	-565.6101	
Total			-1786.9896	(283)
Total Primary energy kWh/year			4483.5938	(286)
Target Primary Energy Rate (TPER)			54.3300	(287)

Full SAP Calculation Printout

Property Reference	Unit 4	**Issued on Date**	22/08/2024
Assessment Reference	Green	**Prop Type Ref**	
Property			

SAP Rating	90 B	**DER**	2.21	**TER**	10.43
Environmental	98 A	**% DER < TER**			78.81
CO_2 Emissions (t/year)	0.15	**DFEE**	30.43	**TFEE**	31.28
Compliance Check	See BREL	**% DFEE < TFEE**			2.72
% DPER < TPER	49.51	**DPER**	27.43	**TPER**	54.33

Assessor Details	Mr. Malcolm Maclean	**Assessor ID**	V497-0002
Client			

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	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.2954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2511	(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	0.3202	0.3139	0.3076	0.2762	0.2699	0.2386	0.2386	0.2323	0.2511	0.2699	0.2825	0.2951	(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	0.5513	0.5493	0.5473	0.5381	0.5364	0.5285	0.5285	0.5270	0.5315	0.5364	0.5399	0.5435	(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)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	21281.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		257.8958 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	10.3600	0.0900	0.9324
P1 Party wall - Ground floor	16.7800	0.1610	2.7016
E6 Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2 Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5 Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12 Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10 Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1 Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3 Sill	7.3000	0.0080	0.0584
E4 Jamb	18.7400	0.0000	0.0000
E18 Party wall between dwellings	15.8000	0.0690	1.0902
E25 Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16 Corner (normal)	16.1000	0.0380	0.6118
E17 Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	37.5286	37.3932	37.2604	36.6366	36.5199	35.9766	35.9766	35.8760	36.1858	36.5199	36.7560	37.0028	(38)
Heat transfer coeff	78.2515	78.1160	77.9832	77.3595	77.2428	76.6995	76.6995	76.5989	76.9087	77.2428	77.4789	77.7257	(39)

Average = Sum(39)m / 12 = 77.3589

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9483	0.9466	0.9450	0.9375	0.9360	0.9295	0.9295	0.9282	0.9320	0.9360	0.9389	0.9419	(40)
HLP (average)												0.9375	
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 2.5089 (42)

Hot water usage for mixer showers

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	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 63.2014 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	68.9526	67.0611	64.9960	62.4257	60.1328	57.7498	57.2547	59.3156	61.4293	63.8764	66.4694	68.8558	(44)
Energy conte	109.2040	95.4941	99.8964	85.4577	80.9503	71.0102	69.2446	73.4451	75.7485	86.6797	94.6979	107.8115	(45)

Energy content (annual) Total = Sum(45)m = 1049.6400

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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(64)

Total per year (kWh/year) = Sum(64)m = 892.1940 (64)

12Total per year (kWh/year) 892 (64)

Electric shower(s)

53.0843	47.2986	51.6482	49.2873	50.2121	47.8975	49.4941	50.2121	49.2873	51.6482	50.6771	53.0843	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 603.8313 (64a)

Heat gains from water heating, kWh/month

36.4769	32.1171	34.1401	30.4816	29.7550	27.0640	27.0880	28.1601	28.4184	31.3315	32.7926	36.1810	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	49.0281	47.7934	45.8872	42.3355	39.9932	37.5889	36.4086	37.8496	39.4700	42.1122	45.5452	48.6304	(72)
Total internal gains	460.2361	474.8265	453.5522	441.6940	419.3685	406.3268	391.0372	390.1472	401.8397	412.7884	436.2046	449.9272	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	520.6832	580.6993	606.1383	643.7063	657.4598	647.8959	621.7717	593.1703	571.4172	531.8836	509.1361	501.3146	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	75.5454	75.6764	75.8053	76.4166	76.5320	77.0741	77.0741	77.1754	76.8644	76.5320	76.2988	76.0565	
alpha	6.0364	6.0451	6.0537	6.0944	6.1021	6.1383	6.1383	6.1450	6.1243	6.1021	6.0866	6.0704	
util living area	0.9977	0.9949	0.9892	0.9657	0.8943	0.7189	0.5369	0.5840	0.8259	0.9712	0.9945	0.9982	(86)
MIT	19.9650	20.1060	20.3014	20.5859	20.8282	20.9669	20.9952	20.9921	20.9226	20.6222	20.2486	19.9400	(87)
Th 2	20.1267	20.1280	20.1294	20.1358	20.1370	20.1425	20.1425	20.1436	20.1404	20.1370	20.1346	20.1320	(88)
util rest of house	0.9969	0.9933	0.9854	0.9528	0.8554	0.6383	0.4355	0.4805	0.7575	0.9577	0.9923	0.9975	(89)
MIT 2	19.1810	19.3223	19.5170	19.7987	20.0193	20.1273	20.1413	20.1413	20.0986	19.8375	19.4700	19.1604	(90)
Living area fraction									fLA = Living area / (4) =			0.2403	(91)
MIT	19.3694	19.5106	19.7055	19.9879	20.2137	20.3290	20.3465	20.3458	20.2966	20.0261	19.6571	19.3478	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3694	19.5106	19.7055	19.9879	20.2137	20.3290	20.3465	20.3458	20.2966	20.0261	19.6571	19.3478	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9960	0.9917	0.9830	0.9501	0.8593	0.6567	0.4600	0.5055	0.7712	0.9556	0.9906	0.9968	(94)
Useful gains	518.5846	575.8579	595.8146	611.5899	564.9564	425.5011	285.9929	299.8687	440.6996	508.2468	504.3748	499.6955	(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	1179.2043	1141.3237	1029.8072	857.7537	657.6198	439.4127	287.3517	302.2404	476.5724	728.0977	972.9073	1177.3720	(97)
Space heating kWh	491.5011	379.9930	322.8905	177.2379	68.9416	0.0000	0.0000	0.0000	0.0000	163.5691	337.3434	504.1913	(98a)
Space heating requirement - total per year (kWh/year)												2445.6678	
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	491.5011	379.9930	322.8905	177.2379	68.9416	0.0000	0.0000	0.0000	0.0000	163.5691	337.3434	504.1913	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2445.6678	
Space heating per m2											(98c) / (4) =	29.6373	(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	720.9749	567.5760	582.1513	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8465	0.9211	0.8977	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	610.2750	522.8138	522.6044	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	699.3131	671.5638	640.7060	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	64.1074	110.6700	87.8676	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	16.0269	27.6675	21.9669	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												65.6612	(107)
Energy for space heating												29.6373	(99)
Energy for space cooling												0.7957	(108)
Total												30.4330	(109)
Fabric Energy Efficiency (DFEE)												30.4	(109)

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

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600	(1b)	x 2.5000	(2b) =	103.1500	(1b) - (3b)
First floor	41.2600	(1c)	x 2.5000	(2c) =	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		206.3000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3361	(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	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(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	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	257.8958	(35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	9.2251	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	43.0561	(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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
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	2.5089	(42)

Hot water usage for mixer showers

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	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day)	63.2014	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	68.9526	67.0611	64.9960	62.4257	60.1328	57.7498	57.2547	59.3156	61.4293	63.8764	66.4694	68.8558	(44)
Energy conte	109.2040	95.4941	99.8964	85.4577	80.9503	71.0102	69.2446	73.4451	75.7485	86.6797	94.6979	107.8115	(45)
Energy content (annual)										Total = Sum(45)m =		1049.6400	

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

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	(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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(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													
	92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(64)
											Total per year (kWh/year) = Sum(64)m =	892.1940	(64)
12Total per year (kWh/year)												892	(64)
Electric shower(s)													
	53.0843	47.2986	51.6482	49.2873	50.2121	47.8975	49.4941	50.2121	49.2873	51.6482	50.6771	53.0843	(64a)
											Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =	603.8313	(64a)
Heat gains from water heating, kWh/month													
	36.4769	32.1171	34.1401	30.4816	29.7550	27.0640	27.0880	28.1601	28.4184	31.3315	32.7926	36.1810	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)													
	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)													
	49.0281	47.7934	45.8872	42.3355	39.9932	37.5889	36.4086	37.8496	39.4700	42.1122	45.5452	48.6304	(72)
Total internal gains													
	456.5685	470.7660	449.8846	437.9042	415.7010	402.5370	387.3696	386.4797	398.0498	409.1208	432.4148	446.2596	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	551.7728	637.5156	690.2077	756.0735	790.6947	783.0083	750.7765	706.2410	665.1345	596.6957	547.2819	527.1948	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area													
	0.9970	0.9925	0.9821	0.9413	0.8352	0.6382	0.4692	0.5180	0.7706	0.9581	0.9926	0.9977	(86)
MIT	19.9059	20.0829	20.3186	20.6381	20.8722	20.9792	20.9970	20.9949	20.9400	20.6394	20.2229	19.8819	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house													
	0.9960	0.9901	0.9759	0.9214	0.7856	0.5574	0.3752	0.4202	0.6949	0.9396	0.9897	0.9969	(89)
MIT 2	19.0804	19.2580	19.4921	19.8065	20.0108	20.0941	20.1024	20.1036	20.0688	19.8147	19.4072	19.0642	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.2788	19.4562	19.6907	20.0063	20.2178	20.3068	20.3174	20.3177	20.2781	20.0129	19.6032	19.2607	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2788	19.4562	19.6907	20.0063	20.2178	20.3068	20.3174	20.3177	20.2781	20.0129	19.6032	19.2607	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9948	0.9879	0.9726	0.9192	0.7931	0.5764	0.3978	0.4438	0.7111	0.9376	0.9876	0.9959	(94)
Useful gains	548.8963	629.7928	671.3222	694.9590	627.0823	451.3174	298.6918	313.4416	472.9811	559.4501	540.5159	525.0419	(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													
	1248.4310	1209.6818	1093.0620	907.9242	694.5362	459.7747	299.4946	314.9315	500.0633	767.5231	1024.7927	1241.0697	(97)
Space heating kWh													
	520.4538	389.6854	313.7744	153.3349	50.1857	0.0000	0.0000	0.0000	0.0000	154.8063	348.6793	532.7247	(98a)
Space heating requirement - total per year (kWh/year)												2463.6446	
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													
	520.4538	389.6854	313.7744	153.3349	50.1857	0.0000	0.0000	0.0000	0.0000	154.8063	348.6793	532.7247	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2463.6446	
Space heating per m2											(98c) / (4) =	29.8551	(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	757.3210	596.1889	610.9322	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9038	0.9545	0.9361	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	684.4684	569.0595	571.8743	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	861.3454	826.2886	776.7026	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	127.3514	191.3785	152.3922	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	31.8379	47.8446	38.0981	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												117.7805 (107)
Energy for space heating												29.8551 (99)
Energy for space cooling												1.4273 (108)
Total												31.2824 (109)
Fabric Energy Efficiency (TFEE)												31.3 (109)

