Dwyer Road

Energy and Overheating Assessment

April 2023

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1.0 Executive summary

HTA Design LLP has been appointed to prepare this Energy and Overheating Assessment Statement to support the submission of the planning application **for the Dwyer Road Site development, in the Reading Borough Council.**

This report sets out how the development responds to all relevant planning and project requirements, including:

- Energy Statement
- Overheating Assessment

A Sustainability Statement is separately submitted, summarising the overall sustainability strategy and covering all aspects which lead to the development of the Dwyer Road achieving and exceeding the national and regional targets, as outlined in the National Planning Policy Framework. This statement has also been prepared in line with the latest Reading Climate Change Strategy on preparing energy assessments.

The strategy for reducing energy use and associated carbon emissions through the design of the scheme follows the 'Be Lean', 'Be Clean', 'Be Green' Energy Hierarchy. The improvement in energy performance will be achieved through the use of high fabric efficiency, good air tightness levels, efficient building services, and the installation of PV panels on the roof.

The development achieves 38% reduction above 2021 Building Regulations at 'Be Lean' stage and 101% overall carbon reduction above 2021 Building Regulations, achieving a net zero regulated carbon. Tables 1-2 and Figure 1 demonstrate the overall reduction in the regulated carbon emissions of the development after each stage of the Energy Hierarchy.

Carbon emission factors

The proposed building has been modelled in Design web-based SAP 10.2. The data produced by the software has been used to calculate the carbon dioxide emissions using the SAP 10.2 carbon factors, in line with the requirements set out in the new Approved Document L. The assessment has been undertaken by the energy modelling team who consists of accredited domestic energy and low carbon assessors.

Establishing CO_2 emissions

This document details the measures adopted to reduce the carbon emissions of the proposed buildings. The following tables report the regulated emissions as well as those emissions associated with uses not covered by Building Regulations, i.e. unregulated energy uses.

These tables demonstrate compliance with the energy hierarchy and the carbon targets. Savings are expressed in tonnes of CO_2 per annum as opposed to $kgCO_2/m^2$ per annum.

Based on the National Calculation Methodology, the total Carbon Emissions for the non-regulated end uses of the building have been calculated. The total carbon emissions of the development from equipment is circa 11.9 tonnes per year. No strategies are proposed to reduce the non-regulated energy demand of the development.

Be Lean

The first step addresses reduction in energy use, through the adoption of fabric, servicing improvements and the incorporation of flexibility measures.

The proposed development will incorporate a range of energy efficiency measures including levels of insulation exceeding current Building Regulation requirements, the installation of high performance glazing, energy efficient lighting and efficient MVHR system for general ventilation purposes in all habitable spaces.

The implementation of these measures at 'Be Lean' stage wll reduce regulated CO_2 emissions by 12.0 tCO_2/year or 38% when compared to a notional building built to current Part L Building Regulations (2021).

Be Clean

The possibility of employing a decentralised energy network was investigated but no current or future decentralized energy schemes were identified within the vicinity of the site.

Be Green

The Air Source Heat Pump absorbs heat from outside air and then transfers it via the central heating system to provide both hot water heating and heating for an indoor space. The use of ASHP would allow the development to reduce its

carbon emissions and contribute to reducing poor air quality.

The majority of the dwellings will be provided with efficient compact Air Source Heat Pumps (ASHPs) with no outdoor units. Efficient Air Source Heat Pumps with outdoor units will be provided to the large end terrace houses.

Photovoltaic panels (PVs) will be installed on the roof. The full electric HVAC design solutions will be benefited from the future de-carbonisation of the grid. PVs provision has been maximised.

The implementation of the above measures at 'Be Green' stage will further reduce regulated CO_2 emissions by 20.1 tCO_2/year or 63% when compared to a notional building built to current Part L Building Regulations (2021), achieving net zero regulated carbon emissions.

Energy Costs

The energy hierarchy has been followed and the energy efficiency measures, and renewable energy generation has been maximised. This includes efficient building fabric, low air tightness, efficient all electric building services solution, low distribution losses and efficient PV panels. These measures are anticipated to all play a significant role in reducing the occupants' energy costs and minimizing potential impacts from future electricity unit costs increases.

Using the predicted energy consumption taken from the Be Green Part L calculations, the expected space heating,hot water and lighting costs are expected to be zero as the building achieves net zero regulated target.

It should be noted that the actual costs will include additional charges for the heating system and maintenance, standing charges, the occupants' preferred internal temperatures and hot water usage patterns, the occupants' use of lights and appliances (unregulated loads) and the fit-out specification and usage of the communal spaces. Unit electricity costs may also be higher by the time the development is occupied.

Residential-Part L 2021 Performance		
	Carbon Dioxide Emissions (Tonnes CO_2 per Annum)	
	Regulated	Unregulated
Baseline: Part L1A 2021 of the Building Regulations Compliant Development	31.7	11.9
After Energy Demand Reduction (Be Lean)	19.7	11.9
After CHP/DHN/Electric systems (Be Clean)	19.7	11.9
After Renewable Energy (Be Green)	-0.4	11.9

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

	Regulated residential carbon dioxide savings	
	(Tonnes CO_2 per Annum)	(%)
Savings from Energy Demand Reduction	12.0	38%
Savings from Heat Network / CHP/Electric syst.	0.0	0%
Savings from renewable energy	20.1	63%
Total Cumulative Savings	**32.1**	**101%**

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

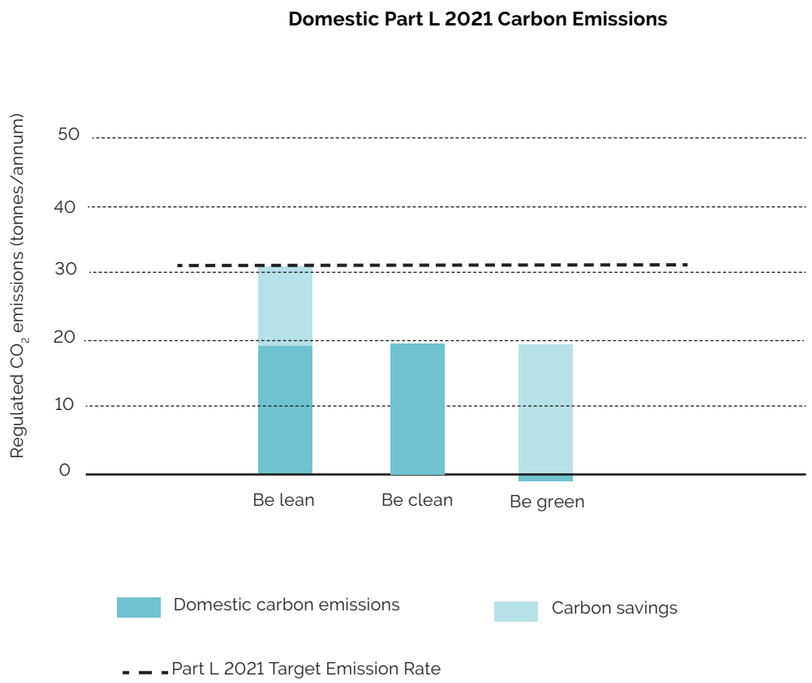

Figure 1: Domestic Part L 2021 Carbon Emissions

Overheating

Overheating analysis on eight representative domestic units have been conducted. These were selected based on design characteristics that establish them as representative of the overall proposed scheme. Among those there are dwellings which are more likely to present a high risk of overheating. Additionally, three typical communal corridors have been included in the modelling.

The representative domestic units have been assessed against CIBSE TM59 Guidance. Approved Part O requirements have been also taken into account when assessing the naturally ventilated homes. The assumptions regarding the building fabric as well as the occupant's behaviour have been summarised in this report.

As required by CIBSE TM59 Assessment Guidance the more extreme DSY2 and DSY3 weather data files for 2020s, describing a short intense warm spell and a less intense but longer warm spell respectively, have also been tested. Compliance with DSY2 and DSY3 is not mandatory but results have been presented.

Finally, a list of general guidelines that future occupants should be aware of, are proposed to help occupants' cope in the event of extreme weather conditions,

The results of the overheating assessment show that all domestic spaces and the communal corridors demonstrate compliance with the overheating criteria as defined by CIBSE TM59.

2.0 Introduction and context

2.1 Wider context

The Site is in the southwest area of the Borough in the Southcote ward, southwest of Reading Town Centre. The site is located between Bath Road, and the Reading-Theale trainline to the south. To the west is Burghfield Road and the Southcote Estate. The area is predominantly residential, with a number of local primary schools and community centres throughout. There are shops and local facilities located on Bath Road with smaller local shops within Southcote Estate to the east. The closest play space amenities for the local neighbourhood are the children's play area within Prospect Park to the north, Linear Park to the south and local play area at Kennet Valley Community centre.

Occupying the end of the street plot, the site is currently hoarded off, but satellite images show an area of previously developed land, which currently contains greenfield with several trees around the perimeter of the site. The site is bounded by Burghfield Road to the east, Dwyer Road to the south and Appleford Road to the west. To the north is Charles Clore Court an extra care and sheltered housing site. " no. semi detached houses are located in the north west corner of the site, outside the redline. The site is located within a residential zone of Reading with houses and flatted development 2 storeys in height, while the extra care facility immediately to the north is a five-storey development. The overall site area is approximately 0.49 hectares.

2.2 Local context

Existing configuration

Previously used as the Alice Burrows Care House, the services were closed in 2007 and the building demolished nearly 15 years ago. The vacant site is now secured and hoarded for the full perimeter, with the exception of a chain link fence to the north along the boundary to Charles Clore Court.

The current site is vacant, with former Alice Burrow's care house already demolished. There do not appear to have been any materials retained, with the exception of an area of hardstanding to the south of the site. The materials held within could be used as aggregate within the hard landscaping design.

2.3 Description of development

Proposed configuration

Following design development and pre-application feedback from Planning Officers across a number of disciplines, the below plan (see Figure 2) represents the emerging scheme. The planning application proposal is described as follows:

- 31 new homes
- A mix of 3, 4 and 5 bedroom homes
- 16x houses (7x 4 bed, 9x 3Bed, 1x 5Bed)
- 15 apartments
- 27 Parking spaces
- All Cat B and TPO trees retained
- PV provision to all roofs
- Biodiverse green roof for all flat roofs

Landscape vision

Reading Borough Council has clear policy guidance in relation to landscape and ecology. Dwyer Road is fairy well located in terms of access to play, with the Kennet Valley play area a five minute walk to the west, and Prospect Park a fifteen minute walk to the east. The existing green spaces to the south of the site could potentially be enhanced and provide natural/ doorstep play as well as be enhanced with wildflower and other planting to increase biodiversity.

The proposed aim for the landscape design (see Figure 2) would be to create generous and inviting garden spaces, capitalising on the maturity and setting of the existing trees around the site perimeter.Generous green verges create a pleasant setting for the new homes and allow the opportunity for management of wildflower grassland to benefit pollinators, and potentially new street tree planting. A mews type street with parallel parking to the north is overlooked by building entrances. The garden for the apartment block would be designed to be secure and accessible to all users, with step free access and wheelchair friendly design of paths and furniture. An amenity space to the south west corner incorporating the TPO tree provides the opportunity for biodiverse planting and inclusion of ecology features such as habitat piles.

Key:

1	**Shared garden for flat block**	7	**Private gardens**
2	**Opportunity for new street tree planting**	8	**Boundary hedge**
3	**Retained trees**	9	**Mixed native hedge**
4	**Amenity space - natural play and seating**	10	**Privacy planting**
5	**Mews street**		
6	**Green verges to site perimeter**		

Figure 2: Illustrative landscape site plan (Source: DAS, HTA 2023).

3.0 Energy statement

The methodology employed to determine the potential CO_2 savings for this development is in accordance 'Be Lean, 'Be Clean', 'Be Green' Energy Hierarchy.

The energy assessment of the proposed scheme has been undertaken following the Approved Document L, Conservation of fuel and power, Volume 1: Dwellings, 2021 edition incorporating 2023 amendments and Standard Assessment Procedure (SAP 10.2).

The data from the approved software used for the analysis was combined in order to give energy consumption and CO_2 emissions of the development. This section outlines the energy strategy developed for the scheme and shows how significant carbon savings can be achieved by integrating energy efficiency measures and using renewable technologies on site.

All components of the development have been designed to exceed the requirements of the Building Regulations (Part L1A). The energy assessment details a number of energy efficiency improvements and includes a renewable energy analysis which leads to a reduced carbon emission rate for the development.

The requirements of Part L will be achieved through:

- Efficient Thermal Elements and Controlled fittings: the building fabric will be designed to improve on minimum Part L 2021 requirements;
- Building Services and Lighting: the new building services will be designed and specified to perform better than the minimum standards detailed in the Part L 2021.

The following sections describe the performance of the proposed development based on the Be Lean, 'Be Clean', 'Be Green' Energy Hierarchy .

The web-based Elmhurst Design SAP 10.2 software has been used to carry out the SAP calculations to demonstrate compliance with Part L1A and assess the energy performance of the homes.

Baseline Part L 2021 regulated carbon emissions for the whole development have been calculated to be 31.7 tCO_2 per year.

Be Lean: use less energy

At this first stage of the energy hierarchy the features that contribute to a reduction of CO_2 emissions compared to Building Regulations are passive and active design measures, i.e. fabric energy efficiency and efficient building services. Energy modelling results show that the scheme will exceed Building Regulations through demand reduction measures alone.

Passive Design Measures

In order to meet the more demanding standards set for this development, the new building will be built to a high specification prioritising a passive "fabric first" approach. Energy demand reductions will be achieved through:

Building Orientation

The orientation of the buildings is largely dictated by the site. The proposed layout maximises the number of rooms which receive direct sunlight throughout the day and balances the percentage of glazing.

Fabric performance

Lower U-values contribute to lower heat losses through different building elements, especially during winter. As a results the heating demand during the cooler months can be significantly reduced. The development will incorporate high levels of insulation and high performance glazing on all the facades to significantly reduce the demand of space heating. Table 3 shows the performance of the building fabric.

Air tightness

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

The maximum air permeability rate set by Part L 2021 Building Regulations is 8 m^3/m^2 at 50Pa. The development will improve upon this to achieve 1 m^3/m^2 at 50Pa.

Active Design Measures

After reducing the energy demand of the development, the next stage would be to use energy efficient building services, lighting and controls throughout the scheme to reduce energy consumption. The proposed energy strategy includes the following measures:

Mechanical Ventilation

Fresh air will be provided via efficient Mechanical Ventilation with Heat Recovery systems.

High efficacy lighting

The development intends to incorporate low energy lighting fittings throughout the building. 100% of all lighting fittings will be specified as low energy lighting.

	Proposed
Ground and Exposed Floor	0.10 W/m²K
External Walls	0.13 W/m²K
Corridor Walls	0.15 W/m²K
Roof	0.11 W/m²K
Windows	Triple glazing 0.80 W/m²K (clear window g-value: 0.54) (Frame factor: 0.8)
Entrance doors	1.00 W/m²K
Air permeability	Whole development: 1 m³/hm² (@50 Pa)
MVHR Unit	Heat Recovery (HR) 90% SFP: 1 Wet Room: 0.54 W per l/s 2 Wet Rooms: 0.55 W per l/s 3 Wet Rooms: 0.62 W per l/s 4 West Rooms: 0.76 W per l/s
Lighting	Low Energy LED Lighting

Table 3: Building fabric performance - Part L 2021

Savings from 'BE LEAN' measures

Domestic spaces

After implementing all the measures listed above, the estimated domestic regulated carbon dioxide emissions at be lean stage have been calculated to be 19.7 tCO_2/year resulting in 38% carbon emissions reduction over Baseline.

