Energy Assessment
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Executive summary

About the Scheme

The proposal includes the demolition of an existing three-story dwelling to be replaced by a newly constructed house and ancillary accommodation designed to function together. The new dwelling will feature a shared, partly unheated basement, which serves as both a garage and leisure space. The development is located in the London Borough of Camden with a GIA of approximately 1935 sqm.

The energy demand and CO_2 emissions have been calculated for the above New Construction proposal and CO_2 savings are shown compared to the notional building. Additionally, the New Construction is compared against the Approved Extension scheme (existing building on site, including approved extensions in a previous planning application). These extensions have been approved but haven't been built yet.

The approved extensions are as outlined below:

1. Addition of loft / attic to the rear of the main house (Planning Application Reference: 2022/2773/P)
2. Erection of a two-storey outbuilding with a basement linked to the main house (Planning Application Reference: 2011/5102/P)

Results demonstrate that the proposed New Construction scheme performs better than the Approved Extension scheme (including the existing building and the changes approved in the latest planning applications) in terms of CO_2 emissions and energy demand.

Table indicating performance of the three scenarios; the existing dwelling (baseline), Approved Extension (Scenario 1) and New Construction (Scenario 2).

	Baseline Existing Building	Scenario 1 (Approved Extension)	Scenario 2 (New Construction)
Energy demand (kWh/m^2/year)	106.0	40.6	4.40
CO_2/m^2 emissions	22.2	6.3	0.90

Please refer to Appendix A for a more detailed comparison between the existing dwelling (baseline), the Approved Extension (Scenario 1) and New Construction (Scenario 2) scenarios. For all scenarios, the energy demand and CO_2 emissions calculations have followed the GLA's guidance. The main body of the report will present the strategy for the New Construction proposal (Scenario 2).

Planning policy

The scheme has been developed in accordance with the London Plan 2021 "The Spatial Development Strategy for Greater London, March 2021" and with the Sustainable, Design and Construction SPG. The assessment also considers the Camden Local Plan Strategic Policies 2016-2031 targeting development to meet zero carbon standards.

According to the planning policies, the scheme should achieve:

- Zero carbon target
- A minimum on-site CO_2 reduction of at least 35% beyond Building Regulations
- Residential development should achieve 10% CO_2 improvement through energy efficiency measures, 'Be Lean' stage
- As least 20% CO_2 improvement through renewable technologies, 'Be Green' stage
- Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:
    - through a cash in lieu contribution to the borough's carbon offset fund, or
    - off-site provided that an alternative proposal is identified, and delivery is certain

Summary

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

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

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

- An on-site CO_2 reduction of 92.9% beyond Building Regulations Part L 2021 through energy efficiency measures and inclusion of renewable technologies (Ground Source Heat Pumps and PV panels)
- The development achieves 22.0% CO_2 improvement through energy efficiency measures, 'Be Lean' stage
- A further improvement of 70.8% CO_2 has been achieved through renewable technologies 'Be Green' stage (Ground Source Heat Pumps and PV panels)
- Zero-carbon target can be achieved through a cash in lieu contribution to the borough's carbon offset fund. The carbon offset payment cost has been calculated as £3,296.
- An overall primary energy reduction of 85.5% is achieved.

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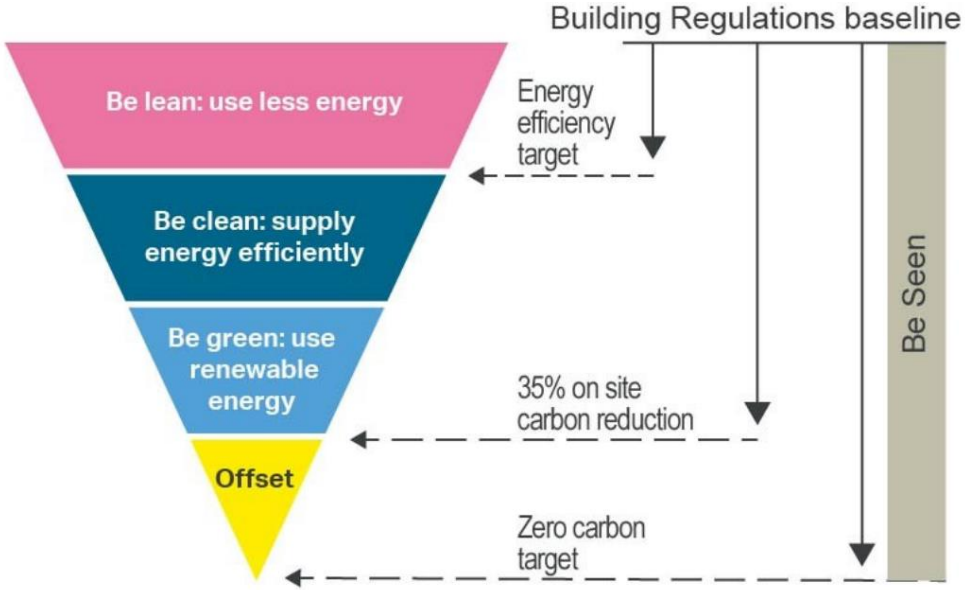
Energy hierarchy
The proposed scheme has followed the energy hierarchy that is illustrated below:



Source: Greater London Authority

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

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

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GLA's Energy Hierarchy: Regulated carbon emissions

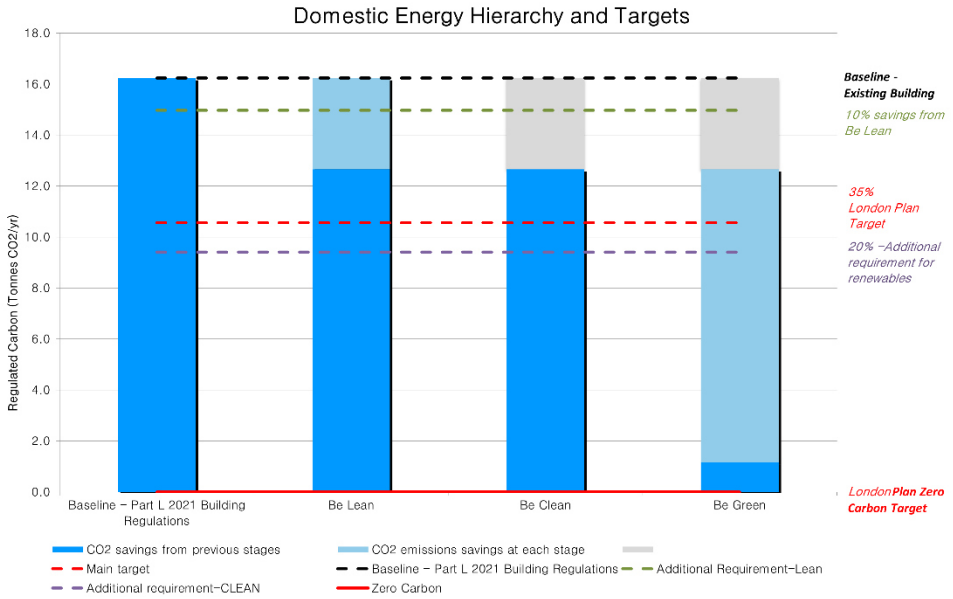
The proposed New Construction scheme has followed the energy hierarchy. A graphical illustration of how the scheme performs in relation to Building Regulations and the Energy Hierarchy is shown below. Carbon dioxide emission factors for SAP 10.2 have been used for the calculation.

As demonstrated in the figure the proposed scheme will reduce carbon emissions by 22.0% from the fabric energy efficiency measures described in the 'Be Lean' section and will reduce total carbon emissions by 92.9% over Building Regulations (using SAP 10.2 carbon dioxide emission factors) with the further inclusion of low and zero carbon technology (Ground source heat pump and PV panels).

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

Regulated CO_2 emissions – Proposed New Construction (Scenario 2)

New Construction (Scenario 2)				
GLA's Energy Hierarchy: Regulated CO_2 - Calculated using SAP 10.2 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	16.24	12.66	-	1.16
CO_2 emissions saving (tCO_2/yr)	-	3.58	-	11.50
Saving from each stage (%)	-	22.0	-	70.8
Total CO_2 emissions saving (tCO_2/yr)	15.08			
92.9% total CO_2 savings over 2021 Building Regulations Part L achieved				



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Establishing Carbon Emissions

Methodology

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

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

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

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

Establishing CO_2 emissions

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

CO_2 Emissions – Regulated and Unregulated (tonnes CO_2/yr) - SAP 10.2 – Proposed New Construction (Scenario 2)			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2021	16.24	7.79	24.03
Be Lean: Use less energy	12.66	7.79	20.45
Be Clean: Supply energy efficiently	-	-	-
Be Green: Use renewable energy	1.16	7.79	8.95

Carbon offsetting

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

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

Regulated carbon dioxide savings from each stage of the energy hierarchy – SAP 10.2		
	(tonnes CO_2/yr)	%
Be Lean: Savings from energy demand reduction	3.58	22.0%
Be Clean: Savings from heat networks	0.00	0.0%
Be Green: Savings from renewable energy	11.50	70.8%
Cumulative on-site savings	15.08	92.9%
Carbon shortfall	1.16	-
	(tonnes CO_2)	
Cumulative savings for offset	34.69	
Cash-in-lieu contribution	**£3,296**	

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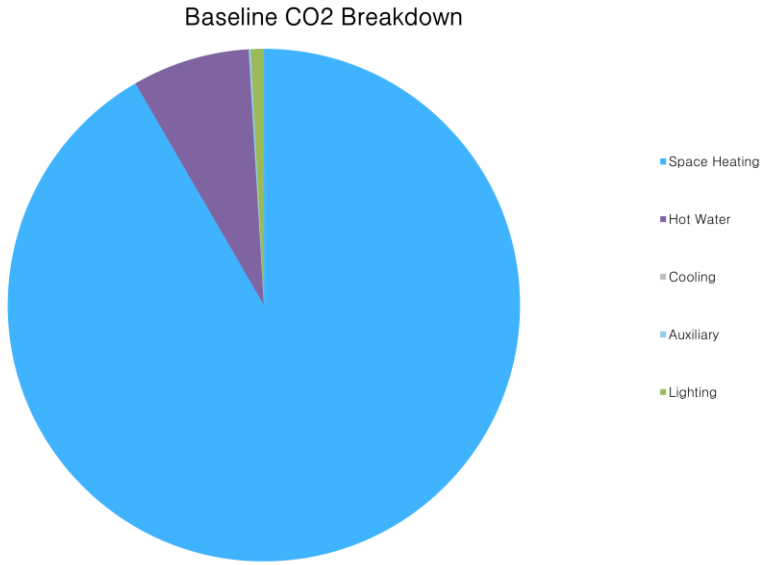
Baseline

Building regulations Part L 2021 minimum compliance
The total baseline carbon emission for the whole scheme is 18.68 tonnes CO_2/yr excluding the solar PV's assumed in the notional building (using SAP 10.2 carbon dioxide emission factors).

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

Carbon Emissions in tonnes CO_2/yr.				
Heating	Hot Water	Cooling	Auxiliary	Lighting
17.00	1.38	0.00	0.02	0.15



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Demand Reduction

Be Lean: summary
Demand reduction measures have reduced the scheme's carbon emissions by 22.0% (using SAP 10.2 figures) over the minimum Part L 2021 Building Regulations baseline.

U-values

	Proposed New Construction (Scenario 2)	
Element	Minimum 2021 Building Regulations U-value W/m^{2}K	Proposed U-value W/m^{2}K
Flat roof	0.16	0.11
Walls	0.26	0.12
Basement / Ground floor	0.18	0.11
Exposed floor	0.18	0.11
Windows	1.60	Triple glazed 0.85 (g-value 0.40)
Rooflights	2.20	1.00 (g-value 0.40)
Doors	1.60	1.00

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

Air permeability (m^3/hm^2 @50 Pa)	Minimum 2021 Building Regulations	Proposed
Proposed New Construction (Scenario 2)	8	2.5

This will require careful attention to two key areas:

- Structural leakage
- Services leakage

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

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

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

Junctions	Psi-value (W/mK)
Lintels (E2)	0.20
Sill (E3)	0.04
Jambs (E4)	0.05
Ground floor (E5)	0.15
Intermediate floor within a dwelling (E6)	0.07
Flat Roof (E14)	0.15
Flat roof with parapet (E15)	0.15
Corners (E16)	0.09
Corner inverted (E17)	-0.09
Exposed floor (normal) (E20)	0.20
Exposed floor (inverted) (E21)	0.20
Basement floor (E22)	0.15
Balcony within or between dwellings, balcony support penetrates wall insulation (E23)	0.30
Eaves (insulation at ceiling- Inverted) (E24)	0.10
Upstands or kerbs of rooflights (R11)	0.20

The default psi-value has been used for the remaining junctions including the junctions connected to retained building fabric elements.

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

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Heating
For the 'Be Lean' scenario, the scheme has been modelled with a gas boiler with a nominal efficiency of 89.5% (as required by the GLA). For the 'Be Green' final scenario, a ground source heat pump (Vaillant flexoTherm or similar) with a minimum COP of 3.7 has been specified as the main heating system. Heat will be provided via radiator and underfloor heating and will be controlled via time and temperature zone control by arrangement.

Hot Water
For the 'Be Lean', the hot water will be provided by the main gas heating system (gas boilers with an efficiency of 89.5%). For the 'Be Green' final scenario, hot water will be provided by the main heating system (Ground Source Heat pump, Vaillant flexoTherm or similar). A hot water cylinder of 400L with a heat loss factor of 2.52 kWh/day has been specified.

Moreover, a wastewater heat recovery has been specified for the showers with a heat recovery efficiency of at least 0.615 (Recoup Pipe+ HE or similar).

Ventilation
Mechanical ventilation with heat recovery has been specified for the scheme, using Vent Axia Sentinel Kinetic Advance BS or a similar system. The scheme comprises 11 wet rooms in the main house and 4 wet rooms in the staff unit. The system has been modelled with a Specific Fan Power (SFP) of 1.05 W/l/s for the main house and 0.76 W/l/s for the staff unit, along with a heat recovery efficiency of 91% for the main house and 90% for the staff unit. The ductwork will be Level 1, fully insulated.

Cooling
No cooling has been specified for the scheme.

Lighting
High efficiency lighting has been specified for the development with a minimum efficacy of 100 lumens/W.

Energy demand following energy efficiency measures (MWh/year)

	Space Heating	Hot water	Lighting	Auxiliary	Cooling	Unregulated gas	Unregulated electricity
Proposed	48.9	5.2	1.0	8.4	0.0	0.0	15.9

Fabric energy efficiency

	Target Fabric Energy Efficiency (MWh/year)	Design Fabric Energy Efficiency (MWh/year)	Improvement (%)
Proposed	73.36	65.54	10.7

Primary Energy

	Target Primary Energy Rate (MWh/year)	Dwelling Primary Energy Rate (MWh/year)	Improvement (%)
Proposed	79.62	11.55	85.5

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Cooling and Overheating

Overheating and cooling

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

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

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

The Cooling Hierarchy in Policy SI4

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

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

Avoiding overheating: measures taken

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

- Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
    - Solar control – all methods limiting solar gain to within tolerable limits have been considered. The location, size, design and type of window openings and glazing have been optimised and reduced solar gain factors from low emissivity windows have been specified.
    - High albedo materials: A high albedo (reflective) surface has been specified for the roof and vertical facades in order to minimise the heat absorbed by the roof, and significant thermal insulation has been specified to prevent any heat absorbed being transferred into the building.
    - Insulation levels have been maximised and the resulting U-values are lower than required by Building Regulations. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target U-values.
    - A reduced air permeability rate has been targeted to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.