Full SAP Calculation Printout

Property Reference	Unit 4	Issued on Date	22/08/2024
Assessment Reference	Green	Prop Type Ref	
Property			

SAP Rating	90 B	DER	2.21	TER	10.43
Environmental	98 A	% DER < TER			78.81
CO_2 Emissions (t/year)	0.15	DFEE	30.43	TFEE	31.28
Compliance Check	See BREL	% DFEE < TFEE			2.72
% DPER < TPER	49.51	DPER	27.43	TPER	54.33

Assessor Details	Mr. Malcolm Maclean	Assessor ID	V497-0002
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.1500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(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) =	78.3000 (23c)

Effective ac	0.2711	0.2679	0.2647	0.2488	0.2456	0.2296	0.2296	0.2264	0.2360	0.2456	0.2519	0.2583	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 0.80)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 21281.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)
List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.3600	0.0900	0.9324
P1 Party wall - Ground floor	16.7800	0.1610	2.7016
E6 Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2 Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5 Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12 Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10 Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1 Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3 Sill	7.3000	0.0080	0.0584
E4 Jamb	18.7400	0.0000	0.0000
E18 Party wall between dwellings	15.8000	0.0690	1.0902
E25 Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16 Corner (normal)	16.1000	0.0380	0.6118
E17 Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	18.4537	18.2367	18.0197	16.9347	16.7176	15.6326	15.6326	15.4156	16.0666	16.7176	17.1517	17.5857	(38)
Heat transfer coeff	59.1766	58.9596	58.7425	57.6575	57.4405	56.3555	56.3555	56.1385	56.7895	57.4405	57.8745	58.3085	(39)

Average = Sum(39)m / 12 = 57.6033

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7171	0.7145	0.7119	0.6987	0.6961	0.6829	0.6829	0.6803	0.6882	0.6961	0.7013	0.7066	(40)
HLP (average)												0.6981	
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 2.5089 (42)
Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)

Energy content (annual) Total = Sum(45)m = 2064.8496

Distribution loss (46)m = 0.15 x (45)m												
32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)

Water storage loss:
Store volume 300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.3400 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 0.7236 (55)
Total storage loss

22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(56)

If cylinder contains dedicated solar storage

22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(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

259.8794	229.7385	243.7080	213.2675	206.0853	184.9813	181.9724	189.5527	192.0388	215.0153	229.7239	256.8963	(62)
WWHRS -35.3914	-31.3004	-32.7760	-27.1398	-25.2933	-21.6437	-20.2875	-21.5737	-22.3934	-26.3993	-29.9073	-34.7360	(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

224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)

Total per year (kWh/year) = Sum(64)m = 2274.0178 (64)
12Total per year (kWh/year) 2274 (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

107.7719	95.6827	102.3949	91.5843	89.8853	82.1791	81.8678	84.3882	84.5258	92.8545	97.0561	106.7800	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	144.8547	142.3850	137.6275	127.2004	120.8136	114.1377	110.0373	113.4250	117.3969	124.8045	134.8001	143.5215	(72)
Total internal gains	556.0626	569.4182	545.2925	526.5589	500.1889	482.8756	464.6659	465.7227	479.7666	495.4807	525.4595	544.8183	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	616.5097	675.2909	697.8786	728.5711	738.2801	724.4447	695.4004	668.7457	649.3442	614.5758	598.3910	596.2057	(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	99.8967	100.2644	100.6348	102.5286	102.9159	104.8973	104.8973	105.3028	104.0957	102.9159	102.1441	101.3838	
alpha	7.6598	7.6843	7.7090	7.8352	7.8611	7.9932	7.9932	8.0202	7.9397	7.8611	7.8096	7.7589	
util living area	0.9897	0.9778	0.9528	0.8667	0.7069	0.4969	0.3565	0.3860	0.5991	0.8742	0.9726	0.9916	(86)
Living	20.4809	20.6030	20.7432	20.9087	20.9830	20.9990	20.9999	20.9999	20.9961	20.9171	20.6936	20.4656	
Non living	19.7267	19.8814	20.0551	20.2553	20.3312	20.3554	20.3559	20.3582	20.3489	20.2691	20.0051	19.7152	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.7344	20.6030	20.7432	20.9087	20.9830	20.9990	20.9999	20.9999	20.9961	20.9171	20.6936	20.5404	(87)
Th 2	20.3257	20.3281	20.3304	20.3420	20.3443	20.3559	20.3559	20.3583	20.3513	20.3443	20.3397	20.3350	(88)
util rest of house	0.9868	0.9718	0.9405	0.8382	0.6625	0.4474	0.3044	0.3322	0.5447	0.8415	0.9642	0.9892	(89)
MIT 2	20.0869	19.8814	20.0551	20.2553	20.3312	20.3554	20.3559	20.3582	20.3489	20.2691	20.0051	19.8269	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	20.2425	20.0548	20.2204	20.4123	20.4878	20.5101	20.5107	20.5124	20.5044	20.4248	20.1706	19.9984	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.2425	20.0548	20.2204	20.4123	20.4878	20.5101	20.5107	20.5124	20.5044	20.4248	20.1706	19.9984	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9863	0.9689	0.9382	0.8414	0.6724	0.4593	0.3169	0.3452	0.5576	0.8459	0.9616	0.9877	(94)
Useful gains	608.0872	654.2660	654.7240	613.0382	496.4531	332.7046	220.3729	230.8355	362.0901	519.8429	575.4331	588.8506	(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	943.4237	893.5193	805.9732	663.7707	504.7776	333.0660	220.3883	230.8654	363.7041	564.3410	756.4543	921.1800	(97)
Space heating kWh	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98a)
Space heating requirement - total per year (kWh/year)												976.2136	
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	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												976.2136	
Space heating per m2											(98c) / (4) =	11.8300	(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 %)	233.0103 (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	249.4903	160.7782	112.5294	36.5274	6.1934	0.0000	0.0000	0.0000	0.0000	33.1066	130.3353	247.2531	(98)
Space heating efficiency (main heating system 1)	233.0103	233.0103	233.0103	233.0103	233.0103	0.0000	0.0000	0.0000	0.0000	233.0103	233.0103	233.0103	(210)
Space heating fuel (main heating system)	107.0727	69.0005	48.2937	15.6763	2.6580	0.0000	0.0000	0.0000	0.0000	14.2082	55.9354	106.1125	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
Efficiency of water heater												172.2755	(216)
(217)m	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	172.2755	(217)
Fuel for water heating, kWh/month	130.3076	115.1865	122.4388	108.0407	104.9435	94.8119	93.8525	97.5060	98.4733	109.4851	115.9867	128.9564	(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	21.3761	19.3074	21.3761	20.6865	21.3761	20.6865	21.3761	21.3761	20.6865	21.3761	20.6865	21.3761	(231)
Lighting	25.6345	20.5649	18.5164	13.5659	10.4787	8.5612	9.5590	12.4252	16.1391	21.1754	23.9175	26.3469	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-23.8242	-36.1175	-55.6717	-66.5365	-75.5194	-72.0041	-71.1296	-65.1695	-54.9963	-42.5812	-26.8962	-20.2925	(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	-6.2277	-14.0305	-29.7360	-47.9267	-65.8902	-67.0241	-66.0613	-54.6949	-38.8816	-21.5263	-8.7496	-4.8558	(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	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	418.9574	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	172.2755	
Water heating fuel used	1319.9890	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.0000)		
mechanical ventilation fans (SFP = 1.0000)	251.6860	(230a)
Total electricity for the above, kWh/year	251.6860	(231)
Electricity for lighting (calculated in Appendix L)	206.8848	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1036.3436	(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	1161.1735	(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	418.9574	0.1579	66.1493	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1319.9890	0.1408	185.8588	(264)
Space and water heating			252.0081	(265)
Pumps, fans and electric keep-hot	251.6860	0.1387	34.9120	(267)
Energy for lighting	206.8848	0.1443	29.8599	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-610.7389	0.1332	-81.3677	
PV Unit electricity exported	-425.6047	0.1242	-52.8745	
Total			-134.2422	(269)
Total CO2, kg/year			182.5377	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			2.2100	(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	418.9574	1.5845	663.8310	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1319.9890	1.5206	2007.2208	(278)
Space and water heating			2671.0518	(279)
Pumps, fans and electric keep-hot	251.6860	1.5128	380.7506	(281)
Energy for lighting	206.8848	1.5338	317.3269	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-610.7389	1.4923	-911.4137	
PV Unit electricity exported	-425.6047	0.4560	-194.0593	
Total			-1105.4730	(283)
Total Primary energy kWh/year			2263.6562	(286)
Dwelling Primary energy Rate (DPER)			27.4300	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 82.5200						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)

Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.3954	(18)
Number of sides sheltered	2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3361	(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	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(22b)
Effective ac	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	257.8958	(35)

List of Thermal Bridges

K1	Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	9.2251	(36)
Point Thermal bridges	(36a) = 0.0000	
Total fabric heat loss	(33) + (36) + (36a) = 43.0561	(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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.5089	(42)

Hot water usage for mixer showers

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day)	124.3152	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)											Total = Sum(45)m =	2064.8496	
Distribution loss (46)m = 0.15 x (45)m													
	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(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													
	272.8143	241.4215	256.6429	225.7851	219.0201	197.4989	194.9073	202.4875	204.5564	227.9501	242.2415	269.8311	(62)
WWHRS	-30.3034	-26.8005	-28.0640	-23.2381	-21.6571	-18.5321	-17.3709	-18.4722	-19.1740	-22.6041	-25.6077	-29.7422	(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	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)
											Total per year (kWh/year) = Sum(64)m =	2473.5904	(64)
12Total per year (kWh/year)												2474	(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

	118.1197	105.0292	112.7427	101.5983	100.2331	92.1932	92.2156	94.7361	94.5398	103.2024	107.0701	117.1278 (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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)

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

	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)

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

	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)

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

	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)

	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)

Water heating gains (Table 5)

	158.7631	156.2934	151.5359	141.1088	134.7220	128.0461	123.9457	127.3334	131.3053	138.7129	148.7085	157.4299	(72)

Total internal gains

	569.3034	582.2660	558.5333	539.6775	513.4297	492.9941	474.9067	475.9635	489.8852	508.7215	538.5780	558.0591	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	664.5077	749.0156	798.8564	857.8467	888.4234	873.4654	838.3136	795.7248	756.9698	696.2964	653.4451	638.9942	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area	0.9924	0.9839	0.9659	0.9068	0.7785	0.5792	0.4213	0.4620	0.7007	0.9234	0.9827	0.9938	(86)
MIT	20.0480	20.2185	20.4406	20.7244	20.9130	20.9873	20.9983	20.9972	20.9633	20.7325	20.3519	20.0240	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house	0.9900	0.9790	0.9552	0.8794	0.7239	0.5029	0.3363	0.3736	0.6237	0.8948	0.9765	0.9918	(89)
MIT 2	18.9793	19.1963	19.4751	19.8225	20.0242	20.0963	20.1026	20.1040	20.0767	19.8404	19.3754	18.9561	(90)
Living area fraction									fLA = Living area / (4) =			0.2403	(91)
MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9870	0.9746	0.9499	0.8776	0.7332	0.5209	0.3568	0.3949	0.6408	0.8934	0.9722	0.9893	(94)
Useful gains	655.8829	729.9986	758.8479	752.8495	651.3802	455.0210	299.0838	314.1994	485.0352	622.0552	635.2908	632.1436	(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	1244.8793	1208.4953	1094.4183	910.6175	696.1649	460.0655	299.5320	315.0023	501.0044	770.9334	1025.3553	1237.1176	(97)
Space heating kWh	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98a)

Space heating requirement - total per year (kWh/year) 1998.0526

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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 1998.0526

Space heating per m2 (98c) / (4) = 24.2130 (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	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(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)	474.7707	348.3746	270.4923	123.0692	36.0994	0.0000	0.0000	0.0000	0.0000	120.0058	304.2757	487.6497	(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												
	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889 (64)
Efficiency of water heater												79.8000 (216)
(217)m	85.3699	84.9643	84.2581	82.8159	80.9856	79.8000	79.8000	79.8000	79.8000	82.7383	84.6430	85.4477 (217)
Fuel for water heating, kWh/month												
	284.0707	252.6014	271.2842	244.5750	243.7015	224.2691	222.4766	230.5957	232.3087	248.1874	255.9383	280.9777 (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	25.4073	20.3827	18.3523	13.4457	10.3859	8.4853	9.4743	12.3151	15.9961	20.9877	23.7056	26.1135 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-38.4047	-54.0339	-77.5047	-86.9444	-93.5754	-87.2696	-86.1902	-81.4622	-73.0794	-61.7013	-42.1832	-33.2159 (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	-22.0081	-46.2711	-91.9250	-138.0064	-182.4269	-183.2859	-181.1288	-153.3807	-112.4497	-66.1500	-29.3763	-17.4052 (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	2164.7374 (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	2990.9862 (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)	205.0515 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-2039.3789 (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	3407.3963 (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	2164.7374	0.2100	454.5949	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2990.9862	0.2100	628.1071	(264)
Space and water heating			1082.7020	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	205.0515	0.1443	29.5953	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	0.1346	-109.8028	
PV Unit electricity exported	-1223.8140	0.1259	-154.0882	
Total			-263.8909	(269)
Total CO2, kg/year			860.3356	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.4300	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	2164.7374	1.1300	2446.1533	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2990.9862	1.1300	3379.8144	(278)
Space and water heating			5825.9677	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	205.0515	1.5338	314.5148	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	1.4976	-1221.3795	
PV Unit electricity exported	-1223.8140	0.4622	-565.6101	
Total			-1786.9896	(283)
Total Primary energy kWh/year			4483.5938	(286)
Target Primary Energy Rate (TPER)			54.3300	(287)

Building Regulations England Part L (BREL) Compliance Report

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

Date: Thu 22 Aug 2024 14:32:41

Project Information			
Assessed By	Malcolm Maclean	Building Type	House, Mid-terrace
OCDEA Registration	EES/022689	Assessment Date	2024-08-22

Dwelling Details			
Assessment Type	As designed	Total Floor Area	83 m^2
Site Reference	Unit 4	Plot Reference	Lean
Address			

Client Details	
Name	Daniel Bradbury
Company	Elstree Land
Address	7 Grena Gardens, London, TW9 1XP

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

1a Target emission rate and dwelling emission rate		
Fuel for main heating system	Mains gas	
Target carbon dioxide emission rate	*10.43 $kgCO_2/m^2$*	
Dwelling carbon dioxide emission rate	10.73 $kgCO_2/m^2$	**FAIL**
1b Target primary energy rate and dwelling primary energy		
Target primary energy	*54.33 kWh_{PE}/m^2*	
Dwelling primary energy	62.76 kWh_{PE}/m^2	**FAIL**
1c Target fabric energy efficiency and dwelling fabric energy efficiency		
Target fabric energy efficiency	*31.3 kWh/m^2*	
Dwelling fabric energy efficiency	30.4 kWh/m^2	**OK**

2a Fabric U-values				
Element	***Maximum permitted average U-Value [W/m^2K]***	**Dwelling average U-Value [W/m^2K]**	**Element with highest individual U-Value**	
External walls	*0.26*	0.14	Walls (1) (0.14)	**OK**
Party walls	*0.2*	0	Party Wall (1) (0)	**N/A**
Curtain walls	*1.6*	0	N/A	**N/A**
Floors	*0.18*	0.11	Ground Floor (0.11)	**OK**
Roofs	*0.16*	0.1	Roof (1) (0.1)	**OK**
Windows, doors, and roof windows	*1.6*	0.83	00_NE Solid Door (1)	**OK**
Rooflights	*2.2*	N/A	N/A	**N/A**

2b Envelope elements (better than typically expected values are flagged with a subsequent (!))		
Name	**Net area [m^2]**	**U-Value [W/m^2K]**
Exposed wall: Walls (1)	17.399	0.14 **(!)**
Exposed wall: Walls (2)	31.713	0.14 **(!)**
Party wall: Party Wall (1)	41.7	0 **(!)**
Party wall: Party Wall (2)	32.6	0 **(!)**
Ground floor: Ground Floor, Ground Floor	41.34	0.11
Exposed roof: Roof (1)	41.26	0.1 **(!)**

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	**Area [m^2]**	**Orientation**	**Frame factor**	**U-Value [W/m^2K]**
00_SW Glazing, Window	4.896	South West	0.7	0.8 **(!)**
01_SW Glazing, Window	2.337	South West	0.7	0.8 **(!)**
00_NE Glazing, Window	1.4	North East	0.7	0.8 **(!)**
00_NE Solid Door, Solid Door	2.205	North East	N/A	1 **(!)**
01_NE Glazing, Window	1.3	North East	0.7	0.8 **(!)**
01_NE Glazing, Window	1.3	North East	0.7	0.8 **(!)**

2d Thermal bridging (better than typically expected values are flagged with a subsequent (!))
Building part **1 - Main Dwelling**: Thermal bridging calculated from linear thermal transmittances for each junction