BE LEAN STAGE - Carbon dioxide emissions reduction

	Domestic
Baseline Emissions	31.7 Tonnes CO_2/ year
Be Lean: After energy demand reduction	19.7 Tonnes CO_2/ year
Carbon Savings over Baseline	12.0 Tonnes CO_2/ year
Carbon reduction over Baseline	38%

Table 4: Carbon dioxide emissions reduction - 'Be Lean' stage

Energy demand reporting

	Target Fabric Energy Efficiency (MWh/ year)	Design Fabric Energy Efficiency (MWh/ year)	Improvement (%)
Development Total	38.57	34.33	11%

Table 5: DFEE-TFEE values

Unregulated loads

Approved Document PL1 takes into account only carbon emissions from regulated loads, i.e. energy consumption for heating, cooling, lighting and auxiliary. However, during the lifespan of a building, carbon emissions due to unregulated loads, e.g. energy consumption for appliances, lifts operation, external lighting, should be also considered.

The carbon emissions due to the unregulated energy consumption have been calculated to be 11.9 tCO_2 per year based on SAP 10.2 electricity carbon factor.

Be Clean: supply low carbon energy

After minimising energy demand in the first "Be Lean" stage, the second stage of the hierarchy assesses the potential and tests the performance of Decentralised Energy (DE) in order to reduce further the energy of the systems and the associated carbon emissions.

Decentralized energy projects using technologies such as Combined Heat and Power (CHP) and district heating networks can provide electricity and heat at very low carbon intensities, therefore they are encouraged by local councils.

Connecting to a Heat Network

The opportunity to link with a district heating network was investigated but no existing or proposed networks within the vicinity of the site that would be feasible to connect) were identified.

Savings from 'BE CLEAN' measures

Domestic spaces

No measures were implemented at Be Clean stage. Regulated carbon dioxide emissions at Be Clean stage are shown below.

BE CLEAN STAGE - Carbon dioxide emissions reduction

	Domestic
Be Lean: After energy demand reduction	19.7 Tonnes CO2/ year
Be Clean: After heat network/CHP/electric system	19.7 Tonnes CO_2/ year
Carbon Savings over 'Be Clean' stage	0 Tonnes CO_2/ year
Carbon reduction over 'Be Clean' stage	0%

Table 6: Carbon dioxide emissions reduction - 'Be Clean' stage

Be Green: renewable energy technologies

In order to further reduce emissions from the development in accordance with the local authority policies and Energy Hierarchy, it is necessary to consider the introduction of renewable energy systems on site.

This section explores the available renewable energy options that have been assessed for the proposed development.

Heat pumps

The Air Source Heat Pump absorbs heat from outside air and then transfers it via the central heating system to provide both hot water heating and heating for an indoor space. The use of ASHP would allow the development to reduce its carbon emissions and contribute to reducing poor air quality.

It should be noted that the efficiency of the heat pumps is dependent on the temperature difference between the heat source and the space required to be heated. The lower the difference between internal and external temperature, the more efficient the system.

The majority of the dwellings will be provided with efficient compact Air Source Heat Pumps (ASHPs) with no outdoor units. Efficient Air Source Heat Pumps with outdoor units will be provided to the large end terrace houses. The full electric HVAC design solutions will be benefited from the future de-carbonisation of the grid. Table 7 shows ASHPs and electric panels specifications.

	Small/Mid Dwellings	Large Dwellings
Space Heating CoP	3.16	3
DHW ASHPs CoP	3.16	3

Table 7: Heating specification

PVs

Assuming the current weather conditions in the area, particularly solar irradiation and favourable solar orientation, a payback period of around six years is estimated for the PV panels. Photovoltaic panels are a relatively discreet technology and are not considered to be a planning issue from the perspective of visual impact. There are no available grants for the procurement of the PV panels.

Initial calculations were carried out to maximise the use of PVs on the roof. In total the proposed system can provide a total of 95 kWp.

As required by the client, the following information is reported:

- Drawings showing the amount of roof that is available within the development and that could be used to install photovoltaic modules with suitable orientation and lack of shading. - An indicative PV layout is provided in Appendix B.
- An estimate of the total PV system output (kWp) - The system will provide 95 kWp.
- Quantification of the amount of roof area that could be used to install photovoltaic modules - A total gross area of 793 m² will be used for the installation of the PVpanels.
- A calculation of the CO_2 savings that may be realised through the use of this technology. - It is estimated that 2.85 Tonnes CO_2/yr savings may be realised through the use of this technology based on 20.1% PV panels efficiency and 30 ˚C south facing inclination .

Savings from 'BE GREEN' measures

Domestic spaces

After implementing the renewable energy measures listed above, the estimated carbon dioxide emissions have been calculated to be -0.4 tCO_2/year.

BE GREEN STAGE - Carbon dioxide emissions reduction	
	Domestic
Baseline Emissions	31.7 Tonnes CO_2/ year
Be Lean: After energy demand reduction	19.7 Tonnes CO2/ year
Be Clean: After heat network / CHP	19.7 Tonnes CO2/ year
Be Green: After renewable energy technologies	-0.4 Tonnes Co_2/ year
Carbon savings over 'Be Green' stage	20.1 Tonnes Co_2/ year
Carbon reduction over 'Be Green' stage	63%

Table 8: Carbon dioxide emissions reduction - 'Be Green' stage

Energy Strategy Summary

The overall energy strategy has been defined by the 'Be Lean, 'Be Clean', 'Be Green' Energy Hierarchy, which focuses on minimising energy use, before using efficient systems and finally making use of renewable energy technology to minimise the energy required from the prime energy sources.

The strategy for reducing energy use and associated carbon emissions through the design of the scheme follows a three-step approach:

- Reducing the energy demand through passive design strategies and provision of high-quality building envelope
- Reducing the energy consumption through best practice design of building services, lighting and control. Connecting the scheme to a District Heating Network was not feasible at this time.
- Installation of on-site renewable energy technologies.

Energy efficiency features incorporated in the development are:

- Building fabric will exceed Part L minimum requirements in terms of u-values and airtightness
- Mechanical Ventilation and Heat Recovery system will be installed in all homes to make use of wasted heat of exhaust air by preheating incoming air. An integrated peak lopping cooling unit will be additionally integrated into the MVHR of specific homes.
- Low energy LED light fitting will be installed throughout the scheme

The scheme will be provided with efficient ASHPs which will provide space heating and domestic hot water.

The majority of the dwellings will be provided with efficient compact Air Source Heat Pumps (ASHPs) with no outdoor units. Efficient Air Source Heat Pumps with outdoor units will be provided to the large end terrace houses.

Tables 9-10 summarise the carbon dioxide emissions and the carbon dioxide savings for each stage of the energy hierarchy.

Energy Costs

The energy hierarchy has been followed and the energy efficiency measures, and renewable energy generation has been maximised. This includes efficient building fabric, low air tightness, efficient all electric building services solution, low distribution losses and efficient PV panels. These measures are anticipated to all play a significant role in reducing the occupants' energy costs and minimizing potential impacts from future electricity unit costs increases.

Using the predicted energy consumption taken from the Be Green Part L calculations, the expected space heating, hot water and lighting costs are expected to be zero as the building achieves net zero regulated target.

It should be noted that the actual costs will include additional charges for the heating system and maintenance, standing charges, the occupants' preferred internal temperatures and hot water usage patterns, the occupants' use of lights and appliances (unregulated loads) and the fit-out specification and usage of the communal spaces. Unit electricity costs may also be higher by the time the development is occupied.

Residential-Part L 2021 Performance		
	Carbon Dioxide Emissions (Tonnes CO_2 per Annum)	
	Regulated	Unregulated
Baseline: Part L1A 2021 of the Building Regulations Compliant Development	31.7	11.9
After Energy Demand Reduction (Be Lean)	19.7	11.9
After CHP/DHN/Electric systems (Be Clean)	19.7	11.9
After Renewable Energy (Be Green)	-0.4	11.9

Table 9: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for residential buildings.

	Regulated residential carbon dioxide savings	
	(Tonnes CO_2 per Annum)	(%)
Savings from Energy Demand Reduction	12.0	38%
Savings from Heat Network / CHP/Electric syst.	0.0	0%
Savings from renewable energy	20.1	63%
Total Cumulative Savings	**32.1**	**101%**

Table 10: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for residential buildings.

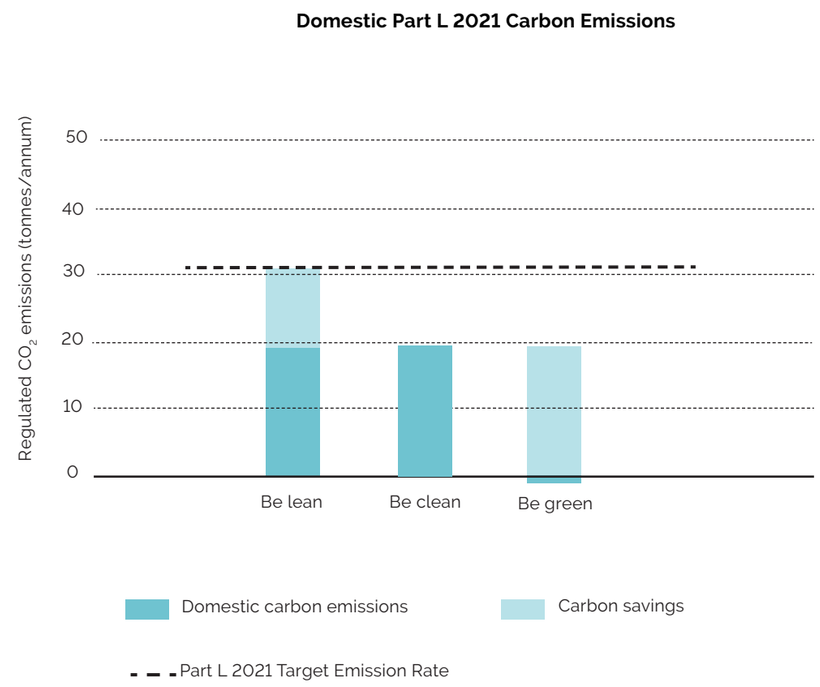

Figure 3: Domestic Part L 2021 Carbon Emissions

4.0 Overheating Assessment

Approved Document O, Requirement 01: Overheating mitigation

The aim of requirement O1 of Approved Document O is to protect the health and welfare of occupants of the building by reducing the occurrence of high indoor temperatures.

Approved Document O, Requirement 01: Overheating mitigation
Dynamic thermal modelling method
2.3 To demonstrate compliance using the dynamic thermal modelling method, all of the following guidance should be followed.
a. CIBSE's TM59 methodology for predicting overheating risk.
b. The limits on the use of CIBSE's TM59 methodology set out in paragraphs 2.5 and 2.6 of this document.
c. The acceptable strategies for reducing overheating risk in paragraphs.
Limits on CIBSE's TM59 modelling
2.5 CIBSE's TM59 method requires the modeller to make choices. The dynamic thermal modelling method in this section applies limits to these choices, which are detailed in paragraph 2.6. These limits should be applied when following the guidance in CIBSE's TM59.
2.6 All of the following limits on CIBSE's TM59, section 3.3, apply.
a. When a room is occupied during the day (8am to 11pm), openings should be modelled to do all of the following.
i. Start to open when the internal temperature exceeds 22˚C.
ii. Be fully open when the internal temperature exceeds 26˚C.
iii. Start to close when the internal temperature falls below 26˚C.
iv. Be fully closed when the internal temperature falls below 22˚C.
b. At night (11pm to 8am), openings should be modelled as fully open if both of the following apply.
i. The opening is on the first floor or above and not easily accessible.
ii. The internal temperature exceeds 23˚C at 11pm.
c. When a ground floor or easily accessible room is unoccupied, both of the following apply.
i. In the day, windows, patio doors and balcony doors should be modelled as open, if this can be done securely, following the guidance in paragraph 3.7 of this document.
ii. At night, windows, patio doors and balcony doors should be modelled as closed.
d. An entrance door should be included, which should be shut all the time.

Table 11: Approved document O, Requirement O1: Overheating mitigation

CIBSE TM59 Overheating Criteria for dwellings

CIBSE has published TM59 '*Design methodology for the assessment of overheating risk in homes*' in May 2017. The guidance replaces the TM52 to be used in residential buildings. TM59 provides designers with a standardised approach to predicting overheating risk for residential building designs using dynamic thermal analysis.

Both of the criteria presented in detail in Table 12 must be met in order to demonstrate compliance. In order to allow the occupants to 'adapt', each habitable room needs openable windows with a minimum free area that satisfies the purge ventilation criteria set in Part F of the Building Regulations for England (NBS, 2010), and equivalent regulations in other countries, i.e. the window opening area should be at least 1/20th of the floor area of the room (different conditions exist for windows with restricted openings, and the same requirement applies for external doors).

CIBSE TM59 Overheating criteria (2017): predominantly naturally ventilated dwellings	
Criterion 1 (for living rooms, bedrooms and kitchens)	The number of hours in which the difference between the actual operative temperature in a room and the maximum acceptable temperature is greater than or equal to one degree during the period May to September inclusive shall not be more than 3% of occupied hours (CIBSE TM52 -Criterion 1).
Criterion 2 (for bedrooms only)	To guarantee comfort during the sleeping hours, the operative temperature in the bedrooms from 10pm to 7am shall not exceed 26˚C for more than 1% of annual hours.

Table 12: CIBSE TM59 Overheating Criteria for dwellings

The inclusion of corridors in the overheating analysis is mandatory where community heating pipework runs through them. At least one corridor should be modelled as part of the assessment and the ventilation of it should be included in the analysis as designed.

Communal corridor heat gains should be modelled based on calculated losses from pipework (see CIBSE Guide C (2007) and/or the Domestic Heating Design Guide (DBSP, 2015)), or based on the simplified method provided in Table 5 of the Domestic Building Services Compliance Guide (HMG, 2013).

CIBSE TM59 Overheating criteria (2017): corridors	
Criterion for corridors	Whilst there is no mandatory target, if an operative temperature of 28 ˚C is exceeded for more than 3% of total annual hours, this should be flagged as a significant risk.

Table 13: CIBSE TM59 Overheating Criteria for corridors

Since some homes will be only predominantly mechanically ventilated due to noise issues and consequently restrictions in opening windows, CIBSE Guide A has been implemented in these cases (for the purposes of the assessment methodology).

CIBSE GUIDE A: predominantly mechanically ventilated dwellings
The CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 ˚C for more than 3% of the annual occupied annual hours.

Table 14: CIBSE Guide A Overheating Criteria for dwellings with restricted window openings or mechanically cooled

4.3 Passive design measures

Detailed dynamic modelling were carried out to assess the design against Part O and TM59 criteria . It should be noted that these have been explored as far as practicable, in order to avoid the use of active cooling, as detailed below.

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure. It is also expected that external shading will form part of major proposals

Orientation	The orientation is dictated by the site limiting the design. The site's axis is located close to the south/north direction.
Shading	External shading in the form of balconies as well as the deep recessions in windows are specified and will contribute significantly to the mitigation of the overheating risk. The use of internal blinds has not been considered in the assessment as per the Part O recommendations but could potentially further contribute to the mitigation of the overheating risk.
High albedo materials, fenestration and insulation	Highly efficient building fabric has been specified with all elements achieving low u-values. The air tightness has also been optimised, aiming balance heat losses and overheating risk. Windows of high performance will be provided to all spaces. These will have a low u-value to reduce heat losses during winter and prevent heat transfer from outside during summer. Solar control glass of a low g-value (0.54) is specified to reduce solar gains being transmitted through the windows.
Provision of green infrastructure	Planting at ground floor level will contribute to the reduction of the heat island effect and will provide an improved quality of life to the occupants and users of the building.