- Minimise internal heat generation through energy efficient design
    - Internal heat gains have been minimised where possible. Energy efficient appliances will help reduce internal heat gains.
    - Energy efficient lighting will also be specified as per the 'Be Lean' section.

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

Active cooling

Air conditioning has not been specified for the scheme.

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Heating Infrastructure

Heating infrastructure including CHP

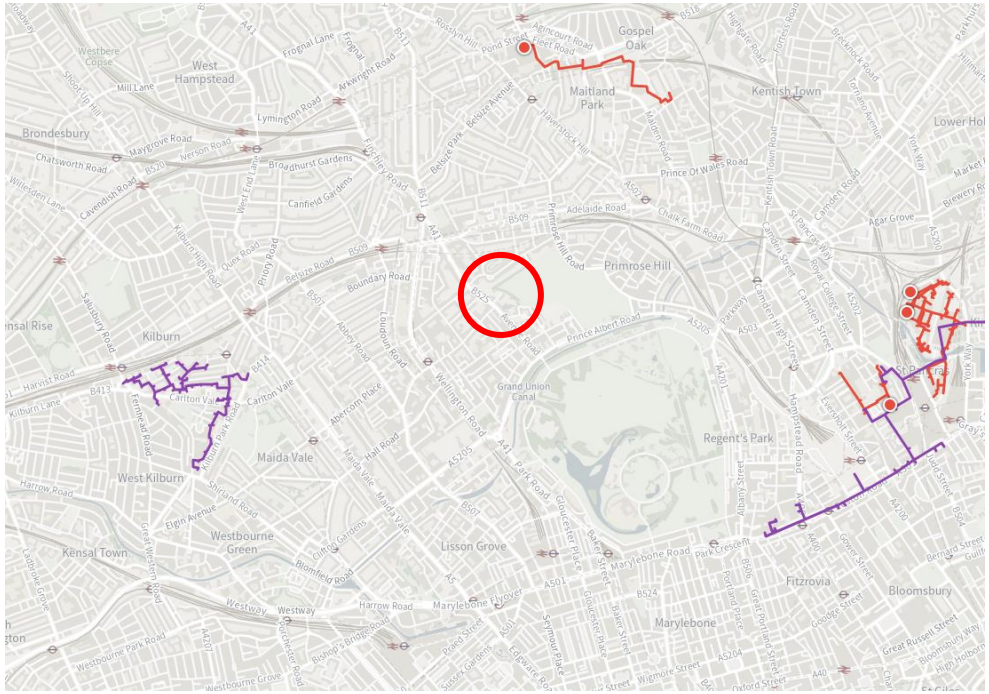
Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy SI3 of London Plan 2021. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and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

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

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

Connect to local existing or planned heat network

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



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

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Use zero-emission and/or local secondary heat sources

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

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

Use low-emission combined heat and power (CHP)

In accordance with section 9 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion.

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

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

Use ultra-low Nox gas boilers

Where it is clearly demonstrated that the above heating options (District heating, local secondary heat source and CHP) have been fully investigated and ruled out, then a site-wide heating strategy led by ultra-low Nox gas boilers can be considered, however this is not applicable to this scheme.

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

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Renewable Energy

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

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

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

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

Economic viability: (Maximum score of 5)

f. Capital cost of all components = ✓
g. Grants and funding available = ✓
h. Payback periods (years) 3-5, 5-10, 10-15 = ✓
i. Servicing requirements (low or high) = ✓
j. Maintenance costs (low or high) = ✓

CO_2 and sustainability: (Maximum score of 10)

k. Carbon saving per year = ✓✓✓✓
l. Impact of future grid decarbonisation (gas vs. electric) = ✓✓
m. Local air quality/pollution = ✓✓
n. Resource use of installation = ✓✓

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

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Biomass & Biofuel – Rejected

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

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

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

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

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

The site is likely to be unsuitable for biomass boilers due to site constraints such as limited transport/access issues, and storage of the biomass fuel. A detailed feasibility study will be required to investigate the suitability.

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

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Photovoltaic Panels (PV) – Accepted

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

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

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

The most suitable location for mounting photovoltaic panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a potential useable roof area of approximately 195 m^2 and is orientated facing southwest.

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

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Solar Thermal – Rejected

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

Like photovoltaic panels the most suitable location for mounting solar hot water panels is on roofs as they usually have the greatest exposure to the sun. Photovoltaic panels have been selected for this scheme.

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

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Wind Energy – Rejected

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

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

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

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

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

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

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Ground Source Heat Pump (GSHP) – Accepted

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

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

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

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

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

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

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Air Source Heat Pump (ASHP) – Rejected

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

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

ASHPs are cheaper to install than ground source heat pumps but carbon dioxide emission savings will typically be less than that of a ground source heat pump. Given the high emissions contribution from space heating and hot water, it is estimated that a ground source heat pump will have a significant impact on reducing carbon emissions from the proposal.

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

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

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

Renewable Technology	Comments	Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)	Total Score
Biomass Boiler	High air quality impact	✓	✓✓✓	✓✓✓✓✓	9
Photovoltaic	High CO_2 savings and low visual impact	✓✓✓✓	✓✓	✓✓✓✓✓ ✓✓✓	14
Solar Thermal	Low CO_2 savings compared to PV panels	✓✓✓	✓✓✓	✓✓✓✓✓ ✓	12
Wind Energy	High visual and noise impact	✓	✓✓✓✓	✓✓✓✓✓	10
GSHP	High capital cost	✓✓✓	✓✓	✓✓✓✓✓ ✓✓✓	13
ASHP	Low capital cost but low CO_2 savings compared to GSHP	✓✓	✓✓	✓✓✓✓✓ ✓✓	11

Photovoltaic panels, solar thermal panels and ground source heat pump have scored the best.

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

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Ground Source Het Pump (GSHP) - Performance

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

A ground source heat pump (Vaillant flexoTherm or similar) has been estimated to have a minimum CoP of 3.7 and it will cover 100% of the space heating demand and 100% of the hot water demand.

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

	Gas Boiler	Air Source Heat Pump
	Heating and hot water	Heating and hot water
Installation cost (£)	9,000	42,000
Maintenance and replacement cost (£)	11,000	10,000
Total (£)	20,000	52,000
Energy demand (kWh)	54,068	14,118
Cost of gas/electricity (p/kWh)	8.0	17.0
Annual operational cost (£)	4,325	2,400

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

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

Cost Performance Criteria	Value
Extra Cost Over Life Cycle (£)	32,000
Predicted Annual Savings (£)	1,925
Payback Period (years)	16.6
Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	39,950
Annual Carbon Emissions Reductions (kg CO_2/year) using SAP10.0 carbon factors	9,177
CO_2 Emissions Reduction (%) with SAP10.0	80.8%

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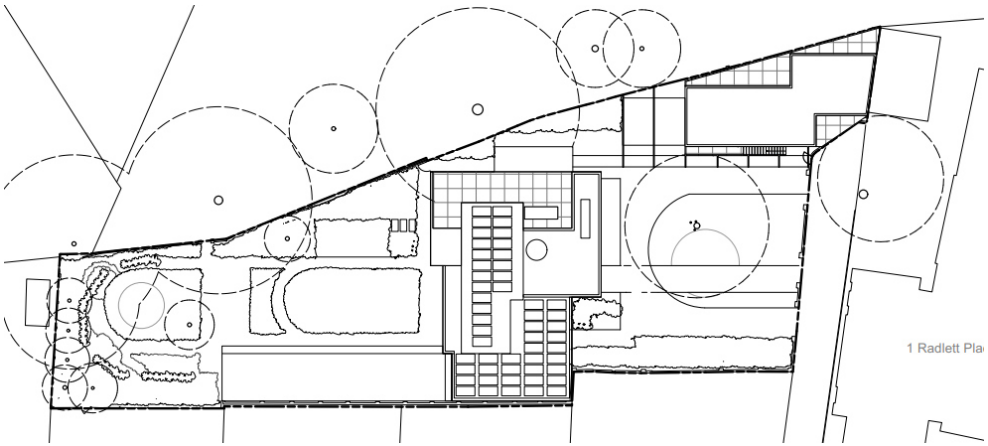
Photovoltaic panels (PV) - Performance

A photovoltaic panel system of 21.58kWp (52 panels of 415 W each) has been specified for the development, a detailed summary of the lifecycle cost, revenue and payback for the photovoltaic panels is presented in this section.

The following drawing shows that there are 195 m^2 of available roof that could be used to install photovoltaic modules and lack of shading. PV panels will be placed with 30° tilt, oriented southwest, covering 104 m^2 of the roof.



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

Capital cost (£)	25,900
Maintenance cost (£)	1,820
Operational cost (£)	900
Total (£)	28,620
Cost of electricity (p/kWh)	17.0
Electricity generation (kWh/yr)	17,768
% of energy used on site	50%
Savings (£)	1,510
Summary	
Cost Performance Criteria	Value
Extra Cost Over Life Cycle (£)	28,620
Predicted Annual Savings (£)	1,988
Payback Period (years)	14.4
Energy and Carbon Performance Criteria	Value
Predicted Annual Energy Saved (kWh/yr)	17,768
Annual Carbon Emissions Reductions (kg CO_2/year) using SAP10.2 carbon factors	2,416
CO_2 Emissions Reduction (%) with SAP10.0	4.0%

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Conclusion

The proposal includes the demolition of an existing three-story dwelling to be replaced by a newly constructed house and ancillary accommodation designed to function together. The new dwelling will feature a shared, partly unheated basement, which serves as both a garage and leisure space. The development is located in the London Borough of Camden with a GIA of approximately 1935 sqm.

The energy demand and CO_2 emissions have been calculated for the above New Construction proposal and CO_2 savings are shown compared to the notional building. Additionally, the New Construction is compared against the Approved Extension scheme (existing building on site, including approved extensions in a previous planning application). These extensions have been approved but haven't been built yet.

The approved extensions are as outlined below:

1. Addition of loft / attic to the rear of the main house (Planning Application Reference: 2022/2773/P)
2. Erection of a two-storey outbuilding with a basement linked to the main house (Planning Application Reference: 2011/5102/P)

Results demonstrate that the proposed New Construction scheme performs better than the Approved Extension scheme (including the existing building and the changes approved in the latest planning applications) in terms of CO2 emissions and energy demand.

Table indicating performance of the three scenarios; the existing dwelling (baseline), Approved Extension (Scenario 1) and New Construction (Scenario 2).

	Baseline Existing Building	Scenario 1 (Approved Extension)	Scenario 2 (New Construction)
Energy demand (kWh/m^2/year)	106.0	40.6	4.40
CO_2/m^2 emissions	22.2	6.3	0.90

According to the assessment, as a result of the retained elements in the Approved Extension scenario, the following applies:

- The air permeability target of the Approved Extension scenario will be higher than in the new build
- The thermal bridging-related heat loss will be higher in the Approved Extension scenario (assuming a default Y-value of 0.2) compared to the New Construction scenario, which benefits from improved psi-values.
- The heat loss through the building fabric will be higher in the Approved Extension scenario due to limitations on achieving lower U-values for the retained elements (limitation on insulation thickness due to condensation risk).
- Lighting energy demand will be higher in the Approved Extension scenario due to a greater Gross Internal Area (GIA) compared to the new built scenario.

Therefore, the New Construction scenario will perform better than the Approved Extension scenario in terms of energy consumption.

Please refer to Appendix A for a more detailed comparison between the existing dwelling (baseline), the Approved Extension (Scenario 1) and New Construction (Scenario 2) scenarios. For all scenarios, the energy demand and CO_2 emissions calculations have followed the GLA's guidance. The main body of the report will present the strategy for the New Construction proposal (Scenario 2).

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

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

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

- An on-site CO2 reduction of 92.9% beyond Building Regulations through energy efficiency measures and inclusion of renewable technologies (Ground Source Heat Pumps and PV panels)
- The development achieves 22.0% CO2 improvement through energy efficiency measures, 'Be Lean' stage
- A further improvement of 70.8% CO2 has been achieved through renewable technologies 'Be Green' stage (Ground Source Heat Pumps and PV panels)
- Zero-carbon target can be achieved through a cash in lieu contribution to the borough's carbon offset fund. The carbon offset payment cost has been calculated as £3,296.
- An overall primary energy reduction of 85.5% is achieved.

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Appendix A
Approved Extension (Scenario 1)

Fabric specification

	Existing building including Approved Extension scheme (Scenario 1)		
Element	Minimum 2021 Building Regulations for new dwellings, U-value W/m^{2}K	Existing Building Baseline U-value W/m^{2}K*	Approved Extension U-value (as per Part L V1 2021) W/m^{2}K
Flat roof – Retained	0.16	0.16	0.16
Flat roof - New	0.16	0.15	0.11
Pitched roof – Retained	0.16	0.16	0.16
Pitched roof – New	0.16	0.15	0.11
Wall – Retained	0.26	0.30	0.30
Wall - New	0.26	0.18	0.12
Exposed floor - New	0.18	0.18	0.11
Basement Floor - New	0.18	0.18	0.11
Windows - New	1.60	1.40	0.85 (g-value of 0.40)
Rooflight - New	2.20	1.40	1.0 (g-value of 0.40)
Rooflight - Retained	2.20	1.40	2.7 (g-value of 0.76)
Air Permeability (m^3/hm^2 @50 Pa)	8.0	Default	7.0

** Existing Building U-value W/m^{2}K*
Newbuilt elements follow Part L 2021's Table 4.2. Limiting U-values for new fabric elements in existing dwellings
Retained elements follow Appendix S: Reduced Data SAP for existing dwellings S. (Age Bande K – 2007-2011)
Please note that the Retained elements U-values cannot be further improved due to risk of interstitial condensation and reduction in floor area.

Building Services Specification for the Approved Extension scheme
Heating: a ground source heat pump (Vaillant flexoTherm or similar) has been specified as the main heating system. Heat will be provided via radiator and underfloor heating and will be controlled via time and temperature zone control by arrangement.

Hot water: Hot water will be provided by the main heating system (Ground Source Heat Hump Vaillant flexoTherm or similar). A hot water cylinder of 400L with a heat loss factor of 2.52 kWh/day will be specified. Moreover, a wastewater heat recovery has been specified for the showers with a heat recovery efficiency of at least 0.615 (Recoup Pipe+ HE or similar).

Mechanical ventilation: Mechanical ventilation with heat recovery has been specified for the scheme (with the same specifications as the proposed new dwelling).

Lighting: High efficiency lighting has been specified for the development with a minimum efficacy of 100 lumens/W.