Main element	Junction detail	Source	Psi value [W/mK]	Drawing / reference
External wall	E5: Ground floor (normal)	Not government-approved scheme	0.09	BRE 600472
Party wall	P1: Ground floor	Not government-approved scheme	0.161	BRE 600424
External wall	E6: Intermediate floor within a dwelling	Not government-approved scheme	0.001 **(!)**	BRE 600475
Party wall	P2: Intermediate floor within a dwelling	SAP table default	0 **(!)**	
Party wall	P5: Roof (insulation at rafter level)	SAP table default	0.48	
External wall	E12: Gable (insulation at ceiling level)	Not government-approved scheme	0.09	BRE 600479
External wall	E10: Eaves (insulation at ceiling level)	Not government-approved scheme	0.046	BRE 600478
External wall	E1: Steel lintel with perforated steel base plate	Not government-approved scheme	0.001 **(!)**	BRE 600466
External wall	E3: Sill	Not government-approved scheme	0.008 **(!)**	BRE 600469
External wall	E4: Jamb	Not government-approved scheme	0 **(!)**	BRE 600471
External wall	E18: Party wall between dwellings	Not government-approved scheme	0.069	BRE 600484
External wall	E25: Staggered party wall between dwellings	SAP table default	0.24	
External wall	E16: Corner (normal)	Not government-approved scheme	0.038 **(!)**	BRE 600482
External wall	E17: Corner (inverted - internal area greater than external area)	Not government-approved scheme	-0.048	BRE 600483

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

4 Space heating	
Main heating system 1: Boiler with radiators or underfloor heating - Mains gas	
Efficiency	88.8%
Emitter type	Radiators
Flow temperature	55°C
System type	
Manufacturer	Gas Boiler
Model	Gas Boiler
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water	
Cylinder/store - type: Cylinder	
Capacity	300 litres
Declared heat loss	1.34 kWh/day
Primary pipework insulated	Yes
Manufacturer	
Model	
Commissioning	
Waste water heat recovery system 1 - type: Instantaneous	
Efficiency	43.1%
Manufacturer	Dutch Solar Systems BV
Model	Easyfit+

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

7 Lighting		
Minimum permitted light source efficacy	*75 lm/W*	
Lowest light source efficacy	85 lm/W	**OK**
External lights control	N/A	

8 Mechanical ventilation		
System type: Balanced whole-house mechanical ventilation with heat recovery		
Maximum permitted specific fan power	*1.5 W/(l/s)*	
Specific fan power	0.8 W/(l/s)	**OK**
Minimum permitted heat recovery efficiency	*73%*	
Heat recovery efficiency	87%	**OK**
Manufacturer/Model	MRXBOXAB-ECO2, MRXBOXAB-ECO2C	
Commissioning		

9 Local generation
N/A

10 Heat networks
N/A

11 Supporting documentary evidence
N/A

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

Full SAP Calculation Printout

Property Reference	Unit 4	Issued on Date	22/08/2024
Assessment Reference	Lean	Prop Type Ref	
Property			

SAP Rating	86 B	DER	10.73	TER	10.43
Environmental	91 B	% DER < TER			-2.88
CO_2 Emissions (t/year)	0.8	DFEE	30.43	TFEE	31.28
Compliance Check	See BREL	% DFEE < TFEE			2.72
% DPER < TPER	-15.52	DPER	62.76	TPER	54.33

Assessor Details	Mr. Malcolm Maclean	Assessor ID	V497-0002
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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			m3 per hour	
Number of open chimneys		0 * 80 =	0.0000	(6a)
Number of open flues		0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire		0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler		0 * 20 =	0.0000	(6d)
Number of flues attached to other heater		0 * 35 =	0.0000	(6e)
Number of blocked chimneys		0 * 20 =	0.0000	(6f)
Number of intermittent extract fans		0 * 10 =	0.0000	(7a)
Number of passive vents		0 * 10 =	0.0000	(7b)
Number of flueless gas fires		0 * 40 =	0.0000	(7c)
		Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =		0.0000 / (5) =	0.0000	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			3.0000	(17)
Infiltration rate			0.1500	(18)
Number of sides sheltered			2	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(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) =		78.3000 (23c)

Effective ac	0.2711	0.2679	0.2647	0.2488	0.2456	0.2296	0.2296	0.2264	0.2360	0.2456	0.2519	0.2583	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 0.80)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 21281.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)
List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.0900	0.9324
P1	Party wall - Ground floor	16.7800	0.1610	2.7016
E6	Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12	Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10	Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1	Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3	Sill	7.3000	0.0080	0.0584
E4	Jamb	18.7400	0.0000	0.0000
E18	Party wall between dwellings	15.8000	0.0690	1.0902
E25	Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16	Corner (normal)	16.1000	0.0380	0.6118
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	18.4537	18.2367	18.0197	16.9347	16.7176	15.6326	15.6326	15.4156	16.0666	16.7176	17.1517	17.5857	(38)
Heat transfer coeff	59.1766	58.9596	58.7425	57.6575	57.4405	56.3555	56.3555	56.1385	56.7895	57.4405	57.8745	58.3085	(39)
Average = Sum(39)m / 12 =												57.6033	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7171	0.7145	0.7119	0.6987	0.6961	0.6829	0.6829	0.6803	0.6882	0.6961	0.7013	0.7066	(40)
HLP (average)												0.6981	
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 2.5089 (42)
Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)										Total = Sum(45)m =		2064.8496	
Distribution loss (46)m = 0.15 x (45)m	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3400	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7236	(55)
Total storage loss	22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(56)
If cylinder contains dedicated solar storage	22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(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	259.8794	229.7385	243.7080	213.2675	206.0853	184.9813	181.9724	189.5527	192.0388	215.0153	229.7239	256.8963	(62)
WWHRS	-35.3914	-31.3004	-32.7760	-27.1398	-25.2933	-21.6437	-20.2875	-21.5737	-22.3934	-26.3993	-29.9073	-34.7360	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
										Total per year (kWh/year) = Sum(64)m =		2274.0178	(64)
12Total per year (kWh/year)												2274	(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	107.7719	95.6827	102.3949	91.5843	89.8853	82.1791	81.8678	84.3882	84.5258	92.8545	97.0561	106.7800	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	144.8547	142.3850	137.6275	127.2004	120.8136	114.1377	110.0373	113.4250	117.3969	124.8045	134.8001	143.5215	(72)
Total internal gains	559.0626	572.4182	548.2925	529.5589	503.1889	482.8756	464.6659	465.7227	479.7666	498.4807	528.4595	547.8183	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	619.5097	678.2909	700.8786	731.5711	741.2801	724.4447	695.4004	668.7457	649.3442	617.5758	601.3910	599.2057	(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	99.8967	100.2644	100.6348	102.5286	102.9159	104.8973	104.8973	105.3028	104.0957	102.9159	102.1441	101.3838	
alpha	7.6598	7.6843	7.7090	7.8352	7.8611	7.9932	7.9932	8.0202	7.9397	7.8611	7.8096	7.7589	
util living area	0.9894	0.9772	0.9518	0.8647	0.7044	0.4969	0.3565	0.3860	0.5991	0.8719	0.9718	0.9913	(86)
MIT	20.4847	20.6065	20.7462	20.9103	20.9834	20.9990	20.9999	20.9999	20.9961	20.9187	20.6970	20.4695	(87)
Th 2	20.3257	20.3281	20.3304	20.3420	20.3443	20.3559	20.3559	20.3583	20.3513	20.3443	20.3397	20.3350	(88)
util rest of house	0.9864	0.9711	0.9392	0.8360	0.6601	0.4474	0.3044	0.3322	0.5447	0.8390	0.9632	0.9888	(89)
MIT 2	19.7315	19.8857	20.0585	20.2569	20.3315	20.3554	20.3559	20.3582	20.3489	20.2707	20.0092	19.7201	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.9125	20.0589	20.2238	20.4139	20.4882	20.5101	20.5107	20.5124	20.5044	20.4264	20.1745	19.9002	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9125	20.0589	20.2238	20.4139	20.4882	20.5101	20.5107	20.5124	20.5044	20.4264	20.1745	19.9002	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9841	0.9682	0.9370	0.8393	0.6700	0.4593	0.3169	0.3452	0.5576	0.8434	0.9607	0.9868	(94)
Useful gains	609.6432	656.6911	656.7031	614.0261	496.6712	332.7046	220.3729	230.8355	362.0901	520.8599	577.7368	591.2881	(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	923.8935	893.7618	806.1689	663.8629	504.7970	333.0660	220.3883	230.8654	363.7041	564.4356	756.6805	915.4558	(97)
Space heating kWh	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98a)
Space heating requirement - total per year (kWh/year)												948.6849	
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	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												948.6849	
Space heating per m2										(98c) / (4) =		11.4964	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	88.8000 (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	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98)
Space heating efficiency (main heating system 1)	88.8000	88.8000	88.8000	88.8000	88.8000	0.0000	0.0000	0.0000	0.0000	88.8000	88.8000	88.8000	(210)
Space heating fuel (main heating system)	263.2908	179.4048	125.2281	40.4082	6.8081	0.0000	0.0000	0.0000	0.0000	36.5093	145.0895	271.5999	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
Efficiency of water heater												79.8000	(216)
(217)m	84.1511	83.5719	82.6932	81.1290	80.0626	79.8000	79.8000	79.8000	79.8000	81.0042	83.1018	84.2444	(217)
Fuel for water heating, kWh/month	266.7679	237.4460	255.0779	229.4220	225.8133	204.6837	202.6127	210.5000	212.5883	232.8472	240.4481	263.7094	(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	28.6802	25.9047	28.6802	27.7550	28.6802	27.7550	28.6802	28.6802	27.7550	28.6802	27.7550	28.6802	(231)
Lighting	25.6345	20.5649	18.5164	13.5659	10.4787	8.5612	9.5590	12.4252	16.1391	21.1754	23.9175	26.3469	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1068.3388 (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	2781.9165	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.0000)		
mechanical ventilation fans (SFP = 1.0000)	251.6860	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	337.6860	(231)
Electricity for lighting (calculated in Appendix L)	206.8848	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4394.8261	(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	1068.3388	0.2100	224.3511	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2781.9165	0.2100	584.2025	(264)
Space and water heating			808.5536	(265)
Pumps, fans and electric keep-hot	337.6860	0.1387	46.8412	(267)
Energy for lighting	206.8848	0.1443	29.8599	(268)
Total CO2, kg/year			885.2547	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			10.7300	(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	1068.3388	1.1300	1207.2228	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2781.9165	1.1300	3143.5656	(278)
Space and water heating			4350.7884	(279)
Pumps, fans and electric keep-hot	337.6860	1.5128	510.8514	(281)
Energy for lighting	206.8848	1.5338	317.3269	(282)
Total Primary energy kWh/year			5178.9667	(286)
Dwelling Primary energy Rate (DPER)			62.7600	(287)