2. Minimise internal heat generation through energy efficient design: For example, heat distribution infrastructure within buildings should be designed to minimise pipe lengths, particularly lateral pipework in corridors of apartment blocks, and adopting pipe configurations which minimise heat loss e.g.. twin pipes.

Low energy LED lighting and lighting controls will be provided. These will minimise lights in use when not required (therefore reducing heat gains).

Pipe insulation has been maximised as much as practicable.

3. Manage the heat within the building through exposed internal thermal mass and high ceilings: Increasing the amount of exposed thermal mass can help to absorb excess heat within the building. Efficient thermal mass should be coupled with night time purge ventilation.

The current design includes concrete slab between floors, the thermal mass of which will help reduce the overheating risk.

4. Provide passive ventilation: For example, through the use of openable windows, shallow floorplates, dual aspect units or designing in the 'stack effect' where possible.

The majority of the dwellings have been designed to be dual aspect offering opportunity for cross-ventilation.

Windows will be openable on restrictors (15 degrees) during daytime and nighttime to provide fresh air and assist in mitigating the overheating risk, where possible.

5. Provide mechanical ventilation: Mechanical ventilation can be used to make use of 'free cooling' where the outside air temperature is below that in the building during summer months. This will require a by-pass on the heat recovery system for summer mode operation.

All homes will have mechanical supply and extract with heat recovery (MVHR).
MVHR will be specified with summer by-pass to prevent recovery of unwanted heat and hence allow heat to escape the building.
MVHR will run at design boost ventilation during warm periods to supplement natural ventilation.

6. Provide active cooling systems: The increased use of air conditioning systems is generally not supported, as these have significant energy requirements and, under conventional operation, expel hot air, thereby adding to the urban heat island effect. However, once passive measures have been prioritised if there is still a need for active cooling systems, such as air conditioning systems, these should be designed in a very efficient way and should aim to reuse the waste heat they produce

No active cooling is suggested at this stage.

4.4 Noise Assessment

The results of the noise assessment carried out by 24 Acoustics (March 2023) have identified that windows can be open for rapid or purge ventilation or for residents' choice during daytime.

The nosie assessment also showed that south and east facades next to the road (see Figure 4) do not achieve Approved Document O noise level requirements during night time and thus, windows can not be open for rapid or purge nigh time ventilation..

To mitigate the overheating risk, these dwellings will be equipped with MVHR units able to provide tempered air at 16˚C when required.

Figure 4: Approved document O noise criteria

4.5 Modelling input data

Building category	Category II: Normal expectation for new building.
Sample size	In total, 8 domestic units (26% of the 31 proposed domestic units) were analysed. The Approved Document O requirements have been taken into account in cases of homes being naturally ventilated.
Weather file used	Based on CIBSE TM59 Guidance, CIBSE Design Summer Year (DSY1) for 2020s, high emissions, 50% percentile scenario has been implemented. The London Gatwick airport data, representing lower density urban and suburban areas, was used. Although not required for compliance, the following additional extreme weather files have been also tested: DSY2 (2020s): featuring short intense warm spell DSY3 (2020s): featuring long, less intense warm spell
Air speed	The modelled air speeds inside the rooms have been set at 0.1 m/s in line with the TM59 methodology.
Exposure type	Depending on the location of each window, various exposure types have been applied in the thermal model.
Air infiltration	0.08 ach domestic spaces

Table 15: Model input data

Data input		Discussion
Natural ventilation	Operation	Windows openable on restrictors during daytime and nighttime.
	Openable area	All openable windows have 80% openable area on restrictors (by 15 degrees) to account for security limitations.
Internal doors	Operation	As per TM 59 guidelines.
Mechanical ventilation	Operation	A mechanical ventilation with heat recovery system able to provide 0.9ach of fresh air at external air temperature or tempred air at 16°C (see section 4.4) to living rooms, kitchens and bedrooms.
Shading devices	Internal blinds	No internal blinds are specified.
	External shading	External shading is mainly provided by deep recessions on all windows and by balconies. At specific domestic spaces external shading will be installed at specific domestic spaces.

Table 17: Ventilation strategy and shading devices

Minimising corridor internal gains by limiting horizontal pipework in the corridor ceiling void where possible, and maximising pipe insulation ensures that internal heat generation is minimal and the ventilation requirements of the communal corridors for overheating mitigation are relatively low.

Corridors	Insulation thickness of pipework	50mm
	Flow & Return Temperatures	65°C Flow, 45°C Return
	Thickness of pipework	40mm
	Ventilation strategy	Mechanically ventilated using environmental ventilation shaft systems. Each shaft will have a closed base and duty/standby environmental fans (with associated dampers/attenuation) on the roof which bypasses any smoke shaft fans. - up to 1.0 ach extract rate to be achieved.

Table 18: Communal corridor assumptions.

4.6 Summary of results

Dynamic thermal modelling has been carried out on the basis of the assumptions presented in the previous paragraphs. The risk of overheating in all the main areas has been assessed against the CIBSE DSY1 weather file.

Table 19 provides a summary of the number of rooms complying with Criteria "a" and "b" of the CIBSE TM59 Guide for the naturally ventilated homes.

Results show that all the assessed rooms comply with the TM59 overheating criteria as a result of the passive design features and the ventilation strategy described in the previous sections being integrated in the proposed design.

All rooms have also been assessed against the more extreme weather conditions, described by weather files DSY2 and DSY3.

Table 20 provides a summary of the corridors spaces compliance against CIBSE TM59 Guide criteria. Results show that the assessed corridors comply with the TM59 overheating criteria as a result of the passive design features and the ventilation strategy described in the previous sections being integrated in the proposed design.

	Part O - TM59 Assessment		
	DSY1-2020	DSY2-2020	DSY3-2020
Percentage of units passing	100%	25%	0%

Table 19: Summary results for the domestic spaces of the TM59 overheating assessment for the 2020 DSY weather files.

	Part O - TM59 Assessment		
	DSY1-2020	DSY2-2020	DSY3-2020
Percentage of corridors passing	100%	100%	100%

Table 20: Summary results for the communal corridors of the TM59 overheating assessment for the 2020 DSY weather files.

4.6 Conclusions

HTA Design LLP has been appointed to prepare an Overheating Assessment to support the submission of a planning application for the development of The Dwyer Road Site.

Overheating analysis on eight representative domestic units have been conducted. These were selected based on design characteristics that establish them as representative of the overall proposed scheme. Among those there are dwellings which are more likely to present a high risk of overheating. Additionally, three typical communal corridors have been included in the modelling.

The representative domestic units have been assessed against CIBSE TM59 Guidance. Approved Part O requirements have been also taken into account when assessing the naturally ventilated homes. The assumptions regarding the building fabric as well as the occupant's behaviour have been summarised in this report.

As required by CIBSE TM59 Assessment Guidance the more extreme DSY2 and DSY3 weather data files for 2020s, describing a short intense warm spell and a less intense but longer warm spell respectively, have also been tested. Compliance with DSY2 and DSY3 is not mandatory but results have been presented.

Finally, a list of general guidelines that future occupants should be aware of, are proposed to help occupants cope in the event of extreme weather conditions,

The results of the overheating assessment show that all domestic spaces and the communal corridors demonstrate compliance with the overheating criteria as defined by CIBSE TM59.

5.0 Appendix A - Sample SAPs

SAP10.2 Be Lean

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Property Reference	3B5PB House _Unit 3_Pitched	Issued on Date	12/04/2023
Assessment Reference	Be LEAN-3B5PB House-Unit 3	Prop Type Ref	House
Property			

SAP Rating	87 B	DER	8.54	TER	9.45
Environmental	93 A	% DER < TER			9.63
CO_2 Emissions (t/year)	0.73	DFEE	27.52	TFEE	30.40
Compliance Check	See BREL	% DFEE < TFEE			9.48
% DPER < TPER	-1.50	DPER	49.80	TPER	49.06

Assessor Details	Mr. Rory Bergin	Assessor ID	N427-0001
Client			

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

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1. Overall dwelling characteristics

			Area (m2)		Storey height (m)		Volume (m3)	
Ground floor			47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b) -	
First floor			47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c) -	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	94.0000							(4)
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000 (5)	

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2. Ventilation rate
---

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.0000	(17)
Infiltration rate		0.0500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0425	(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	0.0542	0.0531	0.0521	0.0468	0.0457	0.0404	0.0404	0.0393	0.0425	0.0457	0.0478	0.0499	(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) =	80.1000	(23c)

Effective ac	0.1537	0.1526	0.1516	0.1462	0.1452	0.1399	0.1399	0.1388	0.1420	0.1452	0.1473	0.1494	(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)			14.3100	0.7752	11.0930			(27)
Door			3.3600	1.2000	4.0320			(26)

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GF			47.0000	0.1000	4.7000	(28a)
EW	56.5600	17.6700	38.8900	0.1300	5.0557	(29a)
ER	47.0000		47.0000	0.1000	4.7000	(30)
Total net area of external elements Aum(A, m2)			150.5600			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		29.5807	(33)
PW			105.7300	0.0000	0.0000	(32)

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

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	10.1000	0.2680	2.7068
E6 Intermediate floor within a dwelling	10.1000	0.1400	1.4140
E18 Party wall between dwellings	20.0000	0.1200	2.4000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.1600	1.6160
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0300	0.2742
E3 Sill	7.7800	0.0200	0.1556
E4 Jamb	25.6600	0.0200	0.5132
P1 Party wall - Ground floor	18.8000	0.1600	3.0080
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.2400	4.5120

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 18.5102 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 48.0909 (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	11.9185	11.8361	11.7537	11.3417	11.2593	10.8473	10.8473	10.7649	11.0121	11.2593	11.4241	11.5889	(38)
Heat transfer coeff	60.0094	59.9270	59.8446	59.4326	59.3502	58.9382	58.9382	58.8558	59.1030	59.3502	59.5150	59.6798	(39)
Average = Sum(39)m / 12 =												59.4120	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6384	0.6375	0.6366	0.6323	0.6314	0.6270	0.6270	0.6261	0.6288	0.6314	0.6331	0.6349	(40)
HLP (average)												0.6320	
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 2.6766 (42)

Hot water usage for mixer showers

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	77.9152	76.7391	75.0658	72.5601	70.3018	67.1930	64.8345	67.7186	69.2322	72.3125	75.5150	77.8534	(42b)
Hot water usage for other uses													
	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)
Average daily hot water use (litres/day)												110.4652	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	119.9564	117.2515	114.0495	110.0149	106.2279	101.5903	99.2318	103.6447	106.6870	111.2961	116.0274	119.8946	(44)
Energy conte	176.5966	155.1474	162.9744	143.7070	136.8854	117.4858	109.6541	121.9917	123.7516	143.4163	156.8150	176.0740	(45)
Energy content (annual)										Total = Sum(45)m =		1724.4992	
Distribution loss (46)m = 0.15 x (45)m													
	26.4895	23.2721	24.4462	21.5560	20.5328	17.6229	16.4481	18.2987	18.5627	21.5124	23.5222	26.4111	(46)
Water storage loss:													
Store volume												110.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0152	(51)
Volume factor from Table 2a												1.0294	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.0327	(55)
Total storage loss													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(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													
	231.8734	205.0749	218.2512	197.2007	192.1622	170.9795	164.9309	177.2685	177.2453	198.6931	210.3086	231.3508	(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													
	231.8734	205.0749	218.2512	197.2007	192.1622	170.9795	164.9309	177.2685	177.2453	198.6931	210.3086	231.3508	(64)
									Total per year (kWh/year) = Sum(64)m =			2375.3389	(64)
12Total per year (kWh/year)												2375	(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													
	102.9398	91.5285	98.4104	90.5775	89.7358	81.8590	80.6814	84.7837	83.9424	91.9073	94.9359	102.7661	(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

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(66)m	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)													
	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)													
	138.3600	136.2031	132.2721	125.8021	120.6127	113.6930	108.4428	113.9565	116.5866	123.5314	131.8554	138.1264	(72)
Total internal gains													
	578.6477	593.0702	568.6759	552.8606	526.0038	507.1837	486.7053	489.6638	503.0961	519.3861	549.3775	567.5491	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.5400	0.8000	0.7700	18.8456	(74)
South	8.3900	46.7521	0.5400	0.8000	0.7700	117.4302	(78)

Solar gains	136.2758	228.3353	306.1803	375.1829	420.9482	419.4286	403.6503	368.4730	329.4927	250.3067	162.4433	117.1811	(83)
Total gains	714.9235	821.4055	874.8561	928.0435	946.9521	926.6123	890.3555	858.1368	832.5888	769.6928	711.8209	684.7302	(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	108.7793	108.9288	109.0788	109.8349	109.9874	110.7563	110.7563	110.9113	110.4474	109.9874	109.6829	109.3800
alpha	8.2520	8.2619	8.2719	8.3223	8.3325	8.3838	8.3838	8.3941	8.3632	8.3325	8.3122	8.2920
util living area												
	0.9815	0.9492	0.8885	0.7519	0.5802	0.4070	0.2913	0.3155	0.4892	0.7730	0.9469	0.9862 (86)
MIT	20.6222	20.7672	20.8862	20.9731	20.9968	20.9998	21.0000	21.0000	20.9993	20.9720	20.8071	20.5880 (87)
Th 2	20.3956	20.3963	20.3971	20.4011	20.4018	20.4058	20.4058	20.4065	20.4042	20.4018	20.4003	20.3987 (88)
util rest of house												
	0.9769	0.9383	0.8682	0.7204	0.5438	0.3692	0.2519	0.2748	0.4472	0.7365	0.9336	0.9826 (89)
MIT 2	19.9639	20.1415	20.2807	20.3768	20.3994	20.4057	20.4058	20.4065	20.4038	20.3778	20.1951	19.9240 (90)
Living area fraction										fLA = Living area / (4) =		0.1729 (91)
MIT	20.0777	20.2496	20.3854	20.4799	20.5027	20.5084	20.5085	20.5091	20.5067	20.4805	20.3009	20.0388 (92)
Temperature adjustment												0.0000
adjusted MIT	20.0777	20.2496	20.3854	20.4799	20.5027	20.5084	20.5085	20.5091	20.5067	20.4805	20.3009	20.0388 (93)

---
8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9740	0.9353	0.8678	0.7246	0.5500	0.3757	0.2587	0.2818	0.4545	0.7414	0.9312	0.9800	(94)
Useful gains	696.3002	768.2820	759.2044	672.4801	520.7840	348.1708	230.3570	241.8420	378.3738	570.6870	662.8218	671.0228	(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													
	946.8102	919.8568	830.9670	688.2235	522.4400	348.2302	230.3591	241.8462	378.6578	586.4106	785.6530	945.2585	(97)
Space heating kWh													
	186.3794	101.8583	53.3914	11.3352	1.2321	0.0000	0.0000	0.0000	0.0000	11.6984	88.4384	204.0313	(98a)
Space heating requirement - total per year (kWh/year)												658.3645	
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													
	186.3794	101.8583	53.3914	11.3352	1.2321	0.0000	0.0000	0.0000	0.0000	11.6984	88.4384	204.0313	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												658.3645	
Space heating per m2											(98c) / (4) =	7.0039	(99)

9b. Energy requirements

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

Space heating:

Space heating requirement													
	186.3794	101.8583	53.3914	11.3352	1.2321	0.0000	0.0000	0.0000	0.0000	11.6984	88.4384	204.0313	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.05													
307a	195.6984	106.9512	56.0609	11.9020	1.2937	0.0000	0.0000	0.0000	0.0000	12.2833	92.8604	214.2329	

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Space heating requirement												
	195.6984	106.9512	56.0609	11.9020	1.2937	0.0000	0.0000	0.0000	0.0000	12.2833	92.8604	214.2329 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000 (308)
Space heating fuel for secondary/supplementary system												
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (309)
Water heating												
Annual water heating requirement												
	231.8734	205.0749	218.2512	197.2007	192.1622	170.9795	164.9309	177.2685	177.2453	198.6931	210.3086	231.3508 (64)
Water heat from Boilers = (64) x 1.00 x 1.00 x 1.05												
310a	243.4670	215.3286	229.1637	207.0607	201.7703	179.5285	173.1774	186.1319	186.1076	208.6277	220.8241	242.9184
Water heating fuel												
	243.4670	215.3286	229.1637	207.0607	201.7703	179.5285	173.1774	186.1319	186.1076	208.6277	220.8241	242.9184 (310)
Cooling System Energy Efficiency Ratio												0.0000 (314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (315)
Pumps and Fa	18.8711	17.0449	18.8711	18.2624	18.8711	18.2624	18.8711	18.8711	18.2624	18.8711	18.2624	18.8711 (331)
Lighting	27.4952	22.0576	19.8605	14.5506	11.2393	9.1826	10.2529	13.3271	17.3106	22.7124	25.6536	28.2593 (332)
Electricity generated by PVs (Appendix M) (negative quantity)												
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)												
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)												
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)												
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)												
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)												
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (335b)

Annual totals kWh/year	
Space heating fuel - community heating	691.2827 (307)
Space heating fuel - secondary	0.0000 (309)
Water heating fuel - community heating	2494.1059 (310)
Efficiency of water heater	0.0000 (311)
Electricity used for heat distribution	6.9128 (313)
Space cooling fuel	0.0000 (321)
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7750)	
mechanical ventilation fans (SFP = 0.7750)	222.1925 (330a)
Total electricity for the above, kWh/year	222.1925 (331)
Electricity for lighting (calculated in Appendix L)	221.9017 (332)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	0.0000 (333)
Wind generation	0.0000 (334)
Hydro-electric generation (Appendix N)	0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)	0.0000 (335)
Appendix Q - special features	
Energy saved or generated	-0.0000 (336)
Energy used	0.0000 (337)
Total delivered energy for all uses	3629.4828 (338)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Boilers			91.0000 (367)
Space and Water heating from Boilers	3500.4270	0.2100	159.5268 (367)
Electrical energy for heat distribution (space & water)	6.9128	0.0000	4.6115 (372)
Overall CO2 factor for heat network			0.2322 (386)
Total CO2 associated with community systems			739.7012 (373)
Space and water heating			739.7012 (376)
Pumps, fans and electric keep-hot	222.1925	0.1387	30.8208 (378)
Energy for lighting	221.9017	0.1443	32.0273 (379)
Total CO2, kg/year			802.5493 (383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			8.5400 (384)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Efficiency of heat source Boilers			91.0000 (467a)
Space and Water heating from Boilers	3500.4270	1.1300	858.4060 (467)
Electrical energy for heat distribution (space & water)	6.9128	0.0000	48.9093 (472)
Overall CO2 factor for heat network			1.2571 (486)
Total CO2 associated with community systems			4004.3919 (473)
Space and water heating			4004.3919 (476)
Pumps, fans and electric keep-hot	222.1925	1.5128	336.1328 (478)
Energy for lighting	221.9017	1.5338	340.3602 (479)
Total Primary energy kWh/year			4680.8849 (483)
Dwelling Primary energy Rate (DPER)			49.8000 (484)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b) -	
First floor	47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c) -	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	94.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000 (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) =	0.1277	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3777	(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) =	0.3210	(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													
	0.4093	0.4013	0.3932	0.3531	0.3451	0.3050	0.3050	0.2969	0.3210	0.3451	0.3611	0.3772	(22b)
Effective ac	0.5838	0.5805	0.5773	0.5623	0.5595	0.5465	0.5465	0.5441	0.5515	0.5595	0.5652	0.5711	(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			3.3600	1.0000	3.3600			(26)
TER Opening Type (Uw = 1.20)			14.3100	1.1450	16.3855			(27)
GF			47.0000	0.1300	6.1100			(28a)
EW	56.5600	17.6700	38.8900	0.1800	7.0002			(29a)
ER	47.0000		47.0000	0.1100	5.1700			(30)
Total net area of external elements Aum(A, m2)			150.5600					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		38.0257			(33)
PW			105.7300	0.0000	0.0000			(32)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.1000	0.1600	1.6160
E6 Intermediate floor within a dwelling	10.1000	0.0000	0.0000
E18 Party wall between dwellings	20.0000	0.0600	1.2000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.0400	0.4040
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0500	0.4570
E3 Sill	7.7800	0.0500	0.3890
E4 Jamb	25.6600	0.0500	1.2830
P1 Party wall - Ground floor	18.8000	0.0800	1.5040
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.1200	2.2560

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		11.0194 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	49.0451 (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	45.2705	45.0182	44.7710	43.6098	43.3925	42.3811	42.3811	42.1938	42.7707	43.3925	43.8320	44.2915	(38)
Heat transfer coeff													
	94.3156	94.0633	93.8161	92.6549	92.4376	91.4262	91.4262	91.2389	91.8158	92.4376	92.8771	93.3366	(39)

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Average = Sum(39)m / 12 = 92.6538

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0034	1.0007	0.9980	0.9857	0.9834	0.9726	0.9726	0.9706	0.9768	0.9834	0.9881	0.9929	(40)
HLP (average)												0.9857	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.6766	(42)
Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	79.6918	78.5082	76.8416	73.7686	71.4675	68.9160	67.5378	69.1928	70.9948	73.7250	76.8613	79.4224	(42b)
Hot water usage for other uses													
	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)
Average daily hot water use (litres/day)												112.1061	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	121.7330	119.0206	115.8252	111.2234	107.3936	103.3133	101.9351	105.1189	108.4497	112.7086	117.3737	121.4635	(44)
Energy conte	192.7952	169.4838	178.0190	152.2593	144.5724	127.0358	123.2817	130.1592	133.7293	152.9446	167.2204	190.1826	(45)
Energy content (annual)										Total = Sum(45)m =		1861.6833	
Distribution loss (46)m = 0.15 x (45)m													
	28.9193	25.4226	26.7029	22.8389	21.6859	19.0554	18.4923	19.5239	20.0594	22.9417	25.0831	28.5274	(46)
Water storage loss:													
Store volume												160.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.4476	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7817	(55)
Total storage loss													
	24.2332	21.8880	24.2332	23.4515	24.2332	23.4515	24.2332	24.2332	23.4515	24.2332	23.4515	24.2332	(56)
If cylinder contains dedicated solar storage													
	24.2332	21.8880	24.2332	23.4515	24.2332	23.4515	24.2332	24.2332	23.4515	24.2332	23.4515	24.2332	(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													
	240.2908	212.3831	225.5146	198.2228	192.0680	172.9993	170.7773	177.6548	179.6928	200.4402	213.1839	237.6781	(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													
	240.2908	212.3831	225.5146	198.2228	192.0680	172.9993	170.7773	177.6548	179.6928	200.4402	213.1839	237.6781	(64)
										Total per year (kWh/year) = Sum(64)m =		2420.9056	(64)
12Total per year (kWh/year)												2421	(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													
	102.1009	90.6728	97.1878	87.3970	86.0668	79.0102	78.9876	81.2744	81.2358	88.8505	92.3716	101.2322	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)													
	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)													
	137.2324	134.9297	130.6288	121.3847	115.6812	109.7364	106.1662	109.2398	112.8275	119.4228	128.2938	136.0647	(72)
Total internal gains													
	580.5201	594.7968	570.0326	551.4432	524.0724	503.2270	484.4287	484.9470	499.3369	518.2775	548.8159	568.4874	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.6300	0.7000	0.7700	19.2382	(74)
South	8.3900	46.7521	0.6300	0.7000	0.7700	119.8766	(78)

Solar gains	139.1149	233.0923	312.5590	382.9992	429.7180	428.1667	412.0596	376.1495	336.3572	255.5214	165.8276	119.6224	(83)
Total gains	719.6350	827.8891	882.5916	934.4425	953.7903	931.3937	896.4883	861.0965	835.6941	773.7989	714.6435	688.1098	(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	69.2121	69.3977	69.5806	70.4526	70.6182	71.3994	71.3994	71.5460	71.0965	70.6182	70.2840	69.9380	
alpha	5.6141	5.6265	5.6387	5.6968	5.7079	5.7600	5.7600	5.7697	5.7398	5.7079	5.6856	5.6625	
util living area													
	0.9933	0.9846	0.9675	0.9163	0.8034	0.6115	0.4463	0.4834	0.7138	0.9263	0.9842	0.9947	(86)
MIT	19.9920	20.1802	20.4061	20.6886	20.8901	20.9816	20.9974	20.9960	20.9565	20.7123	20.3095	19.9627	(87)
Th 2	20.0805	20.0828	20.0850	20.0953	20.0972	20.1062	20.1062	20.1079	20.1027	20.0972	20.0933	20.0892	(88)
util rest of house													
	0.9912	0.9799	0.9576	0.8913	0.7514	0.5332	0.3570	0.3918	0.6376	0.8990	0.9786	0.9930	(89)
MIT 2	18.9152	19.1548	19.4388	19.7869	20.0074	20.0959	20.1054	20.1065	20.0751	19.8221	19.3282	18.8845	(90)
Living area fraction									fLA = Living area / (4) =			0.1729	(91)
MIT	19.1014	19.3321	19.6060	19.9427	20.1600	20.2490	20.2596	20.2602	20.2274	19.9760	19.4978	19.0709	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1014	19.3321	19.6060	19.9427	20.1600	20.2490	20.2596	20.2602	20.2274	19.9760	19.4978	19.0709	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9881	0.9749	0.9511	0.8864	0.7553	0.5461	0.3724	0.4076	0.6488	0.8946	0.9737	0.9904	(94)
Useful gains	711.0791	807.1178	839.4065	828.2807	720.4172	508.6191	333.8631	351.0032	542.2082	692.2664	695.8692	681.5208	(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													
	1396.0019	1357.5295	1229.5556	1023.1639	782.0187	516.4709	334.5820	352.2034	562.5950	866.6985	1151.4767	1387.9964	(97)
Space heating kWh													
	509.5825	369.8767	290.2710	140.3159	45.8316	0.0000	0.0000	0.0000	0.0000	129.7775	328.0374	525.6178	(98a)
Space heating requirement - total per year (kWh/year)												2339.3103	
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													
	509.5825	369.8767	290.2710	140.3159	45.8316	0.0000	0.0000	0.0000	0.0000	129.7775	328.0374	525.6178	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2339.3103	
Space heating per m2											(98c) / (4) =	24.8863	(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													
	509.5825	369.8767	290.2710	140.3159	45.8316	0.0000	0.0000	0.0000	0.0000	129.7775	328.0374	525.6178	(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)													
	552.0937	400.7331	314.4864	152.0216	49.6550	0.0000	0.0000	0.0000	0.0000	140.6040	355.4034	569.4668	(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													
	240.2908	212.3831	225.5146	198.2228	192.0680	172.9993	170.7773	177.6548	179.6928	200.4402	213.1839	237.6781	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.7027	85.2913	84.6269	83.2992	81.3892	79.8000	79.8000	79.8000	79.8000	83.1104	85.0229	85.7873	(217)
Fuel for water heating, kWh/month													
	280.3772	249.0091	266.4809	237.9648	235.9872	216.7911	214.0066	222.6250	225.1789	241.1733	250.7369	277.0552	(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	27.1966	21.8181	19.6448	14.3926	11.1173	9.0829	10.1416	13.1824	17.1226	22.4658	25.3750	27.9525	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-43.2736	-60.6466	-86.6520	-96.8081	-103.8444	-96.7021	-95.4772	-90.3880	-81.3435	-69.0333	-47.4348	-37.4526	(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	-25.5437	-53.6125	-106.3484	-159.4373	-210.5548	-211.4926	-209.0305	-177.1257	-129.9960	-76.6045	-34.0799	-20.2108	(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)													

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(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	2534.4640 (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	2917.3862 (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)	219.4922 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-2323.0928 (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	3434.2497 (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	2534.4640	0.2100	532.2374 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2917.3862	0.2100	612.6511 (264)
Space and water heating			1144.8886 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	219.4922	0.1443	31.6795 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-909.0561	0.1347	-122.4714
PV Unit electricity exported	-1414.0366	0.1259	-178.0931
Total			-300.5645 (269)
Total CO2, kg/year			887.9329 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.4500 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	2534.4640	1.1300	2863.9443 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2917.3862	1.1300	3296.6465 (278)
Space and water heating			6160.5908 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	219.4922	1.5338	336.6645 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-909.0561	1.4979	-1361.6966
PV Unit electricity exported	-1414.0366	0.4623	-653.7270
Total			-2015.4236 (283)
Total Primary energy kWh/year			4611.9325 (286)
Target Primary Energy Rate (TPER)			49.0600 (287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b) -	
First floor	47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c) -	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 94.0000						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000 (5)	

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2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1277	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.0000	(17)
Infiltration rate		0.1777	(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) =	0.1510	(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													
	0.1925	0.1888	0.1850	0.1661	0.1623	0.1435	0.1435	0.1397	0.1510	0.1623	0.1699	0.1774	(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	0.5185	0.5178	0.5171	0.5138	0.5132	0.5103	0.5103	0.5098	0.5114	0.5132	0.5144	0.5157	(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)			14.3100	0.7752	11.0930			(27)
Door			3.3600	1.2000	4.0320			(26)
GF			47.0000	0.1000	4.7000			(28a)
EW	56.5600	17.6700	38.8900	0.1300	5.0557			(29a)
ER	47.0000		47.0000	0.1000	4.7000			(30)
Total net area of external elements Aum(A, m2)			150.5600					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		29.5807			(33)
PW			105.7300	0.0000	0.0000			(32)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.1000	0.2680	2.7068
E6 Intermediate floor within a dwelling	10.1000	0.1400	1.4140
E18 Party wall between dwellings	20.0000	0.1200	2.4000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.1600	1.6160
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0300	0.2742
E3 Sill	7.7800	0.0200	0.1556
E4 Jamb	25.6600	0.0200	0.5132
P1 Party wall - Ground floor	18.8000	0.1600	3.0080
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.2400	4.5120

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		18.5102 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	48.0909 (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	40.2124	40.1566	40.1019	39.8449	39.7968	39.5730	39.5730	39.5316	39.6592	39.7968	39.8941	39.9958	(38)
Heat transfer coeff													
	88.3034	88.2475	88.1928	87.9358	87.8878	87.6639	87.6639	87.6225	87.7502	87.8878	87.9850	88.0867	(39)

Average = Sum(39)m / 12 = 87.9356

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9394	0.9388	0.9382	0.9355	0.9350	0.9326	0.9326	0.9322	0.9335	0.9350	0.9360	0.9371	(40)
HLP (average)												0.9355	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.6766 (42)

Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	29.1724	28.7320	28.1055	27.1673	26.3218	25.1578	24.2748	25.3546	25.9213	27.0746	28.2737	29.1492	(42b)
Hot water usage for other uses													
	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)