PV panels: A photovoltaic panel system of 21.58kWp (52 panels of 415 W each) has been specified.

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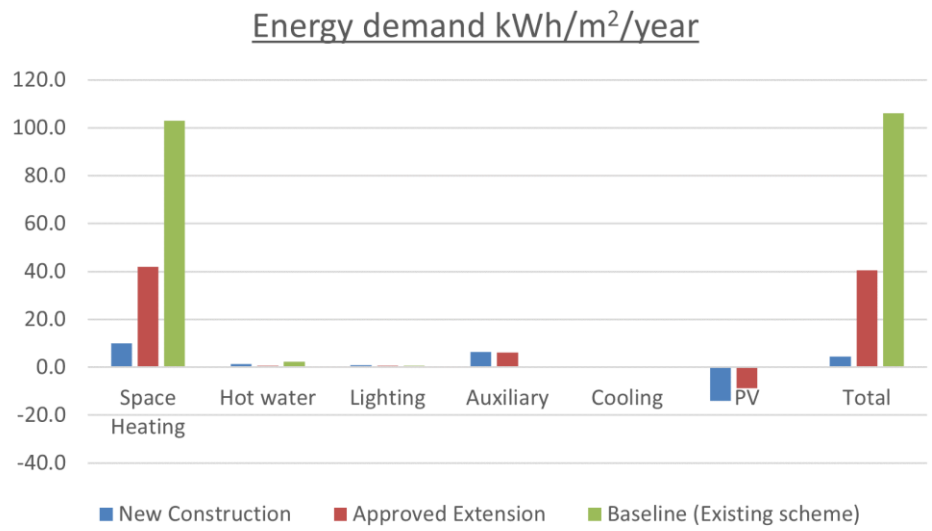
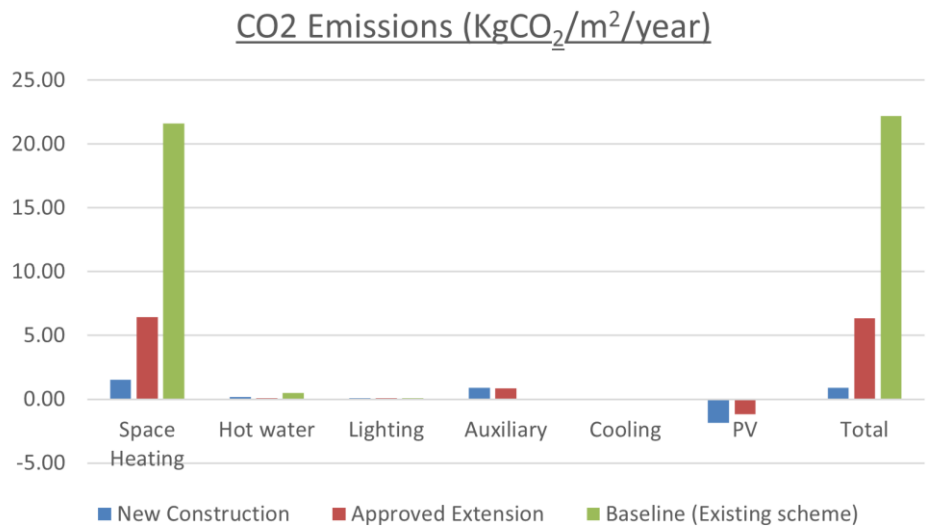
Comparison - Energy demand (kWh/m²/year)

	Space Heating	Hot water	Lighting	Auxiliary	Cooling	PV	Total
Scenario 2 (New Construction)	9.9	1.3	0.8	6.5	0.0	-14.1	4.4
Scenario 1 (Approved Extension)	41.9	0.5	0.6	6.2	0.0	-8.8	40.6
Baseline (Existing scheme)	103.0	2.3	0.7	0.0	0.0	0.0	106.0

Comparison - CO_2 emissions ($kgCO_2/m^2$/year)

	Space Heating	Hot water	Lighting	Auxiliary	Cooling	PV	Total
Scenario 2 (New Construction)	1.55	0.18	0.09	0.91	0.00	-1.8	0.9
Scenario 1 (Approved Extension)	6.46	0.08	0.09	0.87	0.00	-1.2	6.3
Baseline (Existing scheme)	21.64	0.48	0.10	0.01	0.00	0.0	22.2





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Appendix B – SAP files

New Construction scheme (Scenario 2)

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

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

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Baseline – TER from the TER SAP worksheet
Be Lean – DER from the Be Lean scenario DER SAP worksheet

Full SAP Calculation Printout

Property Reference	10605 Main house	**Issued on Date**	19/11/2023
Assessment Reference	Main House - Lean_A	**Prop Type Ref**	Main house
Property	NW8 6BT		

SAP Rating	84 B	**DER**	9.78	**TER**	12.84
Environmental	88 B	**% DER < TER**			23.83
CO_2 Emissions (t/year)	9.65	**DFEE**	56.44	**TFEE**	63.18
Compliance Check	See BREL	**% DFEE < TFEE**			10.68
% DPER < TPER	14.98	**DPER**	58.30	**TPER**	68.57

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

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

---

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	266.3100 (1a)	x	3.5000 (2a)	=	932.0850	(1a) - (3a)
Ground floor	469.8300 (1b)	x	4.2000 (2b)	=	1973.2860	(1b) - (3b)
First floor	357.3200 (1c)	x	3.5000 (2c)	=	1250.6200	(1c) - (3c)
Second floor	67.7400 (1d)	x	2.6000 (2d)	=	176.1240	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1161.2000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	4332.1150	(5)

---

2. Ventilation rate

---

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		2.5000	(17)
Infiltration rate		0.1250	(18)
Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1156	(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	0.1474	0.1445	0.1416	0.1272	0.1243	0.1098	0.1098	0.1070	0.1156	0.1243	0.1301	0.1359	(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) =	81.9000 (23c)

Effective ac	0.2379	0.2350	0.2321	0.2177	0.2148	0.2003	0.2003	0.1975	0.2061	0.2148	0.2206	0.2264	(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	
Doors			3.5200	1.0000	3.5200			(26)
Windows (Uw = 0.85)			291.5300	0.8221	239.6523			(27)
Rooflight			7.4000	0.9615	7.1154			(27a)
Rooflight 2			5.7300	0.9615	5.5096			(27a)
Basement floor			266.3100	0.1100	29.2941			(28)
Ground floor			209.0500	0.1100	22.9955			(28a)
Exposed floor			134.0600	0.1071	14.3519			(28b)
External Wall	984.8100	287.6800	697.1300	0.1200	83.6556			(29a)
Bellow grade wall	177.9300		177.9300	0.1200	21.3516			(29a)
Exposed wall Sheltered	95.6600	7.3700	88.2900	0.1200	10.5948			(29a)
Flat roof	608.8600	13.1300	595.7300	0.1100	65.5303			(30)
Total net area of external elements Aum(A, m2)			2476.6800					(31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 503.5711 (33)

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)	89.8000	0.1500	13.4700
E6	Intermediate floor within a dwelling	46.7500	0.0700	3.2725
E19	Ground floor (inverted)	10.7000	0.1000	1.0700
E20	Exposed floor (normal)	47.6000	0.2000	9.5200
E21	Exposed floor (inverted)	45.0000	0.2000	9.0000
E22	Basement floor	78.1700	0.1500	11.7255
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	5.0000	0.3000	1.5000
E24	Eaves (insulation at ceiling level - inverted)	74.8200	0.1000	7.4820
E14	Flat roof	151.0700	0.1500	22.6605
E15	Flat roof with parapet	85.6900	0.1500	12.8535
E16	Corner (normal)	123.6000	0.0900	11.1240
E17	Corner (inverted - internal area greater than external area)	54.4000	-0.0900	-4.8960
E2	Other lintels (including other steel lintels)	107.0300	0.2000	21.4060
E3	Sill	105.4300	0.0400	4.2172
E4	Jamb	307.3700	0.0500	15.3685
R11	Upstands or kerbs of rooflights	30.8100	0.2000	6.1620

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 145.9357 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 649.5068 (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	340.1326	336.0002	331.8678	311.2056	307.0732	286.4110	286.4110	282.2786	294.6759	307.0732	315.3380	323.6029	(38)
Heat transfer coeff	989.6395	985.5070	981.3746	960.7124	956.5800	935.9179	935.9179	931.7854	944.1827	956.5800	964.8449	973.1097	(39)

Average = Sum(39)m / 12 = 959.6793

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8523	0.8487	0.8451	0.8273	0.8238	0.8060	0.8060	0.8024	0.8131	0.8238	0.8309	0.8380	(40)
HLP (average)												0.8265	
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 4.2515 (42)

Hot water usage for mixer showers

95.5037	94.0685	91.9771	87.9755	85.0225	81.7293	79.8574	81.9330	84.2082	87.7441	91.8316	95.1378	(42a)

Hot water usage for baths

41.1929	40.5812	39.7197	38.1312	36.9418	35.6229	34.9105	35.7660	36.6975	38.1087	39.7299	41.0537	(42b)

Hot water usage for other uses

58.1695	56.0543	53.9390	51.8237	49.7085	47.5932	47.5932	49.7085	51.8237	53.9390	56.0543	58.1695	(42c)

Average daily hot water use (litres/day) 179.1250 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.8662	190.7039	185.6357	177.9305	171.6727	164.9454	162.3612	167.4075	172.7294	179.7918	187.6158	194.3610	(44)
Energy conte	308.6204	271.5598	285.3152	243.5779	231.1045	202.8196	196.3617	207.2854	212.9927	243.9758	267.2931	304.3224	(45)
Energy content (annual)											Total = Sum(45)m =	2975.2286	
Distribution loss (46)m = 0.15 x (45)m	46.2931	40.7340	42.7973	36.5367	34.6657	30.4229	29.4543	31.0928	31.9489	36.5964	40.0940	45.6484	(46)

Water storage loss:

Store volume 300.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.5400 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8316 (55)

Total storage loss	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(56)
If cylinder contains dedicated solar storage	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(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	357.6624	315.8558	334.3572	291.0379	280.1465	250.2796	245.4037	256.3274	260.4527	293.0178	314.7531	353.3644	(62)
WWHRS	-83.0140	-73.4183	-76.8794	-63.6592	-59.3281	-50.7674	-47.5864	-50.6033	-52.5259	-61.9223	-70.1505	-81.4767	(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	274.6484	242.4376	257.4778	227.3788	220.8185	199.5122	197.8174	205.7241	207.9267	231.0955	244.6026	271.8877	(64)
										Total per year (kWh/year) = Sum(64)m =		2781.3272	(64)
12Total per year (kWh/year)												2781	(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	141.8499	125.7304	134.1009	118.9577	116.0759	105.4055	104.5239	108.1560	108.7881	120.3556	126.8429	140.4208	(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	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	505.2767	559.4135	505.2767	522.1192	505.2767	522.1192	505.2767	505.2767	522.1192	505.2767	522.1192	505.2767	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1001.7675	1012.1627	985.9671	930.1998	859.8036	793.6410	749.4404	739.0452	765.2408	821.0081	891.4043	957.5669	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	(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)	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	(71)
Water heating gains (Table 5)	190.6584	187.0989	180.2432	165.2190	156.0159	146.3966	140.4891	145.3710	151.0945	161.7682	176.1708	188.7376	(72)
Total internal gains	1787.4750	1848.4474	1761.2593	1707.3104	1610.8685	1548.9292	1481.9785	1476.4652	1525.2269	1577.8254	1679.4667	1741.3535	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	71.9900	11.2829	0.4000	0.8000	0.7700	180.1265	(75)
Southeast	85.3300	36.7938	0.4000	0.8000	0.7700	696.2416	(77)
Southwest	10.1000	36.7938	0.4000	0.8000	0.7700	82.4099	(79)
Northwest	124.1100	11.2829	0.4000	0.8000	0.7700	310.5363	(81)
Southeast	13.1300	26.0000	0.4000	0.8000	1.0000	98.3174	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	1367.6318	2529.2878	3977.2080	5770.9782	7216.9834	7491.6192	7087.0347	5961.1929	4592.5022	2936.0160	1674.8134	1146.4737	(83)
Total gains	3155.1068	4377.7352	5738.4673	7478.2886	8827.8519	9040.5484	8569.0132	7437.6581	6117.7291	4513.8413	3354.2801	2887.8272	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	81.4831	81.8248	82.1693	83.9366	84.2992	86.1602	86.1602	86.5423	85.4060	84.2992	83.5771	82.8672	
alpha	6.4322	6.4550	6.4780	6.5958	6.6199	6.7440	6.7440	6.7695	6.6937	6.6199	6.5718	6.5245	
util living area	1.0000	0.9998	0.9983	0.9799	0.8721	0.6480	0.4788	0.5704	0.8957	0.9971	0.9999	1.0000	(86)
MIT	19.9728	20.1102	20.3289	20.6368	20.8649	20.9442	20.9528	20.9508	20.8772	20.5520	20.2134	19.9643	(87)
Th 2	20.2083	20.2113	20.2144	20.2297	20.2328	20.2481	20.2481	20.2512	20.2420	20.2328	20.2266	20.2205	(88)
util rest of house	1.0000	0.9998	0.9977	0.9721	0.8323	0.5781	0.3980	0.4807	0.8456	0.9955	0.9999	1.0000	(89)
MIT 2	18.9638	19.1425	19.4254	19.8280	20.0956	20.1833	20.1886	20.1910	20.1232	19.7266	19.2877	18.9629	(90)
Living area fraction									fLA = Living area / (4) =			0.0962	(91)
MIT	19.0608	19.2356	19.5122	19.9058	20.1696	20.2565	20.2621	20.2641	20.1957	19.8060	19.3767	19.0592	(92)
Temperature adjustment												-0.1500	
adjusted MIT	18.9108	19.0856	19.3622	19.7558	20.0196	20.1065	20.1121	20.1141	20.0457	19.6560	19.2267	18.9092	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9996	0.9967	0.9657	0.8197	0.5644	0.3832	0.4639	0.8298	0.9936	0.9998	1.0000	(94)
Useful gains	3154.9689	4376.0633	5719.4594	7221.8825	7235.9542	5102.9271	3283.8640	3450.2883	5076.2541	4484.7549	3353.6299	2887.7600	(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	14459.4140	13979.9970	12622.6724	10429.2770	7958.3425	5153.6338	3287.0304	3460.7389	5613.8036	8662.7496	11700.3656	14313.6742	(97)
Space heating kWh	8410.5071	6453.8434	5135.9905	2309.3240	537.4569	0.0000	0.0000	0.0000	0.0000	3108.4280	6009.6497	8500.8801	(98a)
Space heating requirement - total per year (kWh/year)												40466.0798	
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	8410.5071	6453.8434	5135.9905	2309.3240	537.4569	0.0000	0.0000	0.0000	0.0000	3108.4280	6009.6497	8500.8801	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												40466.0798	
Space heating per m2										(98c) / (4) =		34.8485	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	89.5000 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	8410.5071	6453.8434	5135.9905	2309.3240	537.4569	0.0000	0.0000	0.0000	0.0000	3108.4280	6009.6497	8500.8801	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	9397.2147	7210.9983	5738.5368	2580.2503	600.5105	0.0000	0.0000	0.0000	0.0000	3473.1039	6714.6924	9498.1901	(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	274.6484	242.4376	257.4778	227.3788	220.8185	199.5122	197.8174	205.7241	207.9267	231.0955	244.6026	271.8877	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month	306.8697	270.8800	287.6847	254.0545	246.7245	222.9186	221.0250	229.8593	232.3203	258.2073	273.2990	303.7851	(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	667.1553	602.5918	667.1553	645.6341	667.1553	645.6341	667.1553	667.1553	645.6341	667.1553	645.6341	667.1553	(231)
Lighting	97.6905	78.3710	70.5644	51.6985	39.9334	32.6259	36.4286	47.3513	61.5046	80.6974	91.1475	100.4057	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	45213.4970	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	89.5000	
Water heating fuel used	3107.6281	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)		
mechanical ventilation fans (SFP = 1.4700)	7769.2150	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	7855.2150	(231)
Electricity for lighting (calculated in Appendix L)	788.4187	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	56964.7588	(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	45213.4970	0.2100	9494.8344	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3107.6281	0.2100	652.6019	(264)
Space and water heating			10147.4363	(265)
Pumps, fans and electric keep-hot	7855.2150	0.1387	1089.6152	(267)
Energy for lighting	788.4187	0.1443	113.7932	(268)
Total CO2, kg/year			11350.8446	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			9.7800	(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	45213.4970	1.1300	51091.2516	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3107.6281	1.1300	3511.6198	(278)
Space and water heating			54602.8714	(279)
Pumps, fans and electric keep-hot	7855.2150	1.5128	11883.3693	(281)
Energy for lighting	788.4187	1.5338	1209.3029	(282)
Total Primary energy kWh/year			67695.5436	(286)
Dwelling Primary energy Rate (DPER)			58.3000	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	266.3100 (1a)	x	3.5000 (2a)	=	932.0850	(1a) - (3a)
Ground floor	469.8300 (1b)	x	4.2000 (2b)	=	1973.2860	(1b) - (3b)
First floor	357.3200 (1c)	x	3.5000 (2c)	=	1250.6200	(1c) - (3c)
Second floor	67.7400 (1d)	x	2.6000 (2d)	=	176.1240	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1161.2000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	4332.1150	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0092	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2592	(18)
Number of sides sheltered		1	(19)

Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2398 (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	0.3057	0.2997	0.2937	0.2638	0.2578	0.2278	0.2278	0.2218	0.2398	0.2578	0.2698	0.2818	(22b)
Effective ac	0.5467	0.5449	0.5431	0.5348	0.5332	0.5259	0.5259	0.5246	0.5287	0.5332	0.5364	0.5397	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			3.5200	1.0000	3.5200			(26)
TER Opening Type (Uw = 1.20)			274.4100	1.1450	314.2099			(27)
Rooflight			6.9600	2.0221	14.0735			(27a)
Rooflight 2			5.3900	2.0221	10.8989			(27a)
Basement floor			266.3100	0.1300	34.6203			(28)
Ground floor			209.0500	0.1300	27.1765			(28a)
Exposed floor			134.0600	0.1300	17.4278			(28b)
External Wall	984.8100	270.7900	714.0200	0.1800	128.5236			(29a)
Bellow grade wall	177.9300		177.9300	0.1800	32.0274			(29a)
Exposed wall Sheltered	95.6600	7.1400	88.5200	0.1800	15.9336			(29a)
Flat roof	608.8600	12.3500	596.5100	0.1100	65.6161			(30)
Total net area of external elements Aum(A, m2)			2476.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		664.0277			(33)

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)	89.8000	0.1600	14.3680
E6 Intermediate floor within a dwelling	46.7500	0.0000	0.0000
E19 Ground floor (inverted)	10.7000	0.0700	0.7490
E20 Exposed floor (normal)	47.6000	0.3200	15.2320
E21 Exposed floor (inverted)	45.0000	0.3200	14.4000
E22 Basement floor	78.1700	0.0700	5.4719
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	5.0000	0.0200	0.1000
E24 Eaves (insulation at ceiling level - inverted)	74.8200	0.2400	17.9568
E14 Flat roof	151.0700	0.0800	12.0856
E15 Flat roof with parapet	85.6900	0.5600	47.9864
E16 Corner (normal)	123.6000	0.0900	11.1240
E17 Corner (inverted - internal area greater than external area)	54.4000	-0.0900	-4.8960
E2 Other lintels (including other steel lintels)	107.0300	0.0500	5.3515
E3 Sill	105.4300	0.0500	5.2715
E4 Jamb	307.3700	0.0500	15.3685
R11 Upstands or kerbs of rooflights	30.8100	0.0800	2.4648

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	163.0340	(36)
Point Thermal bridges	(36a) = 0.0000	
Total fabric heat loss	(33) + (36) + (36a) = 827.0617	(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	781.6133	779.0188	776.4757	764.5308	762.2960	751.8924	751.8924	749.9658	755.8997	762.2960	766.8170	771.5436	(38)
Heat transfer coeff	1608.6749	1606.0805	1603.5374	1591.5925	1589.3576	1578.9540	1578.9540	1577.0274	1582.9613	1589.3576	1593.8787	1598.6053	(39)
Average = Sum(39)m / 12 =												1591.5818	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3854	1.3831	1.3809	1.3706	1.3687	1.3598	1.3598	1.3581	1.3632	1.3687	1.3726	1.3767	(40)
HLP (average)												1.3706	
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	4.2515	(42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	95.5037	94.0685	91.9771	87.9755	85.0225	81.7293	79.8574	81.9330	84.2082	87.7441	91.8316	95.1378	(42a)
Hot water usage for baths	41.1929	40.5812	39.7197	38.1312	36.9418	35.6229	34.9105	35.7660	36.6975	38.1087	39.7299	41.0537	(42b)
Hot water usage for other uses	58.1695	56.0543	53.9390	51.8237	49.7085	47.5932	47.5932	49.7085	51.8237	53.9390	56.0543	58.1695	(42c)
Average daily hot water use (litres/day)												179.1250	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.8662	190.7039	185.6357	177.9305	171.6727	164.9454	162.3612	167.4075	172.7294	179.7918	187.6158	194.3610	(44)
Energy conte	308.6204	271.5598	285.3152	243.5779	231.1045	202.8196	196.3617	207.2854	212.9927	243.9758	267.2931	304.3224	(45)
Energy content (annual)										Total = Sum(45)m =		2975.2286	
Distribution loss (46)m = 0.15 x (45)m	46.2931	40.7340	42.7973	36.5367	34.6657	30.4229	29.4543	31.0928	31.9489	36.5964	40.0940	45.6484	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	367.2492	324.5149	343.9440	300.3155	289.7333	259.5572	254.9906	265.9142	269.7302	302.6046	324.0306	362.9512	(62)
WWHRS	-43.6603	-38.6135	-40.4339	-33.4808	-31.2029	-26.7006	-25.0275	-26.6143	-27.6255	-32.5674	-36.8949	-42.8518	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	323.5889	285.9014	303.5102	266.8346	258.5304	232.8566	229.9630	239.3000	242.1048	270.0373	287.1357	320.0994	(64)
									Total per year (kWh/year) = Sum(64)m =			3259.8622	(64)
12Total per year (kWh/year)												3260	(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													
	149.5193	132.6577	141.7704	126.3797	123.7453	112.8276	112.1933	115.8255	116.2101	128.0250	134.2650	148.0902	(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	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	505.2767	559.4135	505.2767	522.1192	505.2767	522.1192	505.2767	505.2767	522.1192	505.2767	522.1192	505.2767	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1001.7675	1012.1627	985.9671	930.1998	859.8036	793.6410	749.4404	739.0452	765.2408	821.0081	891.4043	957.5669	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	(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)													
	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	(71)
Water heating gains (Table 5)													
	200.9668	197.4073	190.5516	175.5274	166.3243	156.7050	150.7975	155.6794	161.4029	172.0766	186.4792	199.0460	(72)
Total internal gains													
	1797.7834	1858.7558	1771.5677	1717.6188	1621.1769	1559.2376	1492.2869	1486.7736	1535.5353	1588.1338	1689.7751	1751.6619	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	67.7600	11.2829	0.6300	0.7000	0.7700	233.6509	(75)
Southeast	80.3100	36.7938	0.6300	0.7000	0.7700	903.0597	(77)
Southwest	9.5100	36.7938	0.6300	0.7000	0.7700	106.9368	(79)
Northwest	116.8300	11.2829	0.6300	0.7000	0.7700	402.8548	(81)
Southeast	12.3500	26.0000	0.6300	0.7000	1.0000	127.4446	(82)

Solar gains	1773.9469	3280.7163	5158.7937	7485.4829	9361.1038	9717.3440	9192.5543	7732.2154	5956.8864	3808.2768	2172.3887	1487.0852	(83)
Total gains	3571.7303	5139.4721	6930.3614	9203.1017	10982.2807	11276.5816	10684.8412	9218.9890	7492.4217	5396.4105	3862.1637	3238.7472	(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	50.1275	50.2085	50.2881	50.6655	50.7368	51.0711	51.0711	51.1335	50.9418	50.7368	50.5929	50.4433	
alpha	4.3418	4.3472	4.3525	4.3777	4.3825	4.4047	4.4047	4.4089	4.3961	4.3825	4.3729	4.3629	
util living area													
	0.9999	0.9993	0.9964	0.9790	0.9124	0.7677	0.6124	0.7066	0.9311	0.9950	0.9996	0.9999	(86)
MIT	18.9380	19.1649	19.5519	20.0905	20.5773	20.8712	20.9640	20.9342	20.6493	20.0092	19.3770	18.9061	(87)
Th 2	19.7746	19.7763	19.7780	19.7859	19.7874	19.7943	19.7943	19.7956	19.7917	19.7874	19.7844	19.7813	(88)
util rest of house													
	0.9998	0.9990	0.9949	0.9696	0.8721	0.6679	0.4627	0.5574	0.8812	0.9919	0.9994	0.9999	(89)
MIT 2	17.3526	17.6447	18.1414	18.8290	19.4142	19.7179	19.7830	19.7709	19.5172	18.7337	17.9222	17.3161	(90)
Living area fraction										fLA = Living area / (4) =		0.0962	(91)
MIT	17.5050	17.7909	18.2770	18.9503	19.5260	19.8288	19.8966	19.8828	19.6260	18.8564	18.0621	17.4690	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5050	17.7909	18.2770	18.9503	19.5260	19.8288	19.8966	19.8828	19.6260	18.8564	18.0621	17.4690	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9996	0.9982	0.9919	0.9602	0.8611	0.6712	0.4764	0.5696	0.8718	0.9879	0.9989	0.9998	(94)
Useful gains	3570.4392	5130.4232	6874.2191	8836.8334	9456.7745	7568.4356	5090.3912	5251.4983	6531.7733	5331.1755	3858.0713	3237.9930	(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													
	21242.6044	20703.8703	18884.9157	15995.9946	12438.3830	8255.9992	5205.1150	5492.4731	8747.4909	13122.3361	17472.2683	21211.8252	(97)
Space heating kWh													
	13148.0909	10465.3565	8935.9583	5154.5961	2218.3167	0.0000	0.0000	0.0000	0.0000	5796.6235	9802.2219	13372.5311	(98a)
Space heating requirement - total per year (kWh/year)												68893.6949	
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													
	13148.0909	10465.3565	8935.9583	5154.5961	2218.3167	0.0000	0.0000	0.0000	0.0000	5796.6235	9802.2219	13372.5311	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												68893.6949	
Space heating per m2											(98c) / (4) =	59.3297	(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													
	13148.0909	10465.3565	8935.9583	5154.5961	2218.3167	0.0000	0.0000	0.0000	0.0000	5796.6235	9802.2219	13372.5311	(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)													
	14244.9522	11338.4144	9681.4282	5584.6111	2403.3767	0.0000	0.0000	0.0000	0.0000	6280.1988	10619.9587	14488.1161	(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												
	323.5889	285.9014	303.5102	266.8346	258.5304	232.8566	229.9630	239.3000	242.1048	270.0373	287.1357	320.0994 (64)
Efficiency of water heater												79.8000 (216)
(217)m	88.5601	88.5345	88.4722	88.3098	87.7668	79.8000	79.8000	79.8000	79.8000	88.3564	88.5159	88.5665 (217)
Fuel for water heating, kWh/month												
	365.3891	322.9266	343.0570	302.1575	294.5651	291.8003	288.1742	299.8746	303.3894	305.6226	324.3889	361.4227 (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	104.9865	84.2241	75.8344	55.5596	42.9158	35.0626	39.1492	50.8877	66.0980	86.7242	97.9548	107.9044 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-221.1332	-298.4894	-410.5758	-440.3960	-456.6810	-418.6252	-412.0574	-396.8270	-368.8832	-329.4226	-237.7185	-192.6449 (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	-168.7971	-348.9222	-682.9970	-1011.5341	-1324.7584	-1327.6580	-1313.3353	-1118.9511	-828.6023	-495.7859	-224.1579	-134.0855 (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	74641.0562 (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	3802.7680 (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)	847.3013 (232)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV generation	-13163.0390 (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	66214.0865 (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	74641.0562	0.2100	15674.6218	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3802.7680	0.2100	798.5813	(264)
Space and water heating			16473.2031	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	847.3013	0.1443	122.2918	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4183.4543	0.1356	-567.3995	
PV Unit electricity exported	-8979.5847	0.1263	-1134.0457	
Total			-1701.4452	(269)
Total CO2, kg/year			14905.9789	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			12.8400	(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	74641.0562	1.1300	84344.3935	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3802.7680	1.1300	4297.1278	(278)
Space and water heating			88641.5214	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	847.3013	1.5338	1299.6190	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4183.4543	1.5013	-6280.7101	
PV Unit electricity exported	-8979.5847	0.4636	-4162.8691	
Total			-10443.5792	(283)
Total Primary energy kWh/year			79627.6620	(286)
Target Primary Energy Rate (TPER)			68.5700	(287)

Full SAP Calculation Printout

Property Reference	10605 Staff house	**Issued on Date**	19/11/2023
Assessment Reference	Staff House - Lean_A	**Prop Type Ref**	Main house
Property	NW8 6BT		

SAP Rating	83 B	**DER**	13.56	**TER**	13.83
Environmental	88 B	**% DER < TER**			1.95
CO_2 Emissions (t/year)	1.12	**DFEE**	58.52	**TFEE**	68.75
Compliance Check	See BREL	**% DFEE < TFEE**			14.88
% DPER < TPER	-5.56	**DPER**	78.68	**TPER**	74.54

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	96.4600	(1b)	x 3.5000	(2b) =	337.6100	(1b) - (3b) (4)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	96.4600					
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		337.6100	(5)

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2. Ventilation rate

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

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		2.5000 (17)
Infiltration rate		0.1250 (18)
Number of sides sheltered		1 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1156 (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	0.1474	0.1445	0.1416	0.1272	0.1243	0.1098	0.1098	0.1070	0.1156	0.1243	0.1301	0.1359	(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) =		81.0000 (23c)