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

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor		41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3361	(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													
	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(22b)
Effective ac	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 9.2251 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 43.0561 (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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
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 2.5089 (42)

Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)										Total = Sum(45)m =		2064.8496	
Distribution loss (46)m = 0.15 x (45)m	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)

Water storage loss:

Store volume 300.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 2.1127 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.1409 (55)

Total storage loss

35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)

If cylinder contains dedicated solar storage

35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
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)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Primary loss

Combi loss

Total heat required for water heating calculated for each month

272.8143	241.4215	256.6429	225.7851	219.0201	197.4989	194.9073	202.4875	204.5564	227.9501	242.2415	269.8311	(62)
-30.3034	-26.8005	-28.0640	-23.2381	-21.6571	-18.5321	-17.3709	-18.4722	-19.1740	-22.6041	-25.6077	-29.7422	(63a)
-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)

WWHRS

PV diverter

Solar input

FGHRS

Output from w/h

242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)

Total per year (kWh/year) = Sum(64)m = 2473.5904 (64)

12Total per year (kWh/year) 2474 (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

118.1197	105.0292	112.7427	101.5983	100.2331	92.1932	92.2156	94.7361	94.5398	103.2024	107.0701	117.1278	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)													
	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)													
	158.7631	156.2934	151.5359	141.1088	134.7220	128.0461	123.9457	127.3334	131.3053	138.7129	148.7085	157.4299	(72)
Total internal gains													
	569.3034	582.2660	558.5333	539.6775	513.4297	492.9941	474.9067	475.9635	489.8852	508.7215	538.5780	558.0591	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	664.5077	749.0156	798.8564	857.8467	888.4234	873.4654	838.3136	795.7248	756.9698	696.2964	653.4451	638.9942	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area													
	0.9924	0.9839	0.9659	0.9068	0.7785	0.5792	0.4213	0.4620	0.7007	0.9234	0.9827	0.9938	(86)
MIT	20.0480	20.2185	20.4406	20.7244	20.9130	20.9873	20.9983	20.9972	20.9633	20.7325	20.3519	20.0240	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house													
	0.9900	0.9790	0.9552	0.8794	0.7239	0.5029	0.3363	0.3736	0.6237	0.8948	0.9765	0.9918	(89)
MIT 2	18.9793	19.1963	19.4751	19.8225	20.0242	20.0963	20.1026	20.1040	20.0767	19.8404	19.3754	18.9561	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9870	0.9746	0.9499	0.8776	0.7332	0.5209	0.3568	0.3949	0.6408	0.8934	0.9722	0.9893	(94)
Useful gains	655.8829	729.9986	758.8479	752.8495	651.3802	455.0210	299.0838	314.1994	485.0352	622.0552	635.2908	632.1436	(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													
	1244.8793	1208.4953	1094.4183	910.6175	696.1649	460.0655	299.5320	315.0023	501.0044	770.9334	1025.3553	1237.1176	(97)
Space heating kWh													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98a)
Space heating requirement - total per year (kWh/year)												1998.0526	
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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1998.0526	
Space heating per m2											(98c) / (4) =	24.2130	(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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(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)													
	474.7707	348.3746	270.4923	123.0692	36.0994	0.0000	0.0000	0.0000	0.0000	120.0058	304.2757	487.6497	(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													
	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.3699	84.9643	84.2581	82.8159	80.9856	79.8000	79.8000	79.8000	79.8000	82.7383	84.6430	85.4477	(217)
Fuel for water heating, kWh/month													
	284.0707	252.6014	271.2842	244.5750	243.7015	224.2691	222.4766	230.5957	232.3087	248.1874	255.9383	280.9777	(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	25.4073	20.3827	18.3523	13.4457	10.3859	8.4853	9.4743	12.3151	15.9961	20.9877	23.7056	26.1135	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-38.4047	-54.0339	-77.5047	-86.9444	-93.5754	-87.2696	-86.1902	-81.4622	-73.0794	-61.7013	-42.1832	-33.2159	(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	-22.0081	-46.2711	-91.9250	-138.0064	-182.4269	-183.2859	-181.1288	-153.3807	-112.4497	-66.1500	-29.3763	-17.4052	(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	2164.7374	(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	2990.9862	(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)	205.0515	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-2039.3789	(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	3407.3963	(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	2164.7374	0.2100	454.5949	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2990.9862	0.2100	628.1071	(264)
Space and water heating			1082.7020	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	205.0515	0.1443	29.5953	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	0.1346	-109.8028	
PV Unit electricity exported	-1223.8140	0.1259	-154.0882	
Total			-263.8909	(269)
Total CO2, kg/year			860.3356	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.4300	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	2164.7374	1.1300	2446.1533	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2990.9862	1.1300	3379.8144	(278)
Space and water heating			5825.9677	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	205.0515	1.5338	314.5148	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	1.4976	-1221.3795	
PV Unit electricity exported	-1223.8140	0.4622	-565.6101	
Total			-1786.9896	(283)
Total Primary energy kWh/year			4483.5938	(286)
Target Primary Energy Rate (TPER)			54.3300	(287)

Full SAP Calculation Printout

Property Reference	Unit 4	**Issued on Date**	22/08/2024
Assessment Reference	Lean	**Prop Type Ref**	
Property			

SAP Rating	86 B	**DER**	10.73	**TER**	10.43
Environmental	91 B	**% DER < TER**			-2.88
CO_2 Emissions (t/year)	0.8	**DFEE**	30.43	**TFEE**	31.28
Compliance Check	See BREL	**% DFEE < TFEE**			2.72
% DPER < TPER	-15.52	**DPER**	62.76	**TPER**	54.33

Assessor Details	Mr. Malcolm Maclean	**Assessor ID**	V497-0002
Client			

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	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.2954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2511	(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	0.3202	0.3139	0.3076	0.2762	0.2699	0.2386	0.2386	0.2323	0.2511	0.2699	0.2825	0.2951	(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	0.5513	0.5493	0.5473	0.5381	0.5364	0.5285	0.5285	0.5270	0.5315	0.5364	0.5399	0.5435	(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)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)
Heat capacity Cm = Sum(A x k)					(28)...(30) + (32) + (32a)...(32e) =		21281.5600	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							257.8958	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	10.3600	0.0900	0.9324
P1 Party wall - Ground floor	16.7800	0.1610	2.7016
E6 Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2 Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5 Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12 Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10 Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1 Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3 Sill	7.3000	0.0080	0.0584
E4 Jamb	18.7400	0.0000	0.0000
E18 Party wall between dwellings	15.8000	0.0690	1.0902
E25 Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16 Corner (normal)	16.1000	0.0380	0.6118
E17 Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	37.5286	37.3932	37.2604	36.6366	36.5199	35.9766	35.9766	35.8760	36.1858	36.5199	36.7560	37.0028	(38)
Heat transfer coeff	78.2515	78.1160	77.9832	77.3595	77.2428	76.6995	76.6995	76.5989	76.9087	77.2428	77.4789	77.7257	(39)

Average = Sum(39)m / 12 = 77.3589

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9483	0.9466	0.9450	0.9375	0.9360	0.9295	0.9295	0.9282	0.9320	0.9360	0.9389	0.9419	(40)
HLP (average)												0.9375	
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 2.5089 (42)

Hot water usage for mixer showers

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	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 63.2014 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	68.9526	67.0611	64.9960	62.4257	60.1328	57.7498	57.2547	59.3156	61.4293	63.8764	66.4694	68.8558	(44)
Energy conte	109.2040	95.4941	99.8964	85.4577	80.9503	71.0102	69.2446	73.4451	75.7485	86.6797	94.6979	107.8115	(45)

Energy content (annual) Total = Sum(45)m = 1049.6400

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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(64)

Total per year (kWh/year) = Sum(64)m = 892.1940 (64)

12Total per year (kWh/year) 892 (64)

Electric shower(s)

53.0843	47.2986	51.6482	49.2873	50.2121	47.8975	49.4941	50.2121	49.2873	51.6482	50.6771	53.0843	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 603.8313 (64a)