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Average daily hot water use (litres/day) 65.2689 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	71.2135	69.2444	67.0891	64.6222	62.2479	59.5552	58.6721	61.2807	63.3762	66.0582	68.7861	71.1904	(44)
Energy conte	104.8386	91.6243	95.8690	84.4127	80.2127	68.8735	64.8344	72.1285	73.5132	85.1227	92.9667	104.5483	(45)
Energy content (annual)										Total = Sum(45)m =		1018.9447	
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													
	89.1128	77.8807	81.4886	71.7508	68.1808	58.5425	55.1092	61.3092	62.4862	72.3543	79.0217	88.8661	(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													
	89.1128	77.8807	81.4886	71.7508	68.1808	58.5425	55.1092	61.3092	62.4862	72.3543	79.0217	88.8661	(64)
									Total per year (kWh/year) = Sum(64)m =			866.1030	(64)
12Total per year (kWh/year)												866	(64)
Electric shower(s)													
	55.3358	49.3046	53.8388	51.3777	52.3418	49.9290	51.5933	52.3418	51.3777	53.8388	52.8264	55.3358	(64a)
									Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =			629.4411	(64a)
Heat gains from water heating, kWh/month													
	36.1121	31.7963	33.8319	30.7821	30.1306	27.1179	26.6756	28.4127	28.4660	31.5483	32.9620	36.0505	(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	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)													
	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)													
	48.5378	47.3160	45.4729	42.7529	40.4982	37.6637	35.8543	38.1892	39.5361	42.4036	45.7806	48.4549	(72)
Total internal gains													
	488.8256	504.1831	481.8767	469.8115	445.8893	431.1543	414.1168	413.8964	426.0455	438.2583	463.3027	477.8776	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.5400	0.8000	0.7700	18.8456	(74)
South	8.3900	46.7521	0.5400	0.8000	0.7700	117.4302	(78)

Solar gains	136.2758	228.3353	306.1803	375.1829	420.9482	419.4286	403.6503	368.4730	329.4927	250.3067	162.4433	117.1811	(83)
Total gains	625.1014	732.5184	788.0570	844.9944	866.8376	850.5829	817.7671	782.3694	755.5383	688.5650	625.7460	595.0587	(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	73.9245	73.9712	74.0171	74.2334	74.2740	74.4637	74.4637	74.4989	74.3905	74.2740	74.1919	74.1063	
alpha	5.9283	5.9314	5.9345	5.9489	5.9516	5.9642	5.9642	5.9666	5.9594	5.9516	5.9461	5.9404	
util living area													
	0.9964	0.9904	0.9775	0.9346	0.8298	0.6397	0.4688	0.5104	0.7472	0.9469	0.9908	0.9973	(86)
MIT	19.9899	20.1753	20.3969	20.6744	20.8836	20.9799	20.9972	20.9955	20.9514	20.6890	20.2845	19.9484	(87)
Th 2	20.1341	20.1346	20.1351	20.1374	20.1379	20.1399	20.1399	20.1403	20.1391	20.1379	20.1370	20.1361	(88)
util rest of house													
	0.9953	0.9874	0.9703	0.9139	0.7818	0.5621	0.3787	0.4175	0.6738	0.9257	0.9874	0.9965	(89)
MIT 2	19.2138	19.3980	19.6158	19.8812	20.0620	20.1310	20.1392	20.1390	20.1143	19.8995	19.5091	19.1742	(90)
Living area fraction									fLA = Living area / (4) =			0.1729	(91)
MIT	19.3480	19.5324	19.7508	20.0183	20.2040	20.2777	20.2875	20.2871	20.2590	20.0360	19.6431	19.3080	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3480	19.5324	19.7508	20.0183	20.2040	20.2777	20.2875	20.2871	20.2590	20.0360	19.6431	19.3080	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9939	0.9847	0.9664	0.9105	0.7858	0.5750	0.3944	0.4336	0.6847	0.9227	0.9849	0.9953	(94)
Useful gains	621.2936	721.3153	761.5697	769.4059	681.1452	489.0741	322.4896	339.2441	517.3125	635.3178	616.2796	592.2899	(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													
	1328.7889	1291.2694	1168.6283	977.6964	747.4002	497.7316	323.2619	340.5942	540.4559	829.3050	1103.6053	1330.8139	(97)
Space heating kWh													
	526.3765	383.0091	302.8517	149.9692	49.2937	0.0000	0.0000	0.0000	0.0000	144.3265	350.8745	549.4618	(98a)
Space heating requirement - total per year (kWh/year)												2456.1630	
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													
	526.3765	383.0091	302.8517	149.9692	49.2937	0.0000	0.0000	0.0000	0.0000	144.3265	350.8745	549.4618	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2456.1630	
Space heating per m2											(98c) / (4) =	26.1294	(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	824.0411	648.7132	665.9310	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9055	0.9563	0.9419	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	746.1805	620.3838	627.2470	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	937.8008	902.2550	863.3702	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	137.9666	209.7122	175.6756	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	34.4916	52.4281	43.9189	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												130.8386	(107)
Energy for space heating												26.1294	(99)
Energy for space cooling												1.3919	(108)
Total												27.5213	(109)
Fabric Energy Efficiency (DFEE)												27.5	(109)

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

1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b)	-
First floor		47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c)	-
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	94.0000						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000	(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) =	0.1277	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)

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Infiltration rate	0.3777 (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) =	0.3210 (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	0.4093	0.4013	0.3932	0.3531	0.3451	0.3050	0.3050	0.2969	0.3210	0.3451	0.3611	0.3772	(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	0.5838	0.5805	0.5773	0.5623	0.5595	0.5465	0.5465	0.5441	0.5515	0.5595	0.5652	0.5711	(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			3.3600	1.0000	3.3600			(26)
TER Opening Type (Uw = 1.20)			14.3100	1.1450	16.3855			(27)
GF			47.0000	0.1300	6.1100			(28a)
EW	56.5600	17.6700	38.8900	0.1800	7.0002			(29a)
ER	47.0000		47.0000	0.1100	5.1700			(30)
Total net area of external elements Aum(A, m2)			150.5600					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	38.0257			(33)
PW			105.7300	0.0000	0.0000			(32)

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

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	10.1000	0.1600	1.6160
E6 Intermediate floor within a dwelling	10.1000	0.0000	0.0000
E18 Party wall between dwellings	20.0000	0.0600	1.2000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.0400	0.4040
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0500	0.4570
E3 Sill	7.7800	0.0500	0.3890
E4 Jamb	25.6600	0.0500	1.2830
P1 Party wall - Ground floor	18.8000	0.0800	1.5040
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.1200	2.2560

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	11.0194	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	49.0451	(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	45.2705	45.0182	44.7710	43.6098	43.3925	42.3811	42.3811	42.1938	42.7707	43.3925	43.8320	44.2915	(38)
Heat transfer coeff	94.3156	94.0633	93.8161	92.6549	92.4376	91.4262	91.4262	91.2389	91.8158	92.4376	92.8771	93.3366	(39)
Average = Sum(39)m / 12 =												92.6538	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0034	1.0007	0.9980	0.9857	0.9834	0.9726	0.9726	0.9706	0.9768	0.9834	0.9881	0.9929	(40)
HLP (average)												0.9857	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.6766	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	29.8375	29.3944	28.7704	27.6198	26.7582	25.8029	25.2869	25.9066	26.5813	27.6035	28.7778	29.7366	(42b)
Hot water usage for other uses	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)
Average daily hot water use (litres/day)												65.8833	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	71.8787	69.9068	67.7540	65.0746	62.6843	60.2003	59.6842	61.8327	64.0361	66.5871	69.2902	71.7778	(44)
Energy conte	113.8383	99.5463	104.1354	89.0839	84.3852	74.0232	72.1829	76.5618	78.9629	90.3581	98.7165	112.3867	(45)
Energy content (annual)										Total = Sum(45)m =		1094.1812	
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	96.7625	84.6144	88.5151	75.7213	71.7274	62.9198	61.3555	65.0775	67.1185	76.8044	83.9090	95.5287	(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)

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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	96.7625	84.6144	88.5151	75.7213	71.7274	62.9198	61.3555	65.0775	67.1185	76.8044	83.9090	95.5287	(64)
Total per year (kWh/year) = Sum(64)m =												930.0540	(64)
12Total per year (kWh/year)												930	(64)
Electric shower(s)	55.3358	49.3046	53.8388	51.3777	52.3418	49.9290	51.5933	52.3418	51.3777	53.8388	52.8264	55.3358	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =												629.4411	(64a)
Heat gains from water heating, kWh/month	38.0246	33.4797	35.5885	31.7748	31.0173	28.2122	28.2372	29.3548	29.6240	32.6608	34.1839	37.7161	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)	51.1083	49.8211	47.8339	44.1316	41.6899	39.1836	37.9532	39.4554	41.1445	43.8989	47.4776	50.6937	(72)
Total internal gains	491.3960	506.6881	484.2378	471.1901	447.0811	432.6742	416.2157	415.1626	427.6540	439.7537	464.9997	480.1164	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.6300	0.7000	0.7700	19.2382	(74)
South	8.3900	46.7521	0.6300	0.7000	0.7700	119.8766	(78)

Solar gains	139.1149	233.0923	312.5590	382.9992	429.7180	428.1667	412.0596	376.1495	336.3572	255.5214	165.8276	119.6224	(83)
Total gains	630.5109	739.7805	796.7968	854.1894	876.7991	860.8409	828.2753	791.3121	764.0112	695.2751	630.8272	599.7388	(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	69.2121	69.3977	69.5806	70.4526	70.6182	71.3994	71.3994	71.5460	71.0965	70.6182	70.2840	69.9380	
alpha	5.6141	5.6265	5.6387	5.6968	5.7079	5.7600	5.7600	5.7697	5.7398	5.7079	5.6856	5.6625	
util living area	0.9965	0.9908	0.9791	0.9397	0.8424	0.6543	0.4817	0.5239	0.7618	0.9509	0.9912	0.9973	(86)
MIT	19.8907	20.0840	20.3195	20.6256	20.8576	20.9742	20.9962	20.9939	20.9393	20.6469	20.2178	19.8613	(87)
Th 2	20.0805	20.0828	20.0850	20.0953	20.0972	20.1062	20.1062	20.1079	20.1027	20.0972	20.0933	20.0892	(88)
util rest of house	0.9953	0.9879	0.9723	0.9198	0.7946	0.5734	0.3860	0.4257	0.6867	0.9305	0.9879	0.9965	(89)
MIT 2	19.0720	19.2654	19.4988	19.7995	20.0037	20.0947	20.1052	20.1062	20.0715	19.8256	19.4076	19.0497	(90)
Living area fraction									fLA = Living area / (4) =			0.1729	(91)
MIT	19.2135	19.4069	19.6407	19.9423	20.1513	20.2467	20.2593	20.2596	20.2216	19.9676	19.5476	19.1900	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2135	19.4069	19.6407	19.9423	20.1513	20.2467	20.2593	20.2596	20.2216	19.9676	19.5476	19.1900	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9939	0.9851	0.9681	0.9158	0.7977	0.5867	0.4026	0.4427	0.6974	0.9269	0.9852	0.9953	(94)
Useful gains	626.6453	728.7809	771.3406	782.2574	699.4511	505.0367	333.4726	350.3134	532.8581	644.4745	621.5132	596.8996	(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	1406.5757	1364.5652	1232.8052	1023.1200	781.2162	516.2603	334.5515	352.1502	562.0562	865.9170	1156.0988	1399.1200	(97)
Space heating kWh	580.2683	427.2471	343.3296	173.4211	60.8332	0.0000	0.0000	0.0000	0.0000	164.7532	384.9017	596.8520	(98a)
Space heating requirement - total per year (kWh/year)												2731.6062	
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	580.2683	427.2471	343.3296	173.4211	60.8332	0.0000	0.0000	0.0000	0.0000	164.7532	384.9017	596.8520	(98c)

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Space heating requirement after solar contribution - total per year (kWh/year)                               2731.6062
Space heating per m2                                                                       (98c) / (4) =      29.0596 (99)


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8c. Space cooling requirement
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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   859.4063   676.5539   693.4156     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation      0.0000     0.0000     0.0000     0.0000     0.0000     0.8910     0.9472     0.9312     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss      0.0000     0.0000     0.0000     0.0000     0.0000   765.7573   640.8271   645.7087     0.0000     0.0000     0.0000     0.0000 (102)
Total gains      0.0000     0.0000     0.0000     0.0000     0.0000   949.5340   914.1830   873.6089     0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000   132.3192   203.3768   169.5578     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    33.0798    50.8442    42.3895     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                        126.3135 (107)
Energy for space heating                                                                                                          29.0596 (99)
Energy for space cooling                                                                                                           1.3438 (108)
Total                                                                                                                             30.4034 (109)
Fabric Energy Efficiency (TFEE)                                                                                                      30.4 (109)
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SAP10.2 Be Green

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Property Reference	3B5PB House _Unit 3_Pitched			Issued on Date	12/04/2023
Assessment Reference	Be GREEN-3B5PB House-Unit 3	Prop Type Ref		House	
Property					
SAP Rating	100 A	DER	-0.98	TER	9.45
Environmental	101 A	% DER < TER			110.37
CO_2 Emissions (t/year)	-0.11	DFEE	27.13	TFEE	30.40
Compliance Check	See BREL	% DFEE < TFEE			10.76
% DPER < TPER	99.91	DPER	0.04	TPER	49.06
Assessor Details	Mr. Rory Bergin			Assessor ID	N427-0001
Client					

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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          Storey height            Volume
                                                                                    (m2)               (m)                  (m3)
Ground floor                                                                     47.0000 (1b)    x      2.5000 (2b)    =    117.5000 (1b) -
First floor                                                                      47.0000 (1c)    x      2.5000 (2c)    =    117.5000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             94.0000                                                            (4)
Dwelling volume                                                                        (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    235.0000 (5)


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

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

                                                                                                         Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =       0.0000 / (5) =      0.0000 (8)
Pressure test                                                                                                                   Yes
Pressure Test Method                                                                                                    Blower Door
Measured/design AP50                                                                                                      1.0000 (17)
Infiltration rate                                                                                                         0.0500 (18)
Number of sides sheltered                                                                                                      2 (19)

Shelter factor                                                                          (20) =  1  -  [0.075 x (19)]  =      0.8500 (20)
Infiltration rate adjusted to include shelter factor                                           (21) = (18) x (20)  =      0.0425 (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
                 0.0542     0.0531     0.0521     0.0468     0.0457     0.0404     0.0404     0.0393     0.0425     0.0457     0.0478     0.0499 (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) =                                   80.1000 (23c)

Effective ac     0.1537     0.1526     0.1516     0.1462     0.1452     0.1399     0.1399     0.1388     0.1420     0.1452     0.1473     0.1494 (25)