Effective ac	0.2424	0.2395	0.2366	0.2222	0.2193	0.2048	0.2048	0.2020	0.2106	0.2193	0.2251	0.2309	(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	
Windows (Uw = 0.85)			23.7400	0.8221	19.5155			(27)
Exposed floor			96.4600	0.1071	10.3266			(28b)
External Wall	167.4800	23.7400	143.7400	0.1200	17.2488			(29a)
Flat roof	96.4600		96.4600	0.1100	10.6106			(30)
Total net area of external elements Aum(A, m2)			360.4000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	57.7015			(33)

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

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E20 Exposed floor (normal)	47.8500	0.2000	9.5700
E14 Flat roof	47.8500	0.1500	7.1775
E16 Corner (normal)	24.5000	0.0900	2.2050
E17 Corner (inverted - internal area greater than external area)	7.0000	-0.0900	-0.6300
E2 Other lintels (including other steel lintels)	10.3200	0.2000	2.0640

E3 Sill									10.3200	0.0400	0.4128		
E4 Jamb									36.8000	0.0500	1.8400		
Thermal bridges (Sum(L x Psi) calculated using Appendix K)												22.6393	(36)
Point Thermal bridges											(36a) =	0.0000	
Total fabric heat loss										(33) + (36) + (36a) =		80.3408	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	27.0085	26.6865	26.3644	24.7542	24.4321	22.8219	22.8219	22.4999	23.4660	24.4321	25.0762	25.7203	(38)
Heat transfer coeff	107.3493	107.0273	106.7052	105.0950	104.7729	103.1627	103.1627	102.8407	103.8068	104.7729	105.4170	106.0611	(39)
Average = Sum(39)m / 12 =												105.0145	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1129	1.1096	1.1062	1.0895	1.0862	1.0695	1.0695	1.0661	1.0762	1.0862	1.0929	1.0995	(40)
HLP (average)												1.0887	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.7042	(42)
Hot water usage for mixer showers	89.3668	88.0238	86.0668	82.3223	79.5591	76.4775	74.7259	76.6681	78.7971	82.1058	85.9307	89.0244	(42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Hot water usage for other uses	42.3242	40.7852	39.2461	37.7070	36.1680	34.6289	34.6289	36.1680	37.7070	39.2461	40.7852	42.3242	(42c)
Average daily hot water use (litres/day)												120.8698	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.6910	128.8089	125.3128	120.0294	115.7270	111.1064	109.3548	112.8361	116.5042	121.3519	126.7158	131.3486	(44)
Energy conte	208.5664	183.4222	192.6012	164.3142	155.7908	136.6182	132.2551	139.7146	143.6613	164.6734	180.5299	205.6602	(45)
Energy content (annual)										Total = Sum(45)m =		2007.8076	
Distribution loss (46)m = 0.15 x (45)m	31.2850	27.5133	28.8902	24.6471	23.3686	20.4927	19.8383	20.9572	21.5492	24.7010	27.0795	30.8490	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5400	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8316	(55)
Total storage loss	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(56)
If cylinder contains dedicated solar storage	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(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	257.6084	227.7182	241.6432	211.7742	204.8328	184.0782	181.2971	188.7566	191.1213	213.7154	227.9899	254.7022	(62)
WWHRS	-77.6796	-68.7005	-71.9392	-59.5685	-55.5157	-47.5052	-44.5285	-47.3516	-49.1507	-57.9433	-65.6427	-76.2411	(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	179.9287	159.0177	169.7040	152.2057	149.3171	136.5730	136.7686	141.4050	141.9706	155.7721	162.3472	178.4611	(64)
										Total per year (kWh/year) = Sum(64)m =		1863.4708	(64)
12Total per year (kWh/year)												1863	(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	108.5819	96.4247	103.2735	92.6025	91.0340	83.3936	83.2084	85.6887	85.7354	93.9875	97.9942	107.6156	(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	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	126.3356	139.8716	126.3356	130.5468	126.3356	130.5468	126.3356	126.3356	130.5468	126.3356	130.5468	126.3356	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	250.4746	253.0737	246.5239	232.5803	214.9789	198.4361	187.3845	184.7854	191.3352	205.2788	222.8802	239.4230	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	(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)	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	(71)
Water heating gains (Table 5)	145.9434	143.4891	138.8085	128.6145	122.3576	115.8244	111.8393	115.1730	119.0769	126.3273	136.1031	144.6446	(72)
Total internal gains	589.3174	602.9982	578.2318	558.3054	530.2359	508.3711	489.1232	489.8578	504.5226	524.5055	556.0938	576.9670	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	21.9000	11.2829	0.4000	0.8000	0.7700	54.7961	(75)
Southwest	1.8400	36.7938	0.4000	0.8000	0.7700	15.0133	(79)

Solar gains	69.8094	137.1122	235.9483	373.3853	492.1868	521.1619	488.9164	395.3112	282.7575	164.5734	86.9301	57.5975	(83)
Total gains	659.1268	740.1104	814.1800	931.6908	1022.4227	1029.5330	978.0396	885.1690	787.2801	689.0789	643.0239	634.5645	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.4001	62.5879	62.7768	63.7386	63.9346	64.9325	64.9325	65.1358	64.5296	63.9346	63.5439	63.1580	
alpha	5.1600	5.1725	5.1851	5.2492	5.2623	5.3288	5.3288	5.3424	5.3020	5.2623	5.2363	5.2105	
util living area	0.9964	0.9928	0.9827	0.9390	0.8194	0.6184	0.4599	0.5255	0.7990	0.9650	0.9924	0.9970	(86)
MIT	19.9867	20.1102	20.3125	20.6066	20.8259	20.9218	20.9384	20.9353	20.8679	20.5830	20.2442	19.9738	(87)
Th 2	19.9903	19.9930	19.9958	20.0094	20.0121	20.0258	20.0258	20.0286	20.0203	20.0121	20.0067	20.0012	(88)
util rest of house	0.9952	0.9904	0.9767	0.9183	0.7662	0.5338	0.3603	0.4191	0.7223	0.9489	0.9895	0.9960	(89)
MIT 2	18.8059	18.9654	19.2239	19.5962	19.8418	19.9402	19.9501	19.9518	19.8956	19.5770	19.1479	18.7981	(90)
Living area fraction										fLA = Living area / (4) =		0.2168	(91)
MIT	19.0619	19.2136	19.4598	19.8152	20.0551	20.1530	20.1643	20.1650	20.1063	19.7951	19.3855	19.0530	(92)
Temperature adjustment												-0.1500	
adjusted MIT	18.9119	19.0636	19.3098	19.6652	19.9051	20.0030	20.0143	20.0150	19.9563	19.6451	19.2355	18.9030	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9934	0.9873	0.9713	0.9094	0.7597	0.5318	0.3591	0.4176	0.7166	0.9410	0.9862	0.9945	(94)
Useful gains	654.7475	730.7127	790.8041	847.2690	776.7095	547.4636	351.2536	369.6643	564.1823	648.3944	634.1810	631.0765	(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	1568.5723	1515.8893	1366.8780	1131.3723	859.6766	557.3850	352.2311	371.7666	607.9266	947.6799	1279.2925	1559.4164	(97)
Space heating kWh	679.8857	527.6386	428.5990	204.5543	61.7275	0.0000	0.0000	0.0000	0.0000	222.6684	464.4803	690.6849	(98a)
Space heating requirement - total per year (kWh/year)												3280.2386	
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	679.8857	527.6386	428.5990	204.5543	61.7275	0.0000	0.0000	0.0000	0.0000	222.6684	464.4803	690.6849	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3280.2386	
Space heating per m2											(98c) / (4) =	34.0062	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	89.5000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	679.8857	527.6386	428.5990	204.5543	61.7275	0.0000	0.0000	0.0000	0.0000	222.6684	464.4803	690.6849	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	759.6488	589.5404	478.8815	228.5523	68.9693	0.0000	0.0000	0.0000	0.0000	248.7915	518.9724	771.7150	(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	179.9287	159.0177	169.7040	152.2057	149.3171	136.5730	136.7686	141.4050	141.9706	155.7721	162.3472	178.4611	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month	201.0377	177.6734	189.6134	170.0622	166.8347	152.5956	152.8141	157.9944	158.6263	174.0471	181.3936	199.3978	(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	44.5249	40.2160	44.5249	43.0886	44.5249	43.0886	44.5249	44.5249	43.0886	44.5249	43.0886	44.5249	(231)
Lighting	24.4258	19.5953	17.6434	12.9263	9.9847	8.1575	9.1083	11.8394	15.3782	20.1770	22.7898	25.1047	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	3665.0711	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	89.5000	
Water heating fuel used	2082.0903	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.0640)		
mechanical ventilation fans (SFP = 1.0640)	438.2448	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	524.2448	(231)
Electricity for lighting (calculated in Appendix L)	197.1304	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)

Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	6468.5366	(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	3665.0711	0.2100	769.6649	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2082.0903	0.2100	437.2390	(264)
Space and water heating			1206.9039	(265)
Pumps, fans and electric keep-hot	524.2448	0.1387	72.7192	(267)
Energy for lighting	197.1304	0.1443	28.4520	(268)
Total CO2, kg/year			1308.0751	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			13.5600	(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	3665.0711	1.1300	4141.5304	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2082.0903	1.1300	2352.7621	(278)
Space and water heating			6494.2924	(279)
Pumps, fans and electric keep-hot	524.2448	1.5128	793.0775	(281)
Energy for lighting	197.1304	1.5338	302.3652	(282)
Total Primary energy kWh/year			7589.7351	(286)
Dwelling Primary energy Rate (DPER)			78.6800	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	96.4600	(1b)	x 3.5000	(2b) =	337.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	96.4600					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		337.6100	(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) = 0.0889	(8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.3389	(18)
Number of sides sheltered	1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.9250	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3134	(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	0.3996	0.3918	0.3840	0.3448	0.3370	0.2978	0.2978	0.2899	0.3134	0.3370	0.3526	0.3683	(22b)
Effective ac	0.5799	0.5768	0.5737	0.5594	0.5568	0.5443	0.5443	0.5420	0.5491	0.5568	0.5622	0.5678	(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 Opening Type (Uw = 1.20)			23.7400	1.1450	27.1832			(27)
Exposed floor			96.4600	0.1300	12.5398			(28b)
External Wall	167.4800	23.7400	143.7400	0.1800	25.8732			(29a)
Flat roof	96.4600		96.4600	0.1100	10.6106			(30)
Total net area of external elements Aum(A, m2)			360.4000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		76.2068			(33)

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

	Length	Psi-value	Total
K1 Element			
E20 Exposed floor (normal)	47.8500	0.3200	15.3120
E14 Flat roof	47.8500	0.0800	3.8280
E16 Corner (normal)	24.5000	0.0900	2.2050
E17 Corner (inverted - internal area greater than external area)	7.0000	-0.0900	-0.6300
E2 Other lintels (including other steel lintels)	10.3200	0.0500	0.5160
E3 Sill	10.3200	0.0500	0.5160
E4 Jamb	36.8000	0.0500	1.8400

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 23.5870 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 99.7938 (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	64.6026	64.2572	63.9185	62.3279	62.0304	60.6450	60.6450	60.3885	61.1786	62.0304	62.6324	63.2618	(38)
Heat transfer coeff	164.3965	164.0510	163.7123	162.1218	161.8242	160.4388	160.4388	160.1823	160.9724	161.8242	162.4262	163.0556	(39)

Average = Sum(39)m / 12 = 162.1203

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.7043	1.7007	1.6972	1.6807	1.6776	1.6633	1.6633	1.6606	1.6688	1.6776	1.6839	1.6904	(40)
HLP (average)												1.6807	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.7042 (42)
Hot water usage for mixer showers

89.3668	88.0238	86.0668	82.3223	79.5591	76.4775	74.7259	76.6681	78.7971	82.1058	85.9307	89.0244	(42a)

Hot water usage for baths

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)

Hot water usage for other uses

42.3242	40.7852	39.2461	37.7070	36.1680	34.6289	34.6289	36.1680	37.7070	39.2461	40.7852	42.3242	(42c)

Average daily hot water use (litres/day) 120.8698 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.6910	128.8089	125.3128	120.0294	115.7270	111.1064	109.3548	112.8361	116.5042	121.3519	126.7158	131.3486	(44)
Energy conte	208.5664	183.4222	192.6012	164.3142	155.7908	136.6182	132.2551	139.7146	143.6613	164.6734	180.5299	205.6602	(45)

Energy content (annual) Total = Sum(45)m = 2007.8076
Distribution loss (46)m = 0.15 x (45)m

31.2850	27.5133	28.8902	24.6471	23.3686	20.4927	19.8383	20.9572	21.5492	24.7010	27.0795	30.8490	(46)

Water storage loss:
Store volume 300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 2.1127 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 1.1409 (55)
Total storage loss

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

If cylinder contains dedicated solar storage

35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss 23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Total heat required for water heating calculated for each month

267.1952	236.3773	251.2300	221.0518	214.4196	193.3558	190.8840	198.3434	200.3988	223.3022	237.2675	264.2890	(62)
WWHRS -40.8548	-36.1323	-37.8357	-31.3294	-29.1979	-24.9848	-23.4193	-24.9041	-25.8503	-30.4746	-34.5241	-40.0982	(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

226.3404	200.2450	213.3943	189.7224	185.2217	168.3710	167.4646	173.4393	174.5486	192.8276	202.7434	224.1908	(64)

Total per year (kWh/year) = Sum(64)m = 2318.5092 (64)
12Total per year (kWh/year) 2319 (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

116.2514	103.3519	110.9429	100.0245	98.7035	90.8156	90.8779	93.3582	93.1574	101.6570	105.4162	115.2851	(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	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	126.3356	139.8716	126.3356	130.5468	126.3356	130.5468	126.3356	126.3356	130.5468	126.3356	130.5468	126.3356	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	250.4746	253.0737	246.5239	232.5803	214.9789	198.4361	187.3845	184.7854	191.3352	205.2788	222.8802	239.4230	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	(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)	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	(71)
Water heating gains (Table 5)	156.2518	153.7975	149.1169	138.9229	132.6660	126.1328	122.1477	125.4814	129.3853	136.6357	146.4115	154.9530	(72)
Total internal gains	599.6258	613.3066	588.5402	568.6138	540.5443	518.6795	499.4316	500.1662	514.8310	534.8139	566.4022	587.2754	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	21.9000	11.2829	0.6300	0.7000	0.7700	75.5159	(75)
Southwest	1.8400	36.7938	0.6300	0.7000	0.7700	20.6902	(79)