Heat gains from water heating, kWh/month

36.4769	32.1171	34.1401	30.4816	29.7550	27.0640	27.0880	28.1601	28.4184	31.3315	32.7926	36.1810	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	49.0281	47.7934	45.8872	42.3355	39.9932	37.5889	36.4086	37.8496	39.4700	42.1122	45.5452	48.6304	(72)
Total internal gains	460.2361	474.8265	453.5522	441.6940	419.3685	406.3268	391.0372	390.1472	401.8397	412.7884	436.2046	449.9272	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	520.6832	580.6993	606.1383	643.7063	657.4598	647.8959	621.7717	593.1703	571.4172	531.8836	509.1361	501.3146	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	75.5454	75.6764	75.8053	76.4166	76.5320	77.0741	77.0741	77.1754	76.8644	76.5320	76.2988	76.0565	
alpha	6.0364	6.0451	6.0537	6.0944	6.1021	6.1383	6.1383	6.1450	6.1243	6.1021	6.0866	6.0704	
util living area	0.9977	0.9949	0.9892	0.9657	0.8943	0.7189	0.5369	0.5840	0.8259	0.9712	0.9945	0.9982	(86)
MIT	19.9650	20.1060	20.3014	20.5859	20.8282	20.9669	20.9952	20.9921	20.9226	20.6222	20.2486	19.9400	(87)
Th 2	20.1267	20.1280	20.1294	20.1358	20.1370	20.1425	20.1425	20.1436	20.1404	20.1370	20.1346	20.1320	(88)
util rest of house	0.9969	0.9933	0.9854	0.9528	0.8554	0.6383	0.4355	0.4805	0.7575	0.9577	0.9923	0.9975	(89)
MIT 2	19.1810	19.3223	19.5170	19.7987	20.0193	20.1273	20.1413	20.1413	20.0986	19.8375	19.4700	19.1604	(90)
Living area fraction									fLA = Living area / (4) =			0.2403	(91)
MIT	19.3694	19.5106	19.7055	19.9879	20.2137	20.3290	20.3465	20.3458	20.2966	20.0261	19.6571	19.3478	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3694	19.5106	19.7055	19.9879	20.2137	20.3290	20.3465	20.3458	20.2966	20.0261	19.6571	19.3478	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9960	0.9917	0.9830	0.9501	0.8593	0.6567	0.4600	0.5055	0.7712	0.9556	0.9906	0.9968	(94)
Useful gains	518.5846	575.8579	595.8146	611.5899	564.9564	425.5011	285.9929	299.8687	440.6996	508.2468	504.3748	499.6955	(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	1179.2043	1141.3237	1029.8072	857.7537	657.6198	439.4127	287.3517	302.2404	476.5724	728.0977	972.9073	1177.3720	(97)
Space heating kWh	491.5011	379.9930	322.8905	177.2379	68.9416	0.0000	0.0000	0.0000	0.0000	163.5691	337.3434	504.1913	(98a)
Space heating requirement - total per year (kWh/year)												2445.6678	
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	491.5011	379.9930	322.8905	177.2379	68.9416	0.0000	0.0000	0.0000	0.0000	163.5691	337.3434	504.1913	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2445.6678	
Space heating per m2											(98c) / (4) =	29.6373	(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	720.9749	567.5760	582.1513	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8465	0.9211	0.8977	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	610.2750	522.8138	522.6044	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	699.3131	671.5638	640.7060	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	64.1074	110.6700	87.8676	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	16.0269	27.6675	21.9669	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												65.6612	(107)
Energy for space heating												29.6373	(99)
Energy for space cooling												0.7957	(108)
Total												30.4330	(109)
Fabric Energy Efficiency (DFEE)												30.4	(109)

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

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600	(1b)	x 2.5000	(2b) =	103.1500	(1b) - (3b)
First floor	41.2600	(1c)	x 2.5000	(2c) =	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		206.3000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3361	(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	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(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	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	257.8958	(35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	9.2251	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	43.0561	(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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
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	2.5089	(42)

Hot water usage for mixer showers

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	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day)	63.2014	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	68.9526	67.0611	64.9960	62.4257	60.1328	57.7498	57.2547	59.3156	61.4293	63.8764	66.4694	68.8558	(44)
Energy conte	109.2040	95.4941	99.8964	85.4577	80.9503	71.0102	69.2446	73.4451	75.7485	86.6797	94.6979	107.8115	(45)
Energy content (annual)										Total = Sum(45)m =		1049.6400	

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

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	(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

92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(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													
	92.8234	81.1700	84.9120	72.6390	68.8077	60.3586	58.8579	62.4283	64.3862	73.6777	80.4932	91.6398	(64)
											Total per year (kWh/year) = Sum(64)m =	892.1940	(64)
12Total per year (kWh/year)												892	(64)
Electric shower(s)													
	53.0843	47.2986	51.6482	49.2873	50.2121	47.8975	49.4941	50.2121	49.2873	51.6482	50.6771	53.0843	(64a)
											Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =	603.8313	(64a)
Heat gains from water heating, kWh/month													
	36.4769	32.1171	34.1401	30.4816	29.7550	27.0640	27.0880	28.1601	28.4184	31.3315	32.7926	36.1810	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)													
	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)													
	49.0281	47.7934	45.8872	42.3355	39.9932	37.5889	36.4086	37.8496	39.4700	42.1122	45.5452	48.6304	(72)
Total internal gains													
	456.5685	470.7660	449.8846	437.9042	415.7010	402.5370	387.3696	386.4797	398.0498	409.1208	432.4148	446.2596	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	551.7728	637.5156	690.2077	756.0735	790.6947	783.0083	750.7765	706.2410	665.1345	596.6957	547.2819	527.1948	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area													
	0.9970	0.9925	0.9821	0.9413	0.8352	0.6382	0.4692	0.5180	0.7706	0.9581	0.9926	0.9977	(86)
MIT	19.9059	20.0829	20.3186	20.6381	20.8722	20.9792	20.9970	20.9949	20.9400	20.6394	20.2229	19.8819	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house													
	0.9960	0.9901	0.9759	0.9214	0.7856	0.5574	0.3752	0.4202	0.6949	0.9396	0.9897	0.9969	(89)
MIT 2	19.0804	19.2580	19.4921	19.8065	20.0108	20.0941	20.1024	20.1036	20.0688	19.8147	19.4072	19.0642	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.2788	19.4562	19.6907	20.0063	20.2178	20.3068	20.3174	20.3177	20.2781	20.0129	19.6032	19.2607	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2788	19.4562	19.6907	20.0063	20.2178	20.3068	20.3174	20.3177	20.2781	20.0129	19.6032	19.2607	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9948	0.9879	0.9726	0.9192	0.7931	0.5764	0.3978	0.4438	0.7111	0.9376	0.9876	0.9959	(94)
Useful gains	548.8963	629.7928	671.3222	694.9590	627.0823	451.3174	298.6918	313.4416	472.9811	559.4501	540.5159	525.0419	(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													
	1248.4310	1209.6818	1093.0620	907.9242	694.5362	459.7747	299.4946	314.9315	500.0633	767.5231	1024.7927	1241.0697	(97)
Space heating kWh													
	520.4538	389.6854	313.7744	153.3349	50.1857	0.0000	0.0000	0.0000	0.0000	154.8063	348.6793	532.7247	(98a)
Space heating requirement - total per year (kWh/year)												2463.6446	
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													
	520.4538	389.6854	313.7744	153.3349	50.1857	0.0000	0.0000	0.0000	0.0000	154.8063	348.6793	532.7247	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2463.6446	
Space heating per m2											(98c) / (4) =	29.8551	(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	757.3210	596.1889	610.9322	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9038	0.9545	0.9361	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	684.4684	569.0595	571.8743	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	861.3454	826.2886	776.7026	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	127.3514	191.3785	152.3922	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	31.8379	47.8446	38.0981	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												117.7805 (107)
Energy for space heating												29.8551 (99)
Energy for space cooling												1.4273 (108)
Total												31.2824 (109)
Fabric Energy Efficiency (TFEE)												31.3 (109)

Full SAP Calculation Printout

Property Reference	Unit 4	Issued on Date	22/08/2024
Assessment Reference	Lean	Prop Type Ref	
Property			

SAP Rating	86 B	DER	10.73	TER	10.43
Environmental	91 B	% DER < TER			-2.88
CO_2 Emissions (t/year)	0.8	DFEE	30.43	TFEE	31.28
Compliance Check	See BREL	% DFEE < TFEE			2.72
% DPER < TPER	-15.52	DPER	62.76	TPER	54.33

Assessor Details	Mr. Malcolm Maclean	Assessor ID	V497-0002
Client			

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor	41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

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2. Ventilation rate

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			m3 per hour	
Number of open chimneys		0 * 80 =	0.0000	(6a)
Number of open flues		0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire		0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler		0 * 20 =	0.0000	(6d)
Number of flues attached to other heater		0 * 35 =	0.0000	(6e)
Number of blocked chimneys		0 * 20 =	0.0000	(6f)
Number of intermittent extract fans		0 * 10 =	0.0000	(7a)
Number of passive vents		0 * 10 =	0.0000	(7b)
Number of flueless gas fires		0 * 40 =	0.0000	(7c)
		Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =		0.0000 / (5) =	0.0000	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			3.0000	(17)
Infiltration rate			0.1500	(18)
Number of sides sheltered			2	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.1275	(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	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(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) =		78.3000 (23c)