-----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                          Gross        Openings       NetArea       U-value          A x U       K-value          A x K
                                                    m2              m2            m2          W/m2K            W/K        kJ/m2K           kJ/K
Window (Uw = 0.80)                                                          14.3100          0.7752        11.0930                                (27)
Door                                                                          3.3600          1.0000         3.3600                                (26)
```

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GF			47.0000	0.1000	4.7000	(28a)
EW	56.5600	17.6700	38.8900	0.1300	5.0557	(29a)
ER	47.0000		47.0000	0.1000	4.7000	(30)
Total net area of external elements Aum(A, m2)			150.5600			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		28.9087	(33)
PW			105.7300	0.0000	0.0000	(32)

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

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E5 Ground floor (normal)	10.1000	0.2680	2.7068
E6 Intermediate floor within a dwelling	10.1000	0.1400	1.4140
E18 Party wall between dwellings	20.0000	0.1200	2.4000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.1600	1.6160
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0300	0.2742
E3 Sill	7.7800	0.0200	0.1556
E4 Jamb	25.6600	0.0200	0.5132
P1 Party wall - Ground floor	18.8000	0.1600	3.0080
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.2400	4.5120
E24 Eaves (insulation at ceiling level - inverted)	0.0000	0.0000	0.0000

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 18.5102 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 47.4189 (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	11.9185	11.8361	11.7537	11.3417	11.2593	10.8473	10.8473	10.7649	11.0121	11.2593	11.4241	11.5889	(38)
Heat transfer coeff	59.3374	59.2550	59.1726	58.7606	58.6782	58.2662	58.2662	58.1838	58.4310	58.6782	58.8430	59.0078	(39)
Average = Sum(39)m / 12 =												58.7400	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6312	0.6304	0.6295	0.6251	0.6242	0.6199	0.6199	0.6190	0.6216	0.6242	0.6260	0.6277	(40)
HLP (average)												0.6249	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.6766 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	77.9152	76.7391	75.0658	72.5601	70.3018	67.1930	64.8345	67.7186	69.2322	72.3125	75.5150	77.8534	(42b)
Hot water usage for other uses	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)

Average daily hot water use (litres/day) 110.4652 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	119.9564	117.2515	114.0495	110.0149	106.2279	101.5903	99.2318	103.6447	106.6870	111.2961	116.0274	119.8946	(44)
Energy conte	176.5966	155.1474	162.9744	143.7070	136.8854	117.4858	109.6541	121.9917	123.7516	143.4163	156.8150	176.0740	(45)
Energy content (annual)										Total = Sum(45)m =		1724.4992	
Distribution loss (46)m = 0.15 x (45)m	26.4895	23.2721	24.4462	21.5560	20.5328	17.6229	16.4481	18.2987	18.5627	21.5124	23.5222	26.4111	(46)

Water storage loss:
Store volume 160.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.1500 (48)
Temperature factor from Table 2b 0.6000 (49)
Enter (49) or (54) in (55) 0.6900 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	21.3900	19.3200	21.3900	20.7000	21.3900	20.7000	21.3900	21.3900	20.7000	21.3900	20.7000	21.3900	(56)
If cylinder contains dedicated solar storage	21.3900	19.3200	21.3900	20.7000	21.3900	20.7000	21.3900	21.3900	20.7000	21.3900	20.7000	21.3900	(57)
Primary loss	31.1612	28.1456	31.1612	30.1560	31.1612	22.5120	23.2624	23.2624	22.5120	31.1612	30.1560	31.1612	(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	229.1478	202.6130	215.5256	194.5630	189.4366	160.6978	154.3065	166.6441	166.9636	195.9675	207.6710	228.6252	(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	229.1478	202.6130	215.5256	194.5630	189.4366	160.6978	154.3065	166.6441	166.9636	195.9675	207.6710	228.6252	(64)

Total per year (kWh/year) = Sum(64)m = 2312.1616 (64)
12Total per year (kWh/year) 2312 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	100.7593	89.5590	96.2299	88.4674	87.5553	73.6336	72.1819	76.2841	75.7170	89.7269	92.8258	100.5856	(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	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)	135.4292	133.2723	129.3413	122.8714	117.6819	102.2689	97.0187	102.5325	105.1625	120.6006	128.9247	135.1957	(72)
Total internal gains	575.7169	590.1394	565.7451	549.9299	523.0731	495.7596	475.2812	478.2397	491.6720	516.4554	546.4468	564.6183	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.5400	0.8000	0.7700	18.8456	(74)
South	8.3900	46.7521	0.5400	0.8000	0.7700	117.4302	(78)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	136.2758	228.3353	306.1803	375.1829	420.9482	419.4286	403.6503	368.4730	329.4927	250.3067	162.4433	117.1811	(83)
Total gains	711.9928	818.4747	871.9254	925.1128	944.0213	915.1882	878.9314	846.7127	821.1647	766.7621	708.8901	681.7995	(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	110.0112	110.1642	110.3176	111.0910	111.2470	112.0336	112.0336	112.1923	111.7177	111.2470	110.9355	110.6257	
alpha	8.3341	8.3443	8.3545	8.4061	8.4165	8.4689	8.4689	8.4795	8.4478	8.4165	8.3957	8.3750	
util living area	0.9812	0.9480	0.8858	0.7473	0.5756	0.4073	0.2917	0.3161	0.4904	0.7690	0.9457	0.9860	(86)
MIT	20.6319	20.7757	20.8921	20.9752	20.9971	20.9999	21.0000	21.0000	20.9994	20.9740	20.8141	20.5979	(87)
Th 2	20.4020	20.4027	20.4035	20.4075	20.4082	20.4122	20.4122	20.4130	20.4106	20.4082	20.4067	20.4051	(88)
util rest of house	0.9765	0.9369	0.8654	0.7160	0.5399	0.3700	0.2527	0.2758	0.4488	0.7327	0.9323	0.9824	(89)
MIT 2	19.9815	20.1575	20.2933	20.3852	20.4061	20.4121	20.4122	20.4129	20.4102	20.3860	20.2092	19.9419	(90)
Living area fraction									fLA = Living area / (4) =			0.1729	(91)
MIT	20.0940	20.2643	20.3968	20.4872	20.5082	20.5137	20.5138	20.5144	20.5121	20.4876	20.3138	20.0553	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.0940	20.2643	20.3968	20.4872	20.5082	20.5137	20.5138	20.5144	20.5121	20.4876	20.3138	20.0553	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9736	0.9341	0.8651	0.7203	0.5459	0.3764	0.2595	0.2827	0.4559	0.7377	0.9300	0.9798	(94)
Useful gains	693.2288	764.5225	754.3328	666.3953	515.3774	344.5140	228.0395	239.3894	374.3939	565.6256	659.2616	668.0261	(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	937.1718	910.4142	822.3120	680.8692	516.8517	344.5689	228.0413	239.3932	374.6633	580.1880	777.5369	935.5847	(97)
Space heating kWh	181.4936	98.0392	50.5765	10.4212	1.0969	0.0000	0.0000	0.0000	0.0000	10.8344	85.1582	199.0636	(98a)
Space heating requirement - total per year (kWh/year)												636.6837	
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	181.4936	98.0392	50.5765	10.4212	1.0969	0.0000	0.0000	0.0000	0.0000	10.8344	85.1582	199.0636	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												636.6837	
Space heating per m2										(98c) / (4) =		6.7732	(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)
Fraction of main heating from main system 2	0.9999	(203)
Fraction of total heating from main system 1	0.0001	(204)
Fraction of total heating from main system 2	0.9999	(205)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	181.4936	98.0392	50.5765	10.4212	1.0969	0.0000	0.0000	0.0000	0.0000	10.8344	85.1582	199.0636	(98)

Space heating efficiency (main heating system 1)

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                100.0000   100.0000   100.0000   100.0000   100.0000     0.0000     0.0000     0.0000     0.0000   100.0000   100.0000   100.0000 (210)
Space heating fuel (main heating system)
                  0.0181     0.0098     0.0051     0.0010     0.0001     0.0000     0.0000     0.0000     0.0000     0.0011     0.0085     0.0199 (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)
Space heating fuel used, main system 2                                                                                                       0.0000 (213)

Water heating
Water heating requirement
                229.1478   202.6130   215.5256   194.5630   189.4366   160.6978   154.3065   166.6441   166.9636   195.9675   207.6710   228.6252 (64)
Efficiency of water heater                                                                                                                 254.4600 (216)
(217)m          254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600   254.4600 (217)
Fuel for water heating, kWh/month
                 90.0526    79.6247    84.6992    76.4611    74.4465    63.1525    60.6408    65.4893    65.6149    77.0131    81.6124    89.8472 (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     15.0969    13.6359    15.0969    14.6099    15.0969    14.6099    15.0969    15.0969    14.6099    15.0969    14.6099    15.0969 (231)
Lighting         27.4952    22.0576    19.8605    14.5506    11.2393     9.1826    10.2529    13.3271    17.3106    22.7124    25.6536    28.2593 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m         -42.2685   -61.1267   -90.2886  -104.3330  -115.0854  -107.6771  -106.0306   -99.6755   -87.2608   -71.3461   -47.1007   -36.3945 (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         -19.8388   -42.5125   -86.2208  -132.2243  -177.1612  -179.6479  -177.4973  -148.0442  -106.7534   -61.1428   -26.5675   -15.5787 (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                                                                                                           0.0637 (211)
Space heating fuel - main system 2                                                                                                           0.0000 (213)
Space heating fuel - secondary                                                                                                               0.0000 (215)
Efficiency of water heater                                                                                                                 254.4600
Water heating fuel used                                                                                                                    908.6542 (219)
Space cooling fuel                                                                                                                           0.0000 (221)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.0000, SFP = 0.6200)
   mechanical ventilation fans (SFP =       0.6200)                                                                                        177.7540 (230a)
Total electricity for the above, kWh/year                                                                                                  177.7540 (231)
Electricity for lighting (calculated in Appendix L)                                                                                        221.9017 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                            -2141.7768 (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                                                                                                       -833.4033 (238)


----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                                   Energy       Emission factor            Emissions
                                                                                                 kWh/year           kg CO2/kWh           kg CO2/year
Space heating - main system 1                                                                      0.0637               0.1593                0.0101 (261)
Space heating - main system 2                                                                      0.0000               0.0000                0.0000 (262)
Total CO2 associated with community systems                                                                                                   0.0000 (373)
Water heating (other fuel)                                                                       908.6542               0.1411              128.2300 (264)
Space and water heating                                                                                                                     128.2401 (265)
Pumps, fans and electric keep-hot                                                                177.7540               0.1387               24.6567 (267)
Energy for lighting                                                                              221.9017               0.1443               32.0273 (268)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                            -968.5874               0.1341             -129.8428
PV Unit electricity exported                                                                   -1173.1895               0.1253             -147.0186
Total                                                                                                                                      -276.8613 (269)
Total CO2, kg/year                                                                                                                          -91.9373 (272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                                                              -0.9800 (273)


----------------------------------------------------------------------------------------------------
13a. Primary energy - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                                   Energy Primary energy factor         Primary energy
                                                                                                 kWh/year           kg CO2/kWh             kWh/year
Space heating - main system 1                                                                      0.0637               1.5896                0.1012 (275)
Space heating - main system 2                                                                      0.0000               0.0000                0.0000 (276)
Total CO2 associated with community systems                                                                                                   0.0000 (473)
Water heating (other fuel)                                                                       908.6542               1.5218             1382.8155 (278)
```


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Space and water heating                                                                                                                    1382.9167 (279)
Pumps, fans and electric keep-hot                                                                177.7540               1.5128              268.9063 (281)
Energy for lighting                                                                              221.9017               1.5338              340.3602 (282)

 Energy saving/generation technologies
PV Unit electricity used in dwelling                                                            -968.5874               1.4954            -1448.4352
PV Unit electricity exported                                                                   -1173.1895               0.4600             -539.6211
Total                                                                                                                                     -1988.0562 (283)
Total Primary energy kWh/year                                                                                                                4.1269 (286)
Dwelling Primary energy Rate (DPER)                                                                                                          0.0400 (287)


----------------------------------------------------------------------------------------------------


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


----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
----------------------------------------------------------------------------------------------------
                                                                                                     Area         Storey height                 Volume
                                                                                                     (m2)                   (m)                   (m3)
Ground floor                                                                                      47.0000 (1b)     x       2.5000 (2b)    =    117.5000 (1b) -
First floor                                                                                       47.0000 (1c)     x       2.5000 (2c)    =    117.5000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)            94.0000                                                                        (4)
Dwelling volume                                                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    235.0000 (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) =      0.1277 (8)
Pressure test                                                                                                                         Yes
Pressure Test Method                                                                                                          Blower Door
Measured/design AP50                                                                                                                5.0000 (17)
Infiltration rate                                                                                                                   0.3777 (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)  =      0.3210 (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
                0.4093     0.4013     0.3932     0.3531     0.3451     0.3050     0.3050     0.2969     0.3210     0.3451     0.3611     0.3772 (22b)
Effective ac    0.5838     0.5805     0.5773     0.5623     0.5595     0.5465     0.5465     0.5441     0.5515     0.5595     0.5652     0.5711 (25)


----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
----------------------------------------------------------------------------------------------------
Element                                               Gross       Openings        NetArea        U-value          A x U        K-value          A x K
                                                         m2             m2             m2          W/m2K            W/K         kJ/m2K           kJ/K
TER Opaque door                                                                    3.3600         1.0000         3.3600                                (26)
TER Opening Type (Uw = 1.20)                                                      14.3100         1.1450        16.3855                                (27)
GF                                                                                47.0000         0.1300         6.1100                                (28a)
EW                                                  56.5600        17.6700        38.8900         0.1800         7.0002                                (29a)
ER                                                  47.0000                       47.0000         0.1100         5.1700                                (30)
Total net area of external elements Aum(A, m2)                                   150.5600                                                              (31)
Fabric heat loss, W/K = Sum (A x U)                                                     (26)...(30) + (32) =    38.0257                                (33)
PW                                                                               105.7300         0.0000         0.0000                                (32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                         250.0000 (35)
List of Thermal Bridges
       K1 Element                                                                          Length      Psi-value          Total
       E5 Ground floor (normal)                                                           10.1000         0.1600         1.6160
       E6 Intermediate floor within a dwelling                                            10.1000         0.0000         0.0000
       E18 Party wall between dwellings                                                   20.0000         0.0600         1.2000
```

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        P2 Party wall - Intermediate floor within a dwelling                                  18.8000        0.0000        0.0000
        E11 Eaves (insulation at rafter level)                                                10.1000        0.0400        0.4040
        P5 Party wall - Roof (insulation at rafter level)                                     23.8800        0.0800        1.9104
        E2 Other lintels (including other steel lintels)                                       9.1400        0.0500        0.4570
        E3 Sill                                                                                7.7800        0.0500        0.3890
        E4 Jamb                                                                               25.6600        0.0500        1.2830
        P1 Party wall - Ground floor                                                          18.8000        0.0800        1.5040
        P4 Party wall - Roof (insulation at ceiling level)                                    18.8000        0.1200        2.2560
        E24 Eaves (insulation at ceiling level - inverted)                                     0.0000        0.2400        0.0000
Thermal bridges (Sum(L x Psi) calculated using Appendix K)                                                                      11.0194 (36)
Point Thermal bridges                                                                                              (36a) =       0.0000
Total fabric heat loss                                                                                    (33) + (36) + (36a) =  49.0451 (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          45.2705    45.0182    44.7710    43.6098    43.3925    42.3811    42.3811    42.1938    42.7707    43.3925    43.8320    44.2915 (38)
Heat transfer coeff
               94.3156    94.0633    93.8161    92.6549    92.4376    91.4262    91.4262    91.2389    91.8158    92.4376    92.8771    93.3366 (39)
Average = Sum(39)m / 12 =                                                                                                        92.6538

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP             1.0034     1.0007     0.9980     0.9857     0.9834     0.9726     0.9726     0.9706     0.9768     0.9834     0.9881     0.9929 (40)
HLP (average)                                                                                                                     0.9857
Days in mont        31         28         31         30         31         30         31         31         30         31         30         31
```

```
-----------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                  2.6766 (42)
Hot water usage for mixer showers
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
               79.6918    78.5082    76.8416    73.7686    71.4675    68.9160    67.5378    69.1928    70.9948    73.7250    76.8613    79.4224 (42b)
Hot water usage for other uses
               42.0412    40.5124    38.9836    37.4549    35.9261    34.3973    34.3973    35.9261    37.4549    38.9836    40.5124    42.0412 (42c)
Average daily hot water use (litres/day)                                                                                         112.1061 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
              121.7330   119.0206   115.8252   111.2234   107.3936   103.3133   101.9351   105.1189   108.4497   112.7086   117.3737   121.4635 (44)
Energy conte  192.7952   169.4838   178.0190   152.2593   144.5724   127.0358   123.2817   130.1592   133.7293   152.9446   167.2204   190.1826 (45)
Energy content (annual)                                                                                        Total = Sum(45)m =   1861.6833
Distribution loss  (46)m = 0.15 x (45)m
               28.9193    25.4226    26.7029    22.8389    21.6859    19.0554    18.4923    19.5239    20.0594    22.9417    25.0831    28.5274 (46)
Water storage loss:
Store volume                                                                                                                     160.0000 (47)
a) If  manufacturer declared loss factor is known  (kWh/day):                                                                      1.4476 (48)
  Temperature factor from Table 2b                                                                                                 0.5400 (49)
Enter (49) or (54) in (55)                                                                                                         0.7817 (55)
Total storage loss
               24.2332    21.8880    24.2332    23.4515    24.2332    23.4515    24.2332    24.2332    23.4515    24.2332    23.4515    24.2332 (56)
If cylinder contains dedicated solar storage
               24.2332    21.8880    24.2332    23.4515    24.2332    23.4515    24.2332    24.2332    23.4515    24.2332    23.4515    24.2332 (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
              240.2908   212.3831   225.5146   198.2228   192.0680   172.9993   170.7773   177.6548   179.6928   200.4402   213.1839   237.6781 (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
              240.2908   212.3831   225.5146   198.2228   192.0680   172.9993   170.7773   177.6548   179.6928   200.4402   213.1839   237.6781 (64)
                                                                                   Total per year (kWh/year) = Sum(64)m =   2420.9056 (64)
12Total per year (kWh/year)                                                                                                         2421 (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
              102.1009    90.6728    97.1878    87.3970    86.0668    79.0102    78.9876    81.2744    81.2358    88.8505    92.3716   101.2322 (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         133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305   133.8305 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              130.8912   144.9153   130.8912   135.2543   130.8912   135.2543   130.8912   130.8912   135.2543   130.8912   135.2543   130.8912 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              246.2474   248.8027   242.3634   228.6551   211.3508   195.0872   184.2221   181.6668   188.1061   201.8144   219.1187   235.3823 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831    36.3831 (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)
             -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644  -107.0644 (71)
Water heating gains (Table 5)
              137.2324   134.9297   130.6288   121.3847   115.6812   109.7364   106.1662   109.2398   112.8275   119.4228   128.2938   136.0647 (72)
Total internal gains
              580.5201   594.7968   570.0326   551.4432   524.0724   503.2270   484.4287   484.9470   499.3369   518.2775   548.8159   568.4874 (73)
```