Solar gains	96.2061	188.9578	325.1662	514.5717	678.2949	718.2262	673.7879	544.7883	389.6752	226.8027	119.8006	79.3766	(83)
Total gains	695.8319	802.2644	913.7064	1083.1855	1218.8393	1236.9058	1173.2195	1044.9545	904.5062	761.6166	686.2028	666.6519	(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	40.7467	40.8325	40.9170	41.3184	41.3944	41.7518	41.7518	41.8187	41.6134	41.3944	41.2410	41.0818	
alpha	3.7164	3.7222	3.7278	3.7546	3.7596	3.7835	3.7835	3.7879	3.7742	3.7596	3.7494	3.7388	
util living area	0.9954	0.9917	0.9823	0.9488	0.8642	0.7119	0.5633	0.6370	0.8631	0.9716	0.9920	0.9962	(86)
MIT	18.9279	19.1359	19.5081	20.0536	20.5421	20.8513	20.9542	20.9276	20.6649	20.0439	19.4027	18.9004	(87)
Th 2	19.5378	19.5403	19.5428	19.5547	19.5569	19.5673	19.5673	19.5692	19.5633	19.5569	19.5524	19.5477	(88)
util rest of house	0.9938	0.9887	0.9754	0.9274	0.8063	0.5948	0.3977	0.4691	0.7793	0.9557	0.9885	0.9948	(89)
MIT 2	17.1888	17.4556	17.9296	18.6149	19.1813	19.4875	19.5549	19.5464	19.3358	18.6182	17.8053	17.1598	(90)
Living area fraction										fLA = Living area / (4) =		0.2168	(91)
MIT	17.5658	17.8198	18.2718	18.9267	19.4762	19.7831	19.8583	19.8458	19.6239	18.9272	18.1516	17.5371	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5658	17.8198	18.2718	18.9267	19.4762	19.7831	19.8583	19.8458	19.6239	18.9272	18.1516	17.5371	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9902	0.9831	0.9665	0.9150	0.8023	0.6146	0.4337	0.5049	0.7837	0.9455	0.9830	0.9916	(94)
Useful gains	689.0118	788.7206	883.0588	991.1031	977.8998	760.2232	508.8511	527.5969	708.9021	720.1117	674.5633	661.0716	(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	2180.8507	2119.5133	1927.1818	1625.5530	1258.3831	831.5719	522.7510	551.9527	889.2034	1347.5456	1795.0642	2174.6908	(97)
Space heating kWh	1109.9282	894.2927	776.8275	456.8039	208.6796	0.0000	0.0000	0.0000	0.0000	466.8108	806.7606	1126.1327	(98a)
Space heating requirement - total per year (kWh/year)												5846.2361	
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	1109.9282	894.2927	776.8275	456.8039	208.6796	0.0000	0.0000	0.0000	0.0000	466.8108	806.7606	1126.1327	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												5846.2361	
Space heating per m2											(98c) / (4) =	60.6079	(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	1109.9282	894.2927	776.8275	456.8039	208.6796	0.0000	0.0000	0.0000	0.0000	466.8108	806.7606	1126.1327	(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)	1202.5224	968.8978	841.6333	494.9122	226.0884	0.0000	0.0000	0.0000	0.0000	505.7539	874.0635	1220.0787	(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	226.3404	200.2450	213.3943	189.7224	185.2217	168.3710	167.4646	173.4393	174.5486	192.8276	202.7434	224.1908	(64)
Efficiency of water heater												79.8000	(216)
(217)m	87.1354	87.0048	86.6930	85.9552	84.3279	79.8000	79.8000	79.8000	79.8000	85.9658	86.8332	87.1678	(217)
Fuel for water heating, kWh/month	259.7571	230.1540	246.1496	220.7222	219.6448	210.9912	209.8554	217.3425	218.7325	224.3073	233.4861	257.1945	(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	26.2501	21.0588	18.9611	13.8917	10.7304	8.7668	9.7886	12.7236	16.5267	21.6839	24.4919	26.9796	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-72.5681	-94.4876	-125.5626	-130.1893	-131.7774	-120.0188	-118.4299	-115.7559	-110.1864	-102.3517	-76.8942	-63.6916	(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	-68.6683	-140.0110	-270.5398	-395.7135	-513.4768	-512.5014	-506.5237	-433.2732	-323.5542	-196.5466	-90.4018	-54.6533	(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 6333.9503 (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 2748.3373 (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) 211.8530 (232)

Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-4767.7772	(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	4612.3633	(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	6333.9503	0.2100	1330.1296	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2748.3373	0.2100	577.1508	(264)
Space and water heating			1907.2804	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	211.8530	0.1443	30.5769	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1261.9135	0.1363	-172.0373	
PV Unit electricity exported	-3505.8637	0.1267	-444.1670	
Total			-616.2043	(269)
Total CO2, kg/year			1333.5823	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			13.8300	(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	6333.9503	1.1300	7157.3638	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2748.3373	1.1300	3105.6211	(278)
Space and water heating			10262.9849	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	211.8530	1.5338	324.9471	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1261.9135	1.5039	-1897.8535	
PV Unit electricity exported	-3505.8637	0.4651	-1630.5201	
Total			-3528.3736	(283)
Total Primary energy kWh/year			7189.6593	(286)
Target Primary Energy Rate (TPER)			74.5400	(287)

Energy Assessment
Radlett House

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

Full SAP Calculation Printout

Property Reference	10605 Main house Green	**Issued on Date**	19/11/2023
Assessment Reference	Main House - Green_A	**Prop Type Ref**	Main house
Property	NW8 6BT		

SAP Rating	95 A	**DER**	0.96	**TER**	12.85
Environmental	99 A	**% DER < TER**			92.53
CO_2 Emissions (t/year)	0.7	**DFEE**	56.44	**TFEE**	63.18
Compliance Check	See BREL	**% DFEE < TFEE**			10.68
% DPER < TPER	85.51	**DPER**	9.95	**TPER**	68.63

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	266.3100	(1a)	x 3.5000	(2a) =	932.0850	(1a) - (3a)
Ground floor	469.8300	(1b)	x 4.2000	(2b) =	1973.2860	(1b) - (3b)
First floor	357.3200	(1c)	x 3.5000	(2c) =	1250.6200	(1c) - (3c)
Second floor	67.7400	(1d)	x 2.6000	(2d) =	176.1240	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1161.2000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	4332.1150	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		2.5000	(17)
Infiltration rate		0.1250	(18)
Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1156	(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	0.1474	0.1445	0.1416	0.1272	0.1243	0.1098	0.1098	0.1070	0.1156	0.1243	0.1301	0.1359	(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) =	81.9000	(23c)

Effective ac	0.2379	0.2350	0.2321	0.2177	0.2148	0.2003	0.2003	0.1975	0.2061	0.2148	0.2206	0.2264	(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	
Doors			3.5200	1.0000	3.5200			(26)
Windows (Uw = 0.85)			291.5300	0.8221	239.6523			(27)
Rooflight			7.4000	0.9615	7.1154			(27a)
Rooflight 2			5.7300	0.9615	5.5096			(27a)
Basement floor			266.3100	0.1100	29.2941			(28)
Ground floor			209.0500	0.1100	22.9955			(28a)
Exposed floor			134.0600	0.1071	14.3519			(28b)
External Wall	984.8100	287.6800	697.1300	0.1200	83.6556			(29a)
Bellow grade wall	177.9300		177.9300	0.1200	21.3516			(29a)
Exposed wall Sheltered	95.6600	7.3700	88.2900	0.1200	10.5948			(29a)
Flat roof	608.8600	13.1300	595.7300	0.1100	65.5303			(30)
Total net area of external elements Aum(A, m2)			2476.6800					(31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 503.5711 (33)

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)	89.8000	0.1500	13.4700
E6	Intermediate floor within a dwelling	46.7500	0.0700	3.2725
E19	Ground floor (inverted)	10.7000	0.1000	1.0700
E20	Exposed floor (normal)	47.6000	0.2000	9.5200
E21	Exposed floor (inverted)	45.0000	0.2000	9.0000
E22	Basement floor	78.1700	0.1500	11.7255
E23	Balcony within or between dwellings, balcony support penetrates wall insulation	5.0000	0.3000	1.5000
E24	Eaves (insulation at ceiling level - inverted)	74.8200	0.1000	7.4820
E14	Flat roof	151.0700	0.1500	22.6605
E15	Flat roof with parapet	85.6900	0.1500	12.8535
E16	Corner (normal)	123.6000	0.0900	11.1240
E17	Corner (inverted - internal area greater than external area)	54.4000	-0.0900	-4.8960
E2	Other lintels (including other steel lintels)	107.0300	0.2000	21.4060
E3	Sill	105.4300	0.0400	4.2172
E4	Jamb	307.3700	0.0500	15.3685
R11	Upstands or kerbs of rooflights	30.8100	0.2000	6.1620

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 145.9357 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 649.5068 (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	340.1326	336.0002	331.8678	311.2056	307.0732	286.4110	286.4110	282.2786	294.6759	307.0732	315.3380	323.6029	(38)
Heat transfer coeff	989.6395	985.5070	981.3746	960.7124	956.5800	935.9179	935.9179	931.7854	944.1827	956.5800	964.8449	973.1097	(39)

Average = Sum(39)m / 12 = 959.6793

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.8523	0.8487	0.8451	0.8273	0.8238	0.8060	0.8060	0.8024	0.8131	0.8238	0.8309	0.8380	(40)
HLP (average)												0.8265	
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 4.2515 (42)

Hot water usage for mixer showers

95.5037	94.0685	91.9771	87.9755	85.0225	81.7293	79.8574	81.9330	84.2082	87.7441	91.8316	95.1378	(42a)

Hot water usage for baths

41.1929	40.5812	39.7197	38.1312	36.9418	35.6229	34.9105	35.7660	36.6975	38.1087	39.7299	41.0537	(42b)

Hot water usage for other uses

58.1695	56.0543	53.9390	51.8237	49.7085	47.5932	47.5932	49.7085	51.8237	53.9390	56.0543	58.1695	(42c)

Average daily hot water use (litres/day) 179.1250 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.8662	190.7039	185.6357	177.9305	171.6727	164.9454	162.3612	167.4075	172.7294	179.7918	187.6158	194.3610	(44)
Energy conte	308.6204	271.5598	285.3152	243.5779	231.1045	202.8196	196.3617	207.2854	212.9927	243.9758	267.2931	304.3224	(45)
Energy content (annual)										Total = Sum(45)m =		2975.2286	
Distribution loss (46)m = 0.15 x (45)m	46.2931	40.7340	42.7973	36.5367	34.6657	30.4229	29.4543	31.0928	31.9489	36.5964	40.0940	45.6484	(46)

Water storage loss:

Store volume 400.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 2.5200 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.3608 (55)

Total storage loss	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(56)
If cylinder contains dedicated solar storage	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(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	374.0676	330.6734	350.7624	306.9139	296.5517	266.1556	261.8089	272.7326	276.3287	309.4230	330.6291	369.7696	(62)
WWHRS	-83.0140	-73.4183	-76.8794	-63.6592	-59.3281	-50.7674	-47.5864	-50.6033	-52.5259	-61.9223	-70.1505	-81.4767	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	291.0536	257.2552	273.8830	243.2548	237.2237	215.3882	214.2226	222.1293	223.8027	247.5007	260.4786	288.2929	(64)
										Total per year (kWh/year) = Sum(64)m =		2974.4852	(64)
12Total per year (kWh/year)												2974	(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	154.9740	137.5845	147.2251	131.6585	129.2000	118.1063	117.6480	121.2802	121.4889	133.4797	139.5437	153.5449	(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	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	505.2767	559.4135	505.2767	522.1192	505.2767	522.1192	505.2767	505.2767	522.1192	505.2767	522.1192	505.2767	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1001.7675	1012.1627	985.9671	930.1998	859.8036	793.6410	749.4404	739.0452	765.2408	821.0081	891.4043	957.5669	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	(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)	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	(71)
Water heating gains (Table 5)	208.2984	204.7389	197.8832	182.8590	173.6559	164.0366	158.1291	163.0110	168.7345	179.4082	193.8108	206.3776	(72)
Total internal gains	1802.1150	1863.0874	1775.8993	1721.9504	1625.5085	1566.5692	1499.6185	1494.1052	1542.8669	1592.4654	1694.1067	1755.9935	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	71.9900	11.2829	0.4000	0.8000	0.7700	180.1265	(75)
Southeast	85.3300	36.7938	0.4000	0.8000	0.7700	696.2416	(77)
Southwest	10.1000	36.7938	0.4000	0.8000	0.7700	82.4099	(79)
Northwest	124.1100	11.2829	0.4000	0.8000	0.7700	310.5363	(81)
Southeast	13.1300	26.0000	0.4000	0.8000	1.0000	98.3174	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	1367.6318	2529.2878	3977.2080	5770.9782	7216.9834	7491.6192	7087.0347	5961.1929	4592.5022	2936.0160	1674.8134	1146.4737	(83)
Total gains	3169.7468	4392.3752	5753.1073	7492.9286	8842.4919	9058.1884	8586.6532	7455.2981	6135.3691	4528.4813	3368.9201	2902.4672	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	81.4831	81.8248	82.1693	83.9366	84.2992	86.1602	86.1602	86.5423	85.4060	84.2992	83.5771	82.8672	
alpha	6.4322	6.4550	6.4780	6.5958	6.6199	6.7440	6.7440	6.7695	6.6937	6.6199	6.5718	6.5245	
util living area													
	1.0000	0.9998	0.9983	0.9797	0.8714	0.6469	0.4778	0.5691	0.8946	0.9970	0.9999	1.0000	(86)
Living	19.9739	20.1112	20.3299	20.6377	20.8654	20.9443	20.9528	20.9509	20.8779	20.5531	20.2145	19.9653	
Non living	18.9651	19.1439	19.4267	19.8292	20.0961	20.1834	20.1886	20.1911	20.1238	19.7279	19.2890	18.9643	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	19	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	12	28	26	0	0	0	0	0	0	0	0	31	
MIT	20.7750	20.4966	20.5736	20.6377	20.8654	20.9443	20.9528	20.9509	20.8779	20.5531	20.2145	20.4140	(87)
Th 2	20.2083	20.2113	20.2144	20.2297	20.2328	20.2481	20.2481	20.2512	20.2420	20.2328	20.2266	20.2205	(88)
util rest of house													
	1.0000	0.9998	0.9977	0.9718	0.8315	0.5771	0.3972	0.4796	0.8442	0.9954	0.9999	1.0000	(89)
MIT 2	19.9959	19.7402	19.7958	19.8292	20.0961	20.1834	20.1886	20.1911	20.1238	19.7279	19.2890	19.6660	(90)
Living area fraction										fLA = Living area / (4) =		0.0962	(91)
MIT	20.0708	19.8129	19.8706	19.9069	20.1700	20.2566	20.2621	20.2641	20.1963	19.8073	19.3780	19.7380	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.0708	19.8129	19.8706	19.9069	20.1700	20.2566	20.2621	20.2641	20.1963	19.8073	19.3780	19.7380	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9997	0.9973	0.9676	0.8279	0.5779	0.3987	0.4811	0.8406	0.9940	0.9998	1.0000	(94)
Useful gains	3169.6578	4391.1083	5737.5988	7250.0829	7320.4319	5234.3496	3423.2143	3586.9861	5157.6960	4501.3991	3368.2987	2902.4178	(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													
	15607.4037	14696.7995	13121.5196	10574.4736	8102.2783	5294.0809	3427.4234	3600.5253	5756.0147	8807.4926	11846.3953	15120.1434	(97)
Space heating kWh													
	9253.6829	6925.4245	5493.6370	2393.5613	581.6937	0.0000	0.0000	0.0000	0.0000	3203.7336	6104.2295	9089.9879	(98a)
Space heating requirement - total per year (kWh/year)												43045.9505	
Solar 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													
	9253.6829	6925.4245	5493.6370	2393.5613	581.6937	0.0000	0.0000	0.0000	0.0000	3203.7336	6104.2295	9089.9879	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												43045.9505	
Space heating per m2											(98c) / (4) =	37.0702	(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 %)	387.7161	(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													
	9253.6829	6925.4245	5493.6370	2393.5613	581.6937	0.0000	0.0000	0.0000	0.0000	3203.7336	6104.2295	9089.9879	(98)
Space heating efficiency (main heating system 1)													
	387.7161	387.7161	387.7161	387.7161	387.7161	0.0000	0.0000	0.0000	0.0000	387.7161	387.7161	387.7161	(210)
Space heating fuel (main heating system)													
	2386.7160	1786.2101	1416.9225	617.3489	150.0308	0.0000	0.0000	0.0000	0.0000	826.3091	1574.4069	2344.4957	(211)
Space heating efficiency (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	291.0536	257.2552	273.8830	243.2548	237.2237	215.3882	214.2226	222.1293	223.8027	247.5007	260.4786	288.2929	(64)
Efficiency of water heater												310.0843	(216)
(217)m	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	310.0843	(217)
Fuel for water heating, kWh/month													
	93.8627	82.9630	88.3253	78.4479	76.5030	69.4612	69.0853	71.6351	72.1748	79.8172	84.0025	92.9724	(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	659.8511	595.9946	659.8511	638.5656	659.8511	638.5656	659.8511	659.8511	638.5656	659.8511	638.5656	659.8511	(231)
Lighting	97.6905	78.3710	70.5644	51.6985	39.9334	32.6259	36.4286	47.3513	61.5046	80.6974	91.1475	100.4057	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-400.3189	-679.8146	-1173.6710	-1536.6180	-1783.9330	-1614.6474	-1619.4103	-1505.0209	-1210.1328	-864.7230	-476.4987	-332.7014	(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	-2.1449	-10.1301	-42.1797	-139.1258	-316.9143	-460.9834	-424.6714	-262.3417	-143.1264	-29.1439	-4.6891	-1.4187	(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	11102.4399	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	310.0843	
Water heating fuel used	959.2505	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)		
mechanical ventilation fans (SFP = 1.4700)	7769.2150	(230a)
Total electricity for the above, kWh/year	7769.2150	(231)
Electricity for lighting (calculated in Appendix L)	788.4187	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-15034.3595	(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	5584.9646	(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	11102.4399	0.1560	1731.9687	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	959.2505	0.1407	134.9302	(264)
Space and water heating			1866.8989	(265)
Pumps, fans and electric keep-hot	7769.2150	0.1387	1077.6859	(267)
Energy for lighting	788.4187	0.1443	113.7932	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-13197.4902	0.1320	-1742.3043	
PV Unit electricity exported	-1836.8693	0.1116	-205.0642	
Total			-1947.3685	(269)
Total CO2, kg/year			1111.0095	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			0.9600	(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	11102.4399	1.5775	17514.5916	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	959.2505	1.5201	1458.1618	(278)
Space and water heating			18972.7534	(279)
Pumps, fans and electric keep-hot	7769.2150	1.5128	11753.2685	(281)
Energy for lighting	788.4187	1.5338	1209.3029	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-13197.4902	1.4878	-19635.0397	
PV Unit electricity exported	-1836.8693	0.4087	-750.6374	
Total			-20385.6770	(283)
Total Primary energy kWh/year			11549.6478	(286)
Dwelling Primary energy Rate (DPER)			9.9500	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	266.3100	(1a)	x 3.5000	(2a)	= 932.0850	(1a) - (3a)
Ground floor	469.8300	(1b)	x 4.2000	(2b)	= 1973.2860	(1b) - (3b)
First floor	357.3200	(1c)	x 3.5000	(2c)	= 1250.6200	(1c) - (3c)
Second floor	67.7400	(1d)	x 2.6000	(2d)	= 176.1240	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	1161.2000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	4332.1150	(5)