Effective ac	0.2711	0.2679	0.2647	0.2488	0.2456	0.2296	0.2296	0.2264	0.2360	0.2456	0.2519	0.2583	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 0.80)			11.2400	0.7752	8.7132			(27)
Solid Door			2.2100	1.0000	2.2100			(26)
Ground Floor			41.3400	0.1100	4.5474	110.0000	4547.4000	(28a)
00_Ground	25.9000	8.5100	17.3900	0.1400	2.4346	150.0000	2608.5000	(29a)
01_First	36.6500	4.9400	31.7100	0.1400	4.4394	150.0000	4756.5000	(29a)
Plane Roof	41.2600		41.2600	0.1000	4.1260	9.0000	371.3400	(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		26.4706			(33)
00_Ground			41.7000	0.0000	0.0000	70.0000	2919.0000	(32)
01_First			32.6000	0.0000	0.0000	110.0000	3586.0000	(32)
00_Ground			53.1000			9.0000	477.9000	(32c)
01_First			100.1000			9.0000	900.9000	(32c)
FFL			41.2600			18.0000	742.6800	(32d)
GFL Ceiling			41.2600			9.0000	371.3400	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 21281.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)
List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.0900	0.9324
P1	Party wall - Ground floor	16.7800	0.1610	2.7016
E6	Intermediate floor within a dwelling	14.6600	0.0010	0.0147
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.4800	6.2400
E12	Gable (insulation at ceiling level)	8.7400	0.0900	0.7866
E10	Eaves (insulation at ceiling level)	5.9200	0.0460	0.2723
E1	Steel lintel with perforated steel base plate	8.3500	0.0010	0.0083
E3	Sill	7.3000	0.0080	0.0584
E4	Jamb	18.7400	0.0000	0.0000
E18	Party wall between dwellings	15.8000	0.0690	1.0902
E25	Staggered party wall between dwellings	6.9000	0.2400	1.6560
E16	Corner (normal)	16.1000	0.0380	0.6118
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0480	-0.1200

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 14.2523 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 40.7229 (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	18.4537	18.2367	18.0197	16.9347	16.7176	15.6326	15.6326	15.4156	16.0666	16.7176	17.1517	17.5857	(38)
Heat transfer coeff	59.1766	58.9596	58.7425	57.6575	57.4405	56.3555	56.3555	56.1385	56.7895	57.4405	57.8745	58.3085	(39)
Average = Sum(39)m / 12 =												57.6033	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7171	0.7145	0.7119	0.6987	0.6961	0.6829	0.6829	0.6803	0.6882	0.6961	0.7013	0.7066	(40)
HLP (average)												0.6981	
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 2.5089 (42)
Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)										Total = Sum(45)m =		2064.8496	
Distribution loss (46)m = 0.15 x (45)m	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3400	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7236	(55)
Total storage loss	22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(56)
If cylinder contains dedicated solar storage	22.4316	20.2608	22.4316	21.7080	22.4316	21.7080	22.4316	22.4316	21.7080	22.4316	21.7080	22.4316	(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	259.8794	229.7385	243.7080	213.2675	206.0853	184.9813	181.9724	189.5527	192.0388	215.0153	229.7239	256.8963	(62)
WWHRS	-35.3914	-31.3004	-32.7760	-27.1398	-25.2933	-21.6437	-20.2875	-21.5737	-22.3934	-26.3993	-29.9073	-34.7360	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
										Total per year (kWh/year) = Sum(64)m =		2274.0178	(64)
12Total per year (kWh/year)												2274	(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	107.7719	95.6827	102.3949	91.5843	89.8853	82.1791	81.8678	84.3882	84.5258	92.8545	97.0561	106.7800	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	125.9473	139.4416	125.9473	130.1455	125.9473	130.1455	125.9473	125.9473	130.1455	125.9473	130.1455	125.9473	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)	144.8547	142.3850	137.6275	127.2004	120.8136	114.1377	110.0373	113.4250	117.3969	124.8045	134.8001	143.5215	(72)
Total internal gains	559.0626	572.4182	548.2925	529.5589	503.1889	482.8756	464.6659	465.7227	479.7666	498.4807	528.4595	547.8183	(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	4.0000	11.2829	0.4000	0.7000	0.7700	8.7574	(75)
Southwest	7.2400	36.7938	0.4000	0.7000	0.7700	51.6898	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	60.4472	105.8727	152.5861	202.0122	238.0913	241.5691	230.7345	203.0230	169.5776	119.0952	72.9315	51.3874	(83)
Total gains	619.5097	678.2909	700.8786	731.5711	741.2801	724.4447	695.4004	668.7457	649.3442	617.5758	601.3910	599.2057	(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	99.8967	100.2644	100.6348	102.5286	102.9159	104.8973	104.8973	105.3028	104.0957	102.9159	102.1441	101.3838	
alpha	7.6598	7.6843	7.7090	7.8352	7.8611	7.9932	7.9932	8.0202	7.9397	7.8611	7.8096	7.7589	
util living area	0.9894	0.9772	0.9518	0.8647	0.7044	0.4969	0.3565	0.3860	0.5991	0.8719	0.9718	0.9913	(86)
MIT	20.4847	20.6065	20.7462	20.9103	20.9834	20.9990	20.9999	20.9999	20.9961	20.9187	20.6970	20.4695	(87)
Th 2	20.3257	20.3281	20.3304	20.3420	20.3443	20.3559	20.3559	20.3583	20.3513	20.3443	20.3397	20.3350	(88)
util rest of house	0.9864	0.9711	0.9392	0.8360	0.6601	0.4474	0.3044	0.3322	0.5447	0.8390	0.9632	0.9888	(89)
MIT 2	19.7315	19.8857	20.0585	20.2569	20.3315	20.3554	20.3559	20.3582	20.3489	20.2707	20.0092	19.7201	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.9125	20.0589	20.2238	20.4139	20.4882	20.5101	20.5107	20.5124	20.5044	20.4264	20.1745	19.9002	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9125	20.0589	20.2238	20.4139	20.4882	20.5101	20.5107	20.5124	20.5044	20.4264	20.1745	19.9002	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9841	0.9682	0.9370	0.8393	0.6700	0.4593	0.3169	0.3452	0.5576	0.8434	0.9607	0.9868	(94)
Useful gains	609.6432	656.6911	656.7031	614.0261	496.6712	332.7046	220.3729	230.8355	362.0901	520.8599	577.7368	591.2881	(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	923.8935	893.7618	806.1689	663.8629	504.7970	333.0660	220.3883	230.8654	363.7041	564.4356	756.6805	915.4558	(97)
Space heating kWh	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98a)
Space heating requirement - total per year (kWh/year)												948.6849	
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	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												948.6849	
Space heating per m2										(98c) / (4) =		11.4964	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	88.8000 (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	233.8022	159.3115	111.2026	35.8825	6.0456	0.0000	0.0000	0.0000	0.0000	32.4203	128.8395	241.1807	(98)
Space heating efficiency (main heating system 1)	88.8000	88.8000	88.8000	88.8000	88.8000	0.0000	0.0000	0.0000	0.0000	88.8000	88.8000	88.8000	(210)
Space heating fuel (main heating system)	263.2908	179.4048	125.2281	40.4082	6.8081	0.0000	0.0000	0.0000	0.0000	36.5093	145.0895	271.5999	(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	224.4881	198.4381	210.9320	186.1277	180.7919	163.3376	161.6849	167.9790	169.6454	188.6160	199.8167	222.1603	(64)
Efficiency of water heater												79.8000	(216)
(217)m	84.1511	83.5719	82.6932	81.1290	80.0626	79.8000	79.8000	79.8000	79.8000	81.0042	83.1018	84.2444	(217)
Fuel for water heating, kWh/month	266.7679	237.4460	255.0779	229.4220	225.8133	204.6837	202.6127	210.5000	212.5883	232.8472	240.4481	263.7094	(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	28.6802	25.9047	28.6802	27.7550	28.6802	27.7550	28.6802	28.6802	27.7550	28.6802	27.7550	28.6802	(231)
Lighting	25.6345	20.5649	18.5164	13.5659	10.4787	8.5612	9.5590	12.4252	16.1391	21.1754	23.9175	26.3469	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1068.3388 (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	2781.9165	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 1.0000)		
mechanical ventilation fans (SFP = 1.0000)	251.6860	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	337.6860	(231)
Electricity for lighting (calculated in Appendix L)	206.8848	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4394.8261	(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	1068.3388	0.2100	224.3511	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2781.9165	0.2100	584.2025	(264)
Space and water heating			808.5536	(265)
Pumps, fans and electric keep-hot	337.6860	0.1387	46.8412	(267)
Energy for lighting	206.8848	0.1443	29.8599	(268)
Total CO2, kg/year			885.2547	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			10.7300	(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	1068.3388	1.1300	1207.2228	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2781.9165	1.1300	3143.5656	(278)
Space and water heating			4350.7884	(279)
Pumps, fans and electric keep-hot	337.6860	1.5128	510.8514	(281)
Energy for lighting	206.8848	1.5338	317.3269	(282)
Total Primary energy kWh/year			5178.9667	(286)
Dwelling Primary energy Rate (DPER)			62.7600	(287)

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

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		41.2600 (1b)	x	2.5000 (2b)	=	103.1500	(1b) - (3b)
First floor		41.2600 (1c)	x	2.5000 (2c)	=	103.1500	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	82.5200						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	206.3000	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1454	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3954	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3361	(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													
	0.4285	0.4201	0.4117	0.3697	0.3613	0.3193	0.3193	0.3109	0.3361	0.3613	0.3781	0.3949	(22b)
Effective ac	0.5918	0.5883	0.5848	0.5683	0.5653	0.5510	0.5510	0.5483	0.5565	0.5653	0.5715	0.5780	(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			2.2100	1.0000	2.2100			(26)
TER Opening Type (Uw = 1.20)			11.2400	1.1450	12.8702			(27)
Ground Floor			41.3400	0.1300	5.3742			(28a)
00_Ground	25.9000	8.5100	17.3900	0.1800	3.1302			(29a)
01_First	36.6500	4.9400	31.7100	0.1800	5.7078			(29a)
Plane Roof	41.2600		41.2600	0.1100	4.5386			(30)
Total net area of external elements Aum(A, m2)			145.1500					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		33.8310			(33)
00_Ground			41.7000	0.0000	0.0000			(32)
01_First			32.6000	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 257.8958 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E5	Ground floor (normal)	10.3600	0.1600	1.6576
P1	Party wall - Ground floor	16.7800	0.0800	1.3424
E6	Intermediate floor within a dwelling	14.6600	0.0000	0.0000
P2	Party wall - Intermediate floor within a dwelling	22.7700	0.0000	0.0000
P5	Party wall - Roof (insulation at rafter level)	13.0000	0.0800	1.0400
E12	Gable (insulation at ceiling level)	8.7400	0.0600	0.5244
E10	Eaves (insulation at ceiling level)	5.9200	0.0600	0.3552
E1	Steel lintel with perforated steel base plate	8.3500	0.0500	0.4175
E3	Sill	7.3000	0.0500	0.3650
E4	Jamb	18.7400	0.0500	0.9370
E18	Party wall between dwellings	15.8000	0.0600	0.9480
E25	Staggered party wall between dwellings	6.9000	0.0600	0.4140
E16	Corner (normal)	16.1000	0.0900	1.4490
E17	Corner (inverted - internal area greater than external area)	2.5000	-0.0900	-0.2250