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-----------------------------------------------------------------------------------------------------
6. Solar gains
-----------------------------------------------------------------------------------------------------
[Jan]                                        Area      Solar flux               g             FF         Access           Gains
                                               m2        Table 6a   Specific data  Specific data         factor               W
                                                             W/m2    or Table 6b    or Table 6c       Table 6d
-----------------------------------------------------------------------------------------------------
North                                      5.9200         10.6334          0.6300         0.7000         0.7700         19.2382 (74)
South                                      8.3900         46.7521          0.6300         0.7000         0.7700        119.8766 (78)
-----------------------------------------------------------------------------------------------------

Solar gains   139.1149   233.0923   312.5590   382.9992   429.7180   428.1667   412.0596   376.1495   336.3572   255.5214   165.8276   119.6224 (83)
Total gains   719.6350   827.8891   882.5916   934.4425   953.7903   931.3937   896.4883   861.0965   835.6941   773.7989   714.6435   688.1098 (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            69.2121    69.3977    69.5806    70.4526    70.6182    71.3994    71.3994    71.5460    71.0965    70.6182    70.2840    69.9380
alpha           5.6141     5.6265     5.6387     5.6968     5.7079     5.7600     5.7600     5.7697     5.7398     5.7079     5.6856     5.6625
util living area
                0.9933     0.9846     0.9675     0.9163     0.8034     0.6115     0.4463     0.4834     0.7138     0.9263     0.9842     0.9947 (86)

MIT            19.9920    20.1802    20.4061    20.6886    20.8901    20.9816    20.9974    20.9960    20.9565    20.7123    20.3095    19.9627 (87)
Th 2           20.0805    20.0828    20.0850    20.0953    20.0972    20.1062    20.1062    20.1079    20.1027    20.0972    20.0933    20.0892 (88)
util rest of house
                0.9912     0.9799     0.9576     0.8913     0.7514     0.5332     0.3570     0.3918     0.6376     0.8990     0.9786     0.9930 (89)
MIT 2          18.9152    19.1548    19.4388    19.7869    20.0074    20.0959    20.1054    20.1065    20.0751    19.8221    19.3282    18.8845 (90)
Living area fraction                                                                                fLA = Living area / (4) =     0.1729 (91)
MIT            19.1014    19.3321    19.6060    19.9427    20.1600    20.2490    20.2596    20.2602    20.2274    19.9760    19.4978    19.0709 (92)
Temperature adjustment                                                                                                            0.0000
adjusted MIT   19.1014    19.3321    19.6060    19.9427    20.1600    20.2490    20.2596    20.2602    20.2274    19.9760    19.4978    19.0709 (93)
```

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

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation     0.9881     0.9749     0.9511     0.8864     0.7553     0.5461     0.3724     0.4076     0.6488     0.8946     0.9737     0.9904 (94)
Useful gains  711.0791   807.1178   839.4065   828.2807   720.4172   508.6191   333.8631   351.0032   542.2082   692.2664   695.8692   681.5208 (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
             1396.0019  1357.5295  1229.5556  1023.1639   782.0187   516.4709   334.5820   352.2034   562.5950   866.6985  1151.4767  1387.9964 (97)
Space heating kWh
              509.5825   369.8767   290.2710   140.3159    45.8316     0.0000     0.0000     0.0000     0.0000   129.7775   328.0374   525.6178 (98a)
Space heating requirement - total per year (kWh/year)                                                                          2339.3103
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
              509.5825   369.8767   290.2710   140.3159    45.8316     0.0000     0.0000     0.0000     0.0000   129.7775   328.0374   525.6178 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                  2339.3103
Space heating per m2                                                                                         (98c) / (4) =       24.8863 (99)
```