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2. Ventilation rate

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	m3 per hour	
Number of open chimneys	0 * 80 = 0.0000	(6a)
Number of open flues	0 * 20 = 0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000	(6d)
Number of flues attached to other heater	0 * 35 = 0.0000	(6e)

Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	4 * 10 =	40.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)
	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0092 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.2592 (18)
Number of sides sheltered		1 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2398 (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	0.3057	0.2997	0.2937	0.2638	0.2578	0.2278	0.2278	0.2218	0.2398	0.2578	0.2698	0.2818	(22b)
Effective ac	0.5467	0.5449	0.5431	0.5348	0.5332	0.5259	0.5259	0.5246	0.5287	0.5332	0.5364	0.5397	(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			3.5200	1.0000	3.5200			(26)
TER Opening Type (Uw = 1.20)			274.4100	1.1450	314.2099			(27)
Rooflight			6.9600	2.0221	14.0735			(27a)
Rooflight 2			5.3900	2.0221	10.8989			(27a)
Basement floor			266.3100	0.1300	34.6203			(28)
Ground floor			209.0500	0.1300	27.1765			(28a)
Exposed floor			134.0600	0.1300	17.4278			(28b)
External Wall	984.8100	270.7900	714.0200	0.1800	128.5236			(29a)
Bellow grade wall	177.9300		177.9300	0.1800	32.0274			(29a)
Exposed wall Sheltered	95.6600	7.1400	88.5200	0.1800	15.9336			(29a)
Flat roof	608.8600	12.3500	596.5100	0.1100	65.6161			(30)
Total net area of external elements Aum(A, m2)			2476.6800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		664.0277			(33)

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)	89.8000	0.1600	14.3680
E6 Intermediate floor within a dwelling	46.7500	0.0000	0.0000
E19 Ground floor (inverted)	10.7000	0.0700	0.7490
E20 Exposed floor (normal)	47.6000	0.3200	15.2320
E21 Exposed floor (inverted)	45.0000	0.3200	14.4000
E22 Basement floor	78.1700	0.0700	5.4719
E23 Balcony within or between dwellings, balcony support penetrates wall insulation	5.0000	0.0200	0.1000
E24 Eaves (insulation at ceiling level - inverted)	74.8200	0.2400	17.9568
E14 Flat roof	151.0700	0.0800	12.0856
E15 Flat roof with parapet	85.6900	0.5600	47.9864
E16 Corner (normal)	123.6000	0.0900	11.1240
E17 Corner (inverted - internal area greater than external area)	54.4000	-0.0900	-4.8960
E2 Other lintels (including other steel lintels)	107.0300	0.0500	5.3515
E3 Sill	105.4300	0.0500	5.2715
E4 Jamb	307.3700	0.0500	15.3685
R11 Upstands or kerbs of rooflights	30.8100	0.0800	2.4648

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		163.0340 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	827.0617 (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	781.6133	779.0188	776.4757	764.5308	762.2960	751.8924	751.8924	749.9658	755.8997	762.2960	766.8170	771.5436	(38)
Heat transfer coeff	1608.6749	1606.0805	1603.5374	1591.5925	1589.3576	1578.9540	1578.9540	1577.0274	1582.9613	1589.3576	1593.8787	1598.6053	(39)

Average = Sum(39)m / 12 = 1591.5818

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3854	1.3831	1.3809	1.3706	1.3687	1.3598	1.3598	1.3581	1.3632	1.3687	1.3726	1.3767	(40)
HLP (average)												1.3706	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy		4.2515 (42)

Hot water usage for mixer showers

95.5037	94.0685	91.9771	87.9755	85.0225	81.7293	79.8574	81.9330	84.2082	87.7441	91.8316	95.1378	(42a)

Hot water usage for baths

41.1929	40.5812	39.7197	38.1312	36.9418	35.6229	34.9105	35.7660	36.6975	38.1087	39.7299	41.0537	(42b)

Hot water usage for other uses

58.1695	56.0543	53.9390	51.8237	49.7085	47.5932	47.5932	49.7085	51.8237	53.9390	56.0543	58.1695	(42c)

Average daily hot water use (litres/day) 179.1250 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	194.8662	190.7039	185.6357	177.9305	171.6727	164.9454	162.3612	167.4075	172.7294	179.7918	187.6158	194.3610	(44)
Energy conte	308.6204	271.5598	285.3152	243.5779	231.1045	202.8196	196.3617	207.2854	212.9927	243.9758	267.2931	304.3224	(45)
Energy content (annual)										Total = Sum(45)m =		2975.2286	
Distribution loss (46)m = 0.15 x (45)m	46.2931	40.7340	42.7973	36.5367	34.6657	30.4229	29.4543	31.0928	31.9489	36.5964	40.0940	45.6484	(46)
Water storage loss:													
Store volume												400.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.5234	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.3626	(55)
Total storage loss	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(56)
If cylinder contains dedicated solar storage	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(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													
	374.1245	330.7248	350.8193	306.9690	296.6086	266.2107	261.8659	272.7895	276.3837	309.4799	330.6841	369.8265	(62)
WWHRS	-43.6603	-38.6135	-40.4339	-33.4808	-31.2029	-26.7006	-25.0275	-26.6143	-27.6255	-32.5674	-36.8949	-42.8518	(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													
	330.4642	292.1113	310.3855	273.4882	265.4057	239.5101	236.8383	246.1753	248.7583	276.9126	293.7893	326.9747	(64)
											Total per year (kWh/year) = Sum(64)m =	3340.8133	(64)
12Total per year (kWh/year)												3341	(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													
	155.0196	137.6257	147.2706	131.7025	129.2455	118.1504	117.6936	121.3257	121.5329	133.5253	139.5878	153.5905	(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	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	212.5745	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	505.2767	559.4135	505.2767	522.1192	505.2767	522.1192	505.2767	505.2767	522.1192	505.2767	522.1192	505.2767	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1001.7675	1012.1627	985.9671	930.1998	859.8036	793.6410	749.4404	739.0452	765.2408	821.0081	891.4043	957.5669	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	44.2574	(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)													
	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	-170.0596	(71)
Water heating gains (Table 5)													
	208.3596	204.8001	197.9444	182.9202	173.7171	164.0978	158.1903	163.0722	168.7957	179.4694	193.8720	206.4388	(72)
Total internal gains													
	1805.1762	1866.1486	1778.9605	1725.0116	1628.5697	1566.6304	1499.6797	1494.1664	1542.9281	1595.5266	1697.1679	1759.0547	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	67.7600	11.2829	0.6300	0.7000	0.7700	233.6509	(75)
Southeast	80.3100	36.7938	0.6300	0.7000	0.7700	903.0597	(77)
Southwest	9.5100	36.7938	0.6300	0.7000	0.7700	106.9368	(79)
Northwest	116.8300	11.2829	0.6300	0.7000	0.7700	402.8548	(81)
Southeast	12.3500	26.0000	0.6300	0.7000	1.0000	127.4446	(82)

Solar gains	1773.9469	3280.7163	5158.7937	7485.4829	9361.1038	9717.3440	9192.5543	7732.2154	5956.8864	3808.2768	2172.3887	1487.0852	(83)
Total gains	3579.1231	5146.8649	6937.7542	9210.4945	10989.6735	11283.9744	10692.2340	9226.3818	7499.8145	5403.8033	3869.5565	3246.1400	(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	50.1275	50.2085	50.2881	50.6655	50.7368	51.0711	51.0711	51.1335	50.9418	50.7368	50.5929	50.4433	
alpha	4.3418	4.3472	4.3525	4.3777	4.3825	4.4047	4.4047	4.4089	4.3961	4.3825	4.3729	4.3629	
util living area													
	0.9999	0.9993	0.9964	0.9789	0.9122	0.7674	0.6120	0.7063	0.9309	0.9950	0.9996	0.9999	(86)
MIT	18.9387	19.1656	19.5526	20.0911	20.5778	20.8715	20.9641	20.9343	20.6498	20.0099	19.3776	18.9068	(87)
Th 2	19.7746	19.7763	19.7780	19.7859	19.7874	19.7943	19.7943	19.7956	19.7917	19.7874	19.7844	19.7813	(88)
util rest of house													
	0.9998	0.9990	0.9949	0.9695	0.8719	0.6676	0.4625	0.5570	0.8809	0.9919	0.9994	0.9999	(89)
MIT 2	17.3534	17.6456	18.1422	18.8297	19.4147	19.7180	19.7830	19.7710	19.5176	18.7345	17.9231	17.3169	(90)
Living area fraction											fLA = Living area / (4) =	0.0962	(91)
MIT	17.5059	17.7917	18.2778	18.9510	19.5265	19.8289	19.8966	19.8829	19.6265	18.8572	18.0629	17.4698	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5059	17.7917	18.2778	18.9510	19.5265	19.8289	19.8966	19.8829	19.6265	18.8572	18.0629	17.4698	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9996	0.9982	0.9919	0.9601	0.8609	0.6709	0.4761	0.5693	0.8715	0.9879	0.9989	0.9998	(94)
Useful gains	3577.8186	5137.7528	6881.3386	8843.0424	9460.8134	7569.9042	5090.7208	5252.2260	6536.0052	5338.1682	3865.4253	3245.3771	(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													
	21243.9253	20705.1844	18886.2024	15997.1332	12439.1091	8256.2390	5205.1671	5492.5887	8748.2497	13123.5966	17473.5775	21213.1403	(97)
Space heating kWh													
	13143.5834	10461.3141	8931.6187	5150.9454	2215.8520	0.0000	0.0000	0.0000	0.0000	5792.3587	9797.8695	13368.0158	(98a)
Space heating requirement - total per year (kWh/year)												68861.5577	
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													
	13143.5834	10461.3141	8931.6187	5150.9454	2215.8520	0.0000	0.0000	0.0000	0.0000	5792.3587	9797.8695	13368.0158	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												68861.5577	
Space heating per m2											(98c) / (4) =	59.3021	(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													
	13143.5834	10461.3141	8931.6187	5150.9454	2215.8520	0.0000	0.0000	0.0000	0.0000	5792.3587	9797.8695	13368.0158	(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)													
	14240.0687	11334.0347	9676.7266	5580.6559	2400.7063	0.0000	0.0000	0.0000	0.0000	6275.5783	10615.2433	14483.2241	(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													
	330.4642	292.1113	310.3855	273.4882	265.4057	239.5101	236.8383	246.1753	248.7583	276.9126	293.7893	326.9747	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.5550	88.5288	88.4649	88.2979	87.7415	79.8000	79.8000	79.8000	79.8000	88.3454	88.5094	88.5615	(217)
Fuel for water heating, kWh/month													
	373.1738	329.9620	350.8571	309.7334	302.4859	300.1380	296.7899	308.4903	311.7272	313.4431	331.9300	369.2062	(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	104.9865	84.2241	75.8344	55.5596	42.9158	35.0626	39.1492	50.8877	66.0980	86.7242	97.9548	107.9044	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-221.1332	-298.4894	-410.5758	-440.3960	-456.6810	-418.6252	-412.0574	-396.8270	-368.8832	-329.4226	-237.7185	-192.6449	(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	-168.7971	-348.9222	-682.9970	-1011.5341	-1324.7584	-1327.6580	-1313.3353	-1118.9511	-828.6023	-495.7859	-224.1579	-134.0855	(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												74606.2380	(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												3897.9368	(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)												847.3013	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-13163.0390	(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												66274.4372	(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	74606.2380	0.2100	15667.3100	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3897.9368	0.2100	818.5667	(264)
Space and water heating			16485.8767	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	847.3013	0.1443	122.2918	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4183.4543	0.1356	-567.3995	
PV Unit electricity exported	-8979.5847	0.1263	-1134.0457	
Total			-1701.4452	(269)
Total CO2, kg/year			14918.6525	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			12.8500	(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	74606.2380	1.1300	84305.0489	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3897.9368	1.1300	4404.6686	(278)
Space and water heating			88709.7176	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	847.3013	1.5338	1299.6190	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-4183.4543	1.5013	-6280.7101	
PV Unit electricity exported	-8979.5847	0.4636	-4162.8691	
Total			-10443.5792	(283)
Total Primary energy kWh/year			79695.8582	(286)
Target Primary Energy Rate (TPER)			68.6300	(287)