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 9.2251 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 43.0561 (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	40.2906	40.0479	39.8099	38.6924	38.4833	37.5099	37.5099	37.3297	37.8849	38.4833	38.9063	39.3485	(38)
Heat transfer coeff	83.3467	83.1040	82.8661	81.7485	81.5394	80.5661	80.5661	80.3858	80.9410	81.5394	81.9624	82.4046	(39)
Average = Sum(39)m / 12 =												81.7475	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0100	1.0071	1.0042	0.9907	0.9881	0.9763	0.9763	0.9741	0.9809	0.9881	0.9932	0.9986	(40)
HLP (average)												0.9906	
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 2.5089 (42)

Hot water usage for mixer showers

66.2864	65.2902	63.8386	61.0613	59.0116	56.7259	55.4267	56.8673	58.4465	60.9007	63.7377	66.0324	(42a)

Hot water usage for baths

28.6285	28.2034	27.6046	26.5007	25.6740	24.7574	24.2623	24.8569	25.5042	26.4850	27.6117	28.5318	(42b)

Hot water usage for other uses

40.3240	38.8577	37.3914	35.9251	34.4587	32.9924	32.9924	34.4587	35.9251	37.3914	38.8577	40.3240	(42c)

Average daily hot water use (litres/day) 124.3152 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.2390	132.3513	128.8346	123.4870	119.1444	114.4758	112.6814	116.1829	119.8758	124.7771	130.2071	134.8882	(44)
Energy conte	214.1854	188.4665	198.0140	169.0475	160.3913	140.7613	136.2784	143.8587	147.8188	169.3213	185.5039	211.2023	(45)
Energy content (annual)										Total = Sum(45)m =		2064.8496	
Distribution loss (46)m = 0.15 x (45)m	32.1278	28.2700	29.7021	25.3571	24.0587	21.1142	20.4418	21.5788	22.1728	25.3982	27.8256	31.6803	(46)

Water storage loss:

Store volume 300.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 2.1127 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.1409 (55)

Total storage loss

35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)

If cylinder contains dedicated solar storage

35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
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)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Primary loss

Combi loss

Total heat required for water heating calculated for each month

272.8143	241.4215	256.6429	225.7851	219.0201	197.4989	194.9073	202.4875	204.5564	227.9501	242.2415	269.8311	(62)
-30.3034	-26.8005	-28.0640	-23.2381	-21.6571	-18.5321	-17.3709	-18.4722	-19.1740	-22.6041	-25.6077	-29.7422	(63a)
-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)

WWHRS

PV diverter

Solar input

FGHRS

Output from w/h

242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)

Total per year (kWh/year) = Sum(64)m = 2473.5904 (64)

12Total per year (kWh/year) 2474 (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

118.1197	105.0292	112.7427	101.5983	100.2331	92.1932	92.2156	94.7361	94.5398	103.2024	107.0701	117.1278	(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	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	125.4469	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	122.2797	135.3811	122.2797	126.3557	122.2797	126.3557	122.2797	122.2797	126.3557	122.2797	126.3557	122.2797	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	224.6266	226.9575	221.0836	208.5789	192.7939	177.9583	168.0472	165.7163	171.5901	184.0948	199.8798	214.7154	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	35.5447	(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)													
	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	-100.3576	(71)
Water heating gains (Table 5)													
	158.7631	156.2934	151.5359	141.1088	134.7220	128.0461	123.9457	127.3334	131.3053	138.7129	148.7085	157.4299	(72)
Total internal gains													
	569.3034	582.2660	558.5333	539.6775	513.4297	492.9941	474.9067	475.9635	489.8852	508.7215	538.5780	558.0591	(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	4.0000	11.2829	0.6300	0.7000	0.7700	13.7929	(75)
Southwest	7.2400	36.7938	0.6300	0.7000	0.7700	81.4114	(79)

Solar gains	95.2043	166.7496	240.3231	318.1692	374.9938	380.4713	363.4069	319.7613	267.0847	187.5749	114.8671	80.9352	(83)
Total gains	664.5077	749.0156	798.8564	857.8467	888.4234	873.4654	838.3136	795.7248	756.9698	696.2964	653.4451	638.9942	(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	70.9271	71.1343	71.3385	72.3138	72.4992	73.3751	73.3751	73.5396	73.0352	72.4992	72.1251	71.7380	
alpha	5.7285	5.7423	5.7559	5.8209	5.8333	5.8917	5.8917	5.9026	5.8690	5.8333	5.8083	5.7825	
util living area													
	0.9924	0.9839	0.9659	0.9068	0.7785	0.5792	0.4213	0.4620	0.7007	0.9234	0.9827	0.9938	(86)
MIT	20.0480	20.2185	20.4406	20.7244	20.9130	20.9873	20.9983	20.9972	20.9633	20.7325	20.3519	20.0240	(87)
Th 2	20.0750	20.0774	20.0798	20.0911	20.0932	20.1031	20.1031	20.1049	20.0993	20.0932	20.0890	20.0845	(88)
util rest of house													
	0.9900	0.9790	0.9552	0.8794	0.7239	0.5029	0.3363	0.3736	0.6237	0.8948	0.9765	0.9918	(89)
MIT 2	18.9793	19.1963	19.4751	19.8225	20.0242	20.0963	20.1026	20.1040	20.0767	19.8404	19.3754	18.9561	(90)
Living area fraction										fLA = Living area / (4) =		0.2403	(91)
MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2361	19.4420	19.7071	20.0393	20.2378	20.3104	20.3178	20.3186	20.2897	20.0547	19.6101	19.2127	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9870	0.9746	0.9499	0.8776	0.7332	0.5209	0.3568	0.3949	0.6408	0.8934	0.9722	0.9893	(94)
Useful gains	655.8829	729.9986	758.8479	752.8495	651.3802	455.0210	299.0838	314.1994	485.0352	622.0552	635.2908	632.1436	(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													
	1244.8793	1208.4953	1094.4183	910.6175	696.1649	460.0655	299.5320	315.0023	501.0044	770.9334	1025.3553	1237.1176	(97)
Space heating kWh													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98a)
Space heating requirement - total per year (kWh/year)												1998.0526	
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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1998.0526	
Space heating per m2											(98c) / (4) =	24.2130	(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													
	438.2133	321.5498	249.6644	113.5929	33.3198	0.0000	0.0000	0.0000	0.0000	110.7653	280.8465	450.1006	(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)													
	474.7707	348.3746	270.4923	123.0692	36.0994	0.0000	0.0000	0.0000	0.0000	120.0058	304.2757	487.6497	(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													
	242.5109	214.6210	228.5789	202.5470	197.3630	178.9668	177.5364	184.0153	185.3824	205.3461	216.6338	240.0889	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.3699	84.9643	84.2581	82.8159	80.9856	79.8000	79.8000	79.8000	79.8000	82.7383	84.6430	85.4477	(217)
Fuel for water heating, kWh/month													
	284.0707	252.6014	271.2842	244.5750	243.7015	224.2691	222.4766	230.5957	232.3087	248.1874	255.9383	280.9777	(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	25.4073	20.3827	18.3523	13.4457	10.3859	8.4853	9.4743	12.3151	15.9961	20.9877	23.7056	26.1135	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-38.4047	-54.0339	-77.5047	-86.9444	-93.5754	-87.2696	-86.1902	-81.4622	-73.0794	-61.7013	-42.1832	-33.2159	(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	-22.0081	-46.2711	-91.9250	-138.0064	-182.4269	-183.2859	-181.1288	-153.3807	-112.4497	-66.1500	-29.3763	-17.4052	(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	2164.7374	(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	2990.9862	(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)	205.0515	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-2039.3789	(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	3407.3963	(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	2164.7374	0.2100	454.5949	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2990.9862	0.2100	628.1071	(264)
Space and water heating			1082.7020	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	205.0515	0.1443	29.5953	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	0.1346	-109.8028	
PV Unit electricity exported	-1223.8140	0.1259	-154.0882	
Total			-263.8909	(269)
Total CO2, kg/year			860.3356	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.4300	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	2164.7374	1.1300	2446.1533	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2990.9862	1.1300	3379.8144	(278)
Space and water heating			5825.9677	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	205.0515	1.5338	314.5148	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-815.5649	1.4976	-1221.3795	
PV Unit electricity exported	-1223.8140	0.4622	-565.6101	
Total			-1786.9896	(283)
Total Primary energy kWh/year			4483.5938	(286)
Target Primary Energy Rate (TPER)			54.3300	(287)

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