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-----------------------------------------------------------------------------------------------------
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
              509.5825   369.8767   290.2710   140.3159    45.8316     0.0000     0.0000     0.0000     0.0000   129.7775   328.0374   525.6178 (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)
              552.0937   400.7331   314.4864   152.0216    49.6550     0.0000     0.0000     0.0000     0.0000   140.6040   355.4034   569.4668 (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
              240.2908   212.3831   225.5146   198.2228   192.0680   172.9993   170.7773   177.6548   179.6928   200.4402   213.1839   237.6781 (64)
Efficiency of water heater                                                                                                        79.8000 (216)
(217)m         85.7027    85.2913    84.6269    83.2992    81.3892    79.8000    79.8000    79.8000    79.8000    83.1104    85.0229    85.7873 (217)
Fuel for water heating, kWh/month
```

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	280.3772	249.0091	266.4809	237.9648	235.9872	216.7911	214.0066	222.6250	225.1789	241.1733	250.7369	277.0552 (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	27.1966	21.8181	19.6448	14.3926	11.1173	9.0829	10.1416	13.1824	17.1226	22.4658	25.3750	27.9525 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-43.2736	-60.6466	-86.6520	-96.8081	-103.8444	-96.7021	-95.4772	-90.3880	-81.3435	-69.0333	-47.4348	-37.4526 (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	-25.5437	-53.6125	-106.3484	-159.4373	-210.5548	-211.4926	-209.0305	-177.1257	-129.9960	-76.6045	-34.0799	-20.2108 (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	2534.4640 (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	2917.3862 (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)	219.4922 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-2323.0928 (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	3434.2497 (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	2534.4640	0.2100	532.2374 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	2917.3862	0.2100	612.6511 (264)
Space and water heating			1144.8886 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	219.4922	0.1443	31.6795 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-909.0561	0.1347	-122.4714
PV Unit electricity exported	-1414.0366	0.1259	-178.0931
Total			-300.5645 (269)
Total CO2, kg/year			887.9329 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.4500 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	2534.4640	1.1300	2863.9443 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2917.3862	1.1300	3296.6465 (278)
Space and water heating			6160.5908 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	219.4922	1.5338	336.6645 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-909.0561	1.4979	-1361.6966
PV Unit electricity exported	-1414.0366	0.4623	-653.7270
Total			-2015.4236 (283)
Total Primary energy kWh/year			4611.9325 (286)
Target Primary Energy Rate (TPER)			49.0600 (287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b) -	
First floor	47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c) -	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 94.0000						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000 (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) =	0.1277 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		1.0000 (17)
Infiltration rate		0.1777 (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) =	0.1510 (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													
	0.1925	0.1888	0.1850	0.1661	0.1623	0.1435	0.1435	0.1397	0.1510	0.1623	0.1699	0.1774	(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	0.5185	0.5178	0.5171	0.5138	0.5132	0.5103	0.5103	0.5098	0.5114	0.5132	0.5144	0.5157	(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)			14.3100	0.7752	11.0930			(27)
Door			3.3600	1.0000	3.3600			(26)
GF			47.0000	0.1000	4.7000			(28a)
EW	56.5600	17.6700	38.8900	0.1300	5.0557			(29a)
ER	47.0000		47.0000	0.1000	4.7000			(30)
Total net area of external elements Aum(A, m2)			150.5600					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		8.9087			(33)
PW			105.7300	0.0000	0.0000			(32)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.1000	0.2680	2.7068
E6 Intermediate floor within a dwelling	10.1000	0.1400	1.4140
E18 Party wall between dwellings	20.0000	0.1200	2.4000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.1600	1.6160
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0300	0.2742
E3 Sill	7.7800	0.0200	0.1556
E4 Jamb	25.6600	0.0200	0.5132
P1 Party wall - Ground floor	18.8000	0.1600	3.0080
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.2400	4.5120
E24 Eaves (insulation at ceiling level - inverted)	0.0000	0.0000	0.0000

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	18.5102 (36)
Point Thermal bridges	(36a) = 0.0000
Total fabric heat loss	(33) + (36) + (36a) = 47.4189 (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	40.2124	40.1566	40.1019	39.8449	39.7968	39.5730	39.5730	39.5316	39.6592	39.7968	39.8941	39.9958	(38)
Heat transfer coeff													
	87.6314	87.5755	87.5208	87.2638	87.2158	86.9919	86.9919	86.9505	87.0782	87.2158	87.3130	87.4147	(39)
Average = Sum(39)m / 12 =												87.2636	

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9322	0.9317	0.9311	0.9283	0.9278	0.9254	0.9254	0.9250	0.9264	0.9278	0.9289	0.9299	(40)
HLP (average)												0.9283	
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												2.6766	(42)
Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	29.1724	28.7320	28.1055	27.1673	26.3218	25.1578	24.2748	25.3546	25.9213	27.0746	28.2737	29.1492	(42b)
Hot water usage for other uses													
	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)
Average daily hot water use (litres/day)												65.2689	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	71.2135	69.2444	67.0891	64.6222	62.2479	59.5552	58.6721	61.2807	63.3762	66.0582	68.7861	71.1904	(44)
Energy conte	104.8386	91.6243	95.8690	84.4127	80.2127	68.8735	64.8344	72.1285	73.5132	85.1227	92.9667	104.5483	(45)
Energy content (annual)										Total = Sum(45)m =		1018.9447	
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													
	89.1128	77.8807	81.4886	71.7508	68.1808	58.5425	55.1092	61.3092	62.4862	72.3543	79.0217	88.8661	(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													
	89.1128	77.8807	81.4886	71.7508	68.1808	58.5425	55.1092	61.3092	62.4862	72.3543	79.0217	88.8661	(64)
										Total per year (kWh/year) = Sum(64)m =		866.1030	(64)
12Total per year (kWh/year)												866	(64)
Electric shower(s)													
	55.3358	49.3046	53.8388	51.3777	52.3418	49.9290	51.5933	52.3418	51.3777	53.8388	52.8264	55.3358	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		629.4411	(64a)
Heat gains from water heating, kWh/month													
	36.1121	31.7963	33.8319	30.7821	30.1306	27.1179	26.6756	28.4127	28.4660	31.5483	32.9620	36.0505	(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	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)													
	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)													
	48.5378	47.3160	45.4729	42.7529	40.4982	37.6637	35.8543	38.1892	39.5361	42.4036	45.7806	48.4549	(72)
Total internal gains													
	488.8256	504.1831	481.8767	469.8115	445.8893	431.1543	414.1168	413.8964	426.0455	438.2583	463.3027	477.8776	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.5400	0.8000	0.7700	18.8456	(74)
South	8.3900	46.7521	0.5400	0.8000	0.7700	117.4302	(78)

Solar gains	136.2758	228.3353	306.1803	375.1829	420.9482	419.4286	403.6503	368.4730	329.4927	250.3067	162.4433	117.1811	(83)
Total gains	625.1014	732.5184	788.0570	844.9944	866.8376	850.5829	817.7671	782.3694	755.5383	688.5650	625.7460	595.0587	(84)

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7. Mean internal temperature (heating season)

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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	74.4913	74.5388	74.5854	74.8051	74.8463	75.0389	75.0389	75.0746	74.9646	74.8463	74.7629	74.6760	
alpha	5.9661	5.9693	5.9724	5.9870	5.9898	6.0026	6.0026	6.0050	5.9976	5.9898	5.9842	5.9784	
util living area													
	0.9964	0.9903	0.9772	0.9333	0.8270	0.6358	0.4654	0.5067	0.7437	0.9459	0.9907	0.9973	(86)
MIT	20.0018	20.1870	20.4073	20.6824	20.8880	20.9811	20.9974	20.9958	20.9537	20.6961	20.2945	19.9604	(87)
Th 2	20.1402	20.1407	20.1412	20.1435	20.1439	20.1459	20.1459	20.1463	20.1451	20.1439	20.1430	20.1421	(88)
util rest of house													
	0.9953	0.9872	0.9699	0.9124	0.7788	0.5589	0.3765	0.4151	0.6704	0.9245	0.9873	0.9965	(89)
MIT 2	19.2306	19.4144	19.6310	19.8937	20.0710	20.1375	20.1453	20.1451	20.1215	19.9112	19.5239	19.1910	(90)
Living area fraction										fLA = Living area / (4) =		0.1729	(91)
MIT	19.3639	19.5480	19.7652	20.0301	20.2122	20.2833	20.2926	20.2922	20.2654	20.0469	19.6571	19.3240	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.3639	19.5480	19.7652	20.0301	20.2122	20.2833	20.2926	20.2922	20.2654	20.0469	19.6571	19.3240	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9939	0.9846	0.9660	0.9092	0.7830	0.5717	0.3919	0.4310	0.6814	0.9215	0.9847	0.9953	(94)
Useful gains	621.2747	721.2070	761.2301	768.2809	678.7160	486.2491	320.5094	337.1711	514.8352	634.5463	616.1899	592.2800	(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													
	1320.0729	1282.8029	1160.9790	971.2539	742.3997	494.4046	321.2252	338.4275	536.8708	823.9153	1096.4011	1322.0579	(97)
Space heating kWh													
	519.9059	377.3924	297.4132	146.1405	47.3807	0.0000	0.0000	0.0000	0.0000	140.8905	345.7521	542.9548	(98a)
Space heating requirement - total per year (kWh/year)												2417.8302	
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													
	519.9059	377.3924	297.4132	146.1405	47.3807	0.0000	0.0000	0.0000	0.0000	140.8905	345.7521	542.9548	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2417.8302	
Space heating per m2											(98c) / (4) =	25.7216	(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	817.7243	643.7404	660.8238	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9088	0.9583	0.9443	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	743.1536	616.9077	624.0416	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	937.8008	902.2550	863.3702	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	140.1460	212.2984	178.0604	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	35.0365	53.0746	44.5151	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												132.6262	(107)
Energy for space heating												25.7216	(99)
Energy for space cooling												1.4109	(108)
Total												27.1325	(109)
Fabric Energy Efficiency (DFEE)												27.1	(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	47.0000 (1b)	x	2.5000 (2b)	=	117.5000 (1b) -	
First floor	47.0000 (1c)	x	2.5000 (2c)	=	117.5000 (1c) -	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	94.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		235.0000	(5)

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2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1277	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3777	(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) =	0.3210	(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	0.4093	0.4013	0.3932	0.3531	0.3451	0.3050	0.3050	0.2969	0.3210	0.3451	0.3611	0.3772	(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	0.5838	0.5805	0.5773	0.5623	0.5595	0.5465	0.5465	0.5441	0.5515	0.5595	0.5652	0.5711	(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			3.3600	1.0000	3.3600			(26)
TER Opening Type (Uw = 1.20)			14.3100	1.1450	16.3855			(27)
GF			47.0000	0.1300	6.1100			(28a)
EW	56.5600	17.6700	38.8900	0.1800	7.0002			(29a)
ER	47.0000		47.0000	0.1100	5.1700			(30)
Total net area of external elements Aum(A, m2)			150.5600					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	38.0257			(33)
PW			105.7300	0.0000	0.0000			(32)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E5 Ground floor (normal)	10.1000	0.1600	1.6160
E6 Intermediate floor within a dwelling	10.1000	0.0000	0.0000
E18 Party wall between dwellings	20.0000	0.0600	1.2000
P2 Party wall - Intermediate floor within a dwelling	18.8000	0.0000	0.0000
E11 Eaves (insulation at rafter level)	10.1000	0.0400	0.4040
P5 Party wall - Roof (insulation at rafter level)	23.8800	0.0800	1.9104
E2 Other lintels (including other steel lintels)	9.1400	0.0500	0.4570
E3 Sill	7.7800	0.0500	0.3890
E4 Jamb	25.6600	0.0500	1.2830
P1 Party wall - Ground floor	18.8000	0.0800	1.5040
P4 Party wall - Roof (insulation at ceiling level)	18.8000	0.1200	2.2560
E24 Eaves (insulation at ceiling level - inverted)	0.0000	0.2400	0.0000

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 11.0194 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 49.0451 (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	45.2705	45.0182	44.7710	43.6098	43.3925	42.3811	42.3811	42.1938	42.7707	43.3925	43.8320	44.2915	(38)
Heat transfer coeff	94.3156	94.0633	93.8161	92.6549	92.4376	91.4262	91.4262	91.2389	91.8158	92.4376	92.8771	93.3366	(39)

Average = Sum(39)m / 12 = 92.6538

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0034	1.0007	0.9980	0.9857	0.9834	0.9726	0.9726	0.9706	0.9768	0.9834	0.9881	0.9929	(40)
HLP (average)												0.9857	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.6766 (42)

Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	29.8375	29.3944	28.7704	27.6198	26.7582	25.8029	25.2869	25.9066	26.5813	27.6035	28.7778	29.7366	(42b)
Hot water usage for other uses	42.0412	40.5124	38.9836	37.4549	35.9261	34.3973	34.3973	35.9261	37.4549	38.9836	40.5124	42.0412	(42c)

Average daily hot water use (litres/day) 65.8833 (43)

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	71.8787	69.9068	67.7540	65.0746	62.6843	60.2003	59.6842	61.8327	64.0361	66.5871	69.2902	71.7778	(44)
Energy conte	113.8383	99.5463	104.1354	89.0839	84.3852	74.0232	72.1829	76.5618	78.9629	90.3581	98.7165	112.3867	(45)

Energy content (annual) Total = Sum(45)m = 1094.1812

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	96.7625	84.6144	88.5151	75.7213	71.7274	62.9198	61.3555	65.0775	67.1185	76.8044	83.9090	95.5287	(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	96.7625	84.6144	88.5151	75.7213	71.7274	62.9198	61.3555	65.0775	67.1185	76.8044	83.9090	95.5287	(64)

Total per year (kWh/year) = Sum(64)m = 930.0540 (64)

12Total per year (kWh/year) 930 (64)

Electric shower(s)

	55.3358	49.3046	53.8388	51.3777	52.3418	49.9290	51.5933	52.3418	51.3777	53.8388	52.8264	55.3358	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 629.4411 (64a)

Heat gains from water heating, kWh/month

	38.0246	33.4797	35.5885	31.7748	31.0173	28.2122	28.2372	29.3548	29.6240	32.6608	34.1839	37.7161	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	133.8305	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	130.8912	144.9153	130.8912	135.2543	130.8912	135.2543	130.8912	130.8912	135.2543	130.8912	135.2543	130.8912	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	246.2474	248.8027	242.3634	228.6551	211.3508	195.0872	184.2221	181.6668	188.1061	201.8144	219.1187	235.3823	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	36.3831	(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)	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	-107.0644	(71)
Water heating gains (Table 5)	51.1083	49.8211	47.8339	44.1316	41.6899	39.1836	37.9532	39.4554	41.1445	43.8989	47.4776	50.6937	(72)
Total internal gains	491.3960	506.6881	484.2378	471.1901	447.0811	432.6742	416.2157	415.1626	427.6540	439.7537	464.9997	480.1164	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	5.9200	10.6334	0.6300	0.7000	0.7700	19.2382	(74)
South	8.3900	46.7521	0.6300	0.7000	0.7700	119.8766	(78)

Solar gains	139.1149	233.0923	312.5590	382.9992	429.7180	428.1667	412.0596	376.1495	336.3572	255.5214	165.8276	119.6224	(83)
Total gains	630.5109	739.7805	796.7968	854.1894	876.7991	860.8409	828.2753	791.3121	764.0112	695.2751	630.8272	599.7388	(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	69.2121	69.3977	69.5806	70.4526	70.6182	71.3994	71.3994	71.5460	71.0965	70.6182	70.2840	69.9380	
alpha	5.6141	5.6265	5.6387	5.6968	5.7079	5.7600	5.7600	5.7697	5.7398	5.7079	5.6856	5.6625	
util living area	0.9965	0.9908	0.9791	0.9397	0.8424	0.6543	0.4817	0.5239	0.7618	0.9509	0.9912	0.9973	(86)
MIT	19.8907	20.0840	20.3195	20.6256	20.8576	20.9742	20.9962	20.9939	20.9393	20.6469	20.2178	19.8613	(87)
Th 2	20.0805	20.0828	20.0850	20.0953	20.0972	20.1062	20.1062	20.1079	20.1027	20.0972	20.0933	20.0892	(88)
util rest of house	0.9953	0.9879	0.9723	0.9198	0.7946	0.5734	0.3860	0.4257	0.6867	0.9305	0.9879	0.9965	(89)
MIT 2	19.0720	19.2654	19.4988	19.7995	20.0037	20.0947	20.1052	20.1062	20.0715	19.8256	19.4076	19.0497	(90)
Living area fraction									fLA = Living area / (4) =			0.1729	(91)
MIT	19.2135	19.4069	19.6407	19.9423	20.1513	20.2467	20.2593	20.2596	20.2216	19.9676	19.5476	19.1900	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2135	19.4069	19.6407	19.9423	20.1513	20.2467	20.2593	20.2596	20.2216	19.9676	19.5476	19.1900	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9939	0.9851	0.9681	0.9158	0.7977	0.5867	0.4026	0.4427	0.6974	0.9269	0.9852	0.9953	(94)
Useful gains	626.6453	728.7809	771.3406	782.2574	699.4511	505.0367	333.4726	350.3134	532.8581	644.4745	621.5132	596.8996	(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	1406.5757	1364.5652	1232.8052	1023.1200	781.2162	516.2603	334.5515	352.1502	562.0562	865.9170	1156.0988	1399.1200	(97)
Space heating kWh	580.2683	427.2471	343.3296	173.4211	60.8332	0.0000	0.0000	0.0000	0.0000	164.7532	384.9017	596.8520	(98a)
Space heating requirement - total per year (kWh/year)												2731.6062	
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	580.2683	427.2471	343.3296	173.4211	60.8332	0.0000	0.0000	0.0000	0.0000	164.7532	384.9017	596.8520	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												2731.6062	
Space heating per m2											(98c) / (4) =	29.0596	(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	859.4063	676.5539	693.4156	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8910	0.9472	0.9312	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	765.7573	640.8271	645.7087	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	949.5340	914.1830	873.6089	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	132.3192	203.3768	169.5578	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	33.0798	50.8442	42.3895	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												126.3135	(107)
Energy for space heating												29.0596	(99)
Energy for space cooling												1.3438	(108)
Total												30.4034	(109)
Fabric Energy Efficiency (TFEE)												30.4	(109)

6.0 Appendix B - TM59/O Overheating

London Gatwick DSY1 2020 High emissions

Natvent room name	Natvent criterion (a) result	Natvent criterion (b) result	Pass/Fail
00-3B5P House B-Kitchen	Pass	NA	Pass
00-3B5P House B-Livingroom	Pass	NA	Pass
00-4B8P House A- Livingroom	Pass	NA	Pass
00-4B8P House A-Kitchen	Pass	NA	Pass
00-4B8P House B-Kitchen	Pass	NA	Pass
00-4B8P House B-Livingroom	Pass	NA	Pass
00-Bedroom	Pass	Pass	Pass
00-Bedroom	Pass	Pass	Pass
00-LKD	Pass	NA	Pass
00-LKD	Pass	NA	Pass
01-3B5P House B-Bedroom	Pass	Pass	Pass
01-3B5P House B-Bedroom	Pass	Pass	Pass
01-3B5P House B-Bedroom	Pass	Pass	Pass
01-4B8P House A- Bedroom	Pass	Pass	Pass
01-4B8P House A- Bedroom	Pass	Pass	Pass
01-4B8P House B-Bedroom	Pass	Pass	Pass
01-4B8P House B-Bedroom	Pass	Pass	Pass
01-Bedroom	Pass	Pass	Pass
01-Bedroom	Pass	Pass	Pass
01-LKD	Pass	NA	Pass
01-LKD	Pass	NA	Pass
02-4B8P House A- Bedroom	Pass	Pass	Pass
02-4B8P House A- Bedroom	Pass	Pass	Pass
02-4B8P House B- Bedroom	Pass	Pass	Pass
02-4B8P House B- Bedroom	Pass	Pass	Pass
03-Bedroom	Pass	Pass	Pass
03-Bedroom	Pass	Pass	Pass
03-LKD	Pass	NA	Pass
03-LKD	Pass	NA	Pass
Corridor name	**Significant overheating risk?**		
00-Circulation	No		
01-Circulation	No		
03-Circulation	No		
01-Staircase	No		
00-Circulation	No		
00-Staircase	No		
03-Staircase	No		
01-Circulation	No		
00-Circulation	No		
03-Circulation	No		

London Gatwick DSY2 2020 High emissions

Natvent room name	Natvent criterion (a) result	Natvent criterion (b) result	Pass/Fail
00-3B5P House B-Kitchen	Fail	NA	Fail
00-3B5P House B-Livingroom	Fail	NA	Fail
00-4B8P House A- Livingroom	Fail	NA	Fail
00-4B8P House A-Kitchen	Fail	NA	Fail
00-4B8P House B-Kitchen	Fail	NA	Fail
00-4B8P House B-Livingroom	Fail	NA	Fail
00-Bedroom	Pass	Fail	Fail
00-Bedroom	Pass	Pass	Pass
00-LKD	Pass	NA	Pass
00-LKD	Pass	NA	Pass
01-3B5P House B-Bedroom	Pass	Fail	Fail
01-3B5P House B-Bedroom	Pass	Pass	Pass
01-3B5P House B-Bedroom	Pass	Pass	Pass
01-4B8P House A- Bedroom	Pass	Fail	Fail
01-4B8P House A- Bedroom	Pass	Fail	Fail
01-4B8P House B-Bedroom	Pass	Fail	Fail
01-4B8P House B-Bedroom	Pass	Fail	Fail
01-Bedroom	Pass	Pass	Pass
01-Bedroom	Pass	Fail	Fail
01-LKD	Pass	NA	Pass
01-LKD	Pass	NA	Pass
02-4B8P House A- Bedroom	Pass	Fail	Fail
02-4B8P House A- Bedroom	Pass	Fail	Fail
02-4B8P House B- Bedroom	Fail	Fail	Fail
02-4B8P House B- Bedroom	Pass	Fail	Fail
03-Bedroom	Pass	Pass	Pass
03-Bedroom	Pass	Fail	Fail
03-LKD	Fail	NA	Fail
03-LKD	Fail	NA	Fail
Corridor name	**Significant overheating risk?**		
00-Circulation	No		
01-Circulation	No		
03-Circulation	No		
01-Staircase	No		
00-Circulation	No		
00-Staircase	No		
03-Staircase	No		
01-Circulation	No		
00-Circulation	No		
03-Circulation	No		

London Gatwick DSY3 2020 High emissions

Natvent room name	Natvent criterion (a) result	Natvent criterion (b) result	Pass/Fail
00-3B5P House B-Kitchen	Fail	NA	Fail
00-3B5P House B-Livingroom	Fail	NA	Fail
00-4B8P House A- Livingroom	Fail	NA	Fail
00-4B8P House A-Kitchen	Fail	NA	Fail
00-4B8P House B-Kitchen	Fail	NA	Fail
00-4B8P House B-Livingroom	Fail	NA	Fail
00-Bedroom	Pass	Fail	Fail
00-Bedroom	Pass	Fail	Fail
00-LKD	Fail	NA	Fail
00-LKD	Fail	NA	Fail
01-3B5P House B-Bedroom	Fail	Fail	Fail
01-3B5P House B-Bedroom	Pass	Fail	Fail
01-3B5P House B-Bedroom	Fail	Fail	Fail
01-4B8P House A- Bedroom	Pass	Fail	Fail
01-4B8P House A- Bedroom	Pass	Fail	Fail
01-4B8P House B-Bedroom	Pass	Fail	Fail
01-4B8P House B-Bedroom	Fail	Fail	Fail
01-Bedroom	Pass	Pass	Pass
01-Bedroom	Pass	Fail	Fail
01-LKD	Fail	NA	Fail
01-LKD	Pass	NA	Pass
02-4B8P House A- Bedroom	Fail	Fail	Fail
02-4B8P House A- Bedroom	Fail	Fail	Fail
02-4B8P House B- Bedroom	Fail	Fail	Fail
02-4B8P House B- Bedroom	Fail	Fail	Fail
03-Bedroom	Fail	Pass	Fail
03-Bedroom	Fail	Fail	Fail
03-LKD	Fail	NA	Fail
03-LKD	Fail	NA	Fail
Corridor name	**Significant overheating risk?**		
00-Circulation	No		
01-Circulation	No		
03-Circulation	No		
01-Staircase	No		
00-Circulation	No		
00-Staircase	No		
03-Staircase	No		
01-Circulation	No		
00-Circulation	No		
03-Circulation	No		

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