Full SAP Calculation Printout

Property Reference	10605 Staff house Green	**Issued on Date**	19/11/2023
Assessment Reference	Staff House - Green_A	**Prop Type Ref**	Main house
Property	NW8 6BT		

SAP Rating	97 A	**DER**	0.50	**TER**	13.97
Environmental	100 A	**% DER < TER**			96.42
CO_2 Emissions (t/year)	-0.02	**DFEE**	58.52	**TFEE**	68.75
Compliance Check	See BREL	**% DFEE < TFEE**			14.88
% DPER < TPER	87.19	**DPER**	9.65	**TPER**	75.32

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	96.4600	(1b)	x 3.5000	(2b) =	337.6100	(1b) - (3b) (4)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	96.4600					
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		337.6100	(5)

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2. Ventilation rate

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

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		2.5000 (17)
Infiltration rate		0.1250 (18)
Number of sides sheltered		1 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1156 (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	0.1474	0.1445	0.1416	0.1272	0.1243	0.1098	0.1098	0.1070	0.1156	0.1243	0.1301	0.1359	(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) =	81.0000 (23c)

Effective ac	0.2424	0.2395	0.2366	0.2222	0.2193	0.2048	0.2048	0.2020	0.2106	0.2193	0.2251	0.2309	(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	
Windows (Uw = 0.85)			23.7400	0.8221	19.5155			(27)
Exposed floor			96.4600	0.1071	10.3266			(28b)
External Wall	167.4800	23.7400	143.7400	0.1200	17.2488			(29a)
Flat roof	96.4600		96.4600	0.1100	10.6106			(30)
Total net area of external elements Aum(A, m2)			360.4000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	57.7015			(33)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E20 Exposed floor (normal)	47.8500	0.2000	9.5700
E14 Flat roof	47.8500	0.1500	7.1775
E16 Corner (normal)	24.5000	0.0900	2.2050
E17 Corner (inverted - internal area greater than external area)	7.0000	-0.0900	-0.6300
E2 Other lintels (including other steel lintels)	10.3200	0.2000	2.0640

E3 Sill									10.3200	0.0400	0.4128		
E4 Jamb									36.8000	0.0500	1.8400		
Thermal bridges (Sum(L x Psi) calculated using Appendix K)												22.6393	(36)
Point Thermal bridges											(36a) =	0.0000	
Total fabric heat loss										(33) + (36) + (36a) =		80.3408	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	27.0085	26.6865	26.3644	24.7542	24.4321	22.8219	22.8219	22.4999	23.4660	24.4321	25.0762	25.7203	(38)
Heat transfer coeff	107.3493	107.0273	106.7052	105.0950	104.7729	103.1627	103.1627	102.8407	103.8068	104.7729	105.4170	106.0611	(39)
Average = Sum(39)m / 12 =												105.0145	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1129	1.1096	1.1062	1.0895	1.0862	1.0695	1.0695	1.0661	1.0762	1.0862	1.0929	1.0995	(40)
HLP (average)												1.0887	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.7042	(42)
Hot water usage for mixer showers	89.3668	88.0238	86.0668	82.3223	79.5591	76.4775	74.7259	76.6681	78.7971	82.1058	85.9307	89.0244	(42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Hot water usage for other uses	42.3242	40.7852	39.2461	37.7070	36.1680	34.6289	34.6289	36.1680	37.7070	39.2461	40.7852	42.3242	(42c)
Average daily hot water use (litres/day)												120.8698	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.6910	128.8089	125.3128	120.0294	115.7270	111.1064	109.3548	112.8361	116.5042	121.3519	126.7158	131.3486	(44)
Energy conte	208.5664	183.4222	192.6012	164.3142	155.7908	136.6182	132.2551	139.7146	143.6613	164.6734	180.5299	205.6602	(45)
Energy content (annual)										Total = Sum(45)m =		2007.8076	
Distribution loss (46)m = 0.15 x (45)m	31.2850	27.5133	28.8902	24.6471	23.3686	20.4927	19.8383	20.9572	21.5492	24.7010	27.0795	30.8490	(46)
Water storage loss:													
Store volume												400.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.5200	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.3608	(55)
Total storage loss	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(56)
If cylinder contains dedicated solar storage	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(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	274.0136	242.5358	258.0484	227.6502	221.2380	199.9542	197.7023	205.1618	206.9973	230.1206	243.8659	271.1074	(62)
WWHRS	-77.6796	-68.7005	-71.9392	-59.5685	-55.5157	-47.5052	-44.5285	-47.3516	-49.1507	-57.9433	-65.6427	-76.2411	(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	196.3339	173.8353	186.1092	168.0817	165.7223	152.4490	153.1738	157.8102	157.8466	172.1773	178.2232	194.8663	(64)
									Total per year (kWh/year) = Sum(64)m =			2056.6288	(64)
12Total per year (kWh/year)												2057	(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	121.7061	108.2788	116.3977	105.3033	104.1582	96.0944	96.3326	98.8129	98.4362	107.1117	110.6950	120.7398	(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	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	126.3356	139.8716	126.3356	130.5468	126.3356	130.5468	126.3356	126.3356	130.5468	126.3356	130.5468	126.3356	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	250.4746	253.0737	246.5239	232.5803	214.9789	198.4361	187.3845	184.7854	191.3352	205.2788	222.8802	239.4230	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	(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)	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	(71)
Water heating gains (Table 5)	163.5834	161.1291	156.4485	146.2545	139.9976	133.4644	129.4793	132.8130	136.7169	143.9673	153.7431	162.2846	(72)
Total internal gains	603.9574	617.6382	592.8718	572.9454	544.8759	526.0111	506.7632	507.4978	522.1626	539.1455	570.7338	591.6070	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	21.9000	11.2829	0.4000	0.8000	0.7700	54.7961	(75)
Southwest	1.8400	36.7938	0.4000	0.8000	0.7700	15.0133	(79)

Solar gains	69.8094	137.1122	235.9483	373.3853	492.1868	521.1619	488.9164	395.3112	282.7575	164.5734	86.9301	57.5975	(83)
Total gains	673.7668	754.7504	828.8200	946.3308	1037.0627	1047.1730	995.6796	902.8090	804.9201	703.7189	657.6639	649.2045	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.4001	62.5879	62.7768	63.7386	63.9346	64.9325	64.9325	65.1358	64.5296	63.9346	63.5439	63.1580	
alpha	5.1600	5.1725	5.1851	5.2492	5.2623	5.3288	5.3288	5.3424	5.3020	5.2623	5.2363	5.2105	
util living area													
	0.9960	0.9921	0.9814	0.9356	0.8130	0.6094	0.4521	0.5160	0.7885	0.9621	0.9916	0.9967	(86)
Living	19.9987	20.1220	20.3237	20.6154	20.8304	20.9231	20.9386	20.9358	20.8726	20.5931	20.2559	19.9859	
Non living	18.8212	18.9804	19.2377	19.6063	19.8460	19.9409	19.9502	19.9520	19.8992	19.5889	19.1628	18.8136	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.4878	20.1220	20.3237	20.6154	20.8304	20.9231	20.9386	20.9358	20.8726	20.5931	20.2559	20.1278	(87)
Th 2	19.9903	19.9930	19.9958	20.0094	20.0121	20.0258	20.0258	20.0286	20.0203	20.0121	20.0067	20.0012	(88)
util rest of house													
	0.9947	0.9895	0.9750	0.9139	0.7590	0.5255	0.3540	0.4112	0.7107	0.9448	0.9884	0.9956	(89)
MIT 2	19.5242	18.9804	19.2377	19.6063	19.8460	19.9409	19.9502	19.9520	19.8992	19.5889	19.1628	19.0276	(90)
Living area fraction										fLA = Living area / (4) =		0.2168	(91)
MIT	19.7331	19.2278	19.4731	19.8251	20.0594	20.1539	20.1645	20.1653	20.1102	19.8066	19.3997	19.2661	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7331	19.2278	19.4731	19.8251	20.0594	20.1539	20.1645	20.1653	20.1102	19.8066	19.3997	19.2661	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9943	0.9869	0.9707	0.9091	0.7619	0.5370	0.3682	0.4262	0.7186	0.9403	0.9857	0.9945	(94)
Useful gains	669.9008	744.8299	804.5318	860.3467	790.1222	562.2822	366.5683	384.8080	578.4196	661.6732	648.2594	645.6616	(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													
	1656.7335	1533.4677	1384.2999	1148.1715	875.8359	572.9510	367.7187	387.2214	623.9016	964.6045	1296.6031	1597.9251	(97)
Space heating kWh													
	734.2036	529.9646	431.3475	207.2339	63.7710	0.0000	0.0000	0.0000	0.0000	225.3809	466.8075	708.4840	(98a)
Space heating requirement - total per year (kWh/year)												3367.1929	
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													
	734.2036	529.9646	431.3475	207.2339	63.7710	0.0000	0.0000	0.0000	0.0000	225.3809	466.8075	708.4840	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3367.1929	
Space heating per m2											(98c) / (4) =	34.9077	(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 %)	241.8533	(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													
	734.2036	529.9646	431.3475	207.2339	63.7710	0.0000	0.0000	0.0000	0.0000	225.3809	466.8075	708.4840	(98)
Space heating efficiency (main heating system 1)													
	241.8533	241.8533	241.8533	241.8533	241.8533	0.0000	0.0000	0.0000	0.0000	241.8533	241.8533	241.8533	(210)
Space heating fuel (main heating system)													
	303.5739	219.1265	178.3509	85.6858	26.3676	0.0000	0.0000	0.0000	0.0000	93.1891	193.0126	292.9396	(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													
	196.3339	173.8353	186.1092	168.0817	165.7223	152.4490	153.1738	157.8102	157.8466	172.1773	178.2232	194.8663	(64)
Efficiency of water heater												309.7853	(216)
(217)m	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	309.7853	(217)
Fuel for water heating, kWh/month													
	63.3774	56.1148	60.0768	54.2575	53.4959	49.2112	49.4451	50.9418	50.9535	55.5796	57.5312	62.9037	(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	37.2208	33.6188	37.2208	36.0201	37.2208	36.0201	37.2208	37.2208	36.0201	37.2208	36.0201	37.2208	(231)
Lighting	24.4258	19.5953	17.6434	12.9263	9.9847	8.1575	9.1083	11.8394	15.3782	20.1770	22.7898	25.1047	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-69.5200	-113.2685	-184.9994	-224.6184	-244.9530	-225.4246	-222.9174	-206.1635	-174.6448	-137.1283	-81.0406	-58.1168	(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	-3.6552	-12.1760	-36.0644	-80.0623	-137.0192	-151.9628	-148.7338	-115.1752	-71.4024	-25.3930	-6.4481	-2.6323	(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												1392.2459	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												309.7853	
Water heating fuel used												663.8885	(219)
Space cooling fuel												0.0000	(221)

Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.0640)		
mechanical ventilation fans (SFP = 1.0640)	438.2448	(230a)
Total electricity for the above, kWh/year	438.2448	(231)
Electricity for lighting (calculated in Appendix L)	197.1304	(232)

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

PV generation	-2733.5199	(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	-42.0103	(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	1392.2459	0.1560	217.1318	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	663.8885	0.1403	93.1358	(264)
Space and water heating			310.2676	(265)
Pumps, fans and electric keep-hot	438.2448	0.1387	60.7900	(267)
Energy for lighting	197.1304	0.1443	28.4520	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1942.7952	0.1332	-258.7652	
PV Unit electricity exported	-790.7247	0.1173	-92.7358	
Total			-351.5010	(269)
Total CO2, kg/year			48.0086	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			0.5000	(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	1392.2459	1.5774	2196.1010	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	663.8885	1.5187	1008.2505	(278)
Space and water heating			3204.3515	(279)
Pumps, fans and electric keep-hot	438.2448	1.5128	662.9767	(281)
Energy for lighting	197.1304	1.5338	302.3652	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1942.7952	1.4922	-2899.0392	
PV Unit electricity exported	-790.7247	0.4300	-339.9985	
Total			-3239.0377	(283)
Total Primary energy kWh/year			930.6557	(286)
Dwelling Primary energy Rate (DPER)			9.6500	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	96.4600	(1b)	x 3.5000	(2b) =	337.6100	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	96.4600					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		337.6100	(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) = 0.0889	(8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.3389	(18)
Number of sides sheltered	1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 0.9250	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.3134	(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	0.3996	0.3918	0.3840	0.3448	0.3370	0.2978	0.2978	0.2899	0.3134	0.3370	0.3526	0.3683	(22b)
Effective ac	0.5799	0.5768	0.5737	0.5594	0.5568	0.5443	0.5443	0.5420	0.5491	0.5568	0.5622	0.5678	(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 Opening Type (Uw = 1.20)			23.7400	1.1450	27.1832			(27)
Exposed floor			96.4600	0.1300	12.5398			(28b)
External Wall	167.4800	23.7400	143.7400	0.1800	25.8732			(29a)
Flat roof	96.4600		96.4600	0.1100	10.6106			(30)
Total net area of external elements Aum(A, m2)			360.4000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		76.2068			(33)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E20 Exposed floor (normal)	47.8500	0.3200	15.3120
E14 Flat roof	47.8500	0.0800	3.8280
E16 Corner (normal)	24.5000	0.0900	2.2050
E17 Corner (inverted - internal area greater than external area)	7.0000	-0.0900	-0.6300
E2 Other lintels (including other steel lintels)	10.3200	0.0500	0.5160
E3 Sill	10.3200	0.0500	0.5160
E4 Jamb	36.8000	0.0500	1.8400

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 23.5870 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 99.7938 (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	64.6026	64.2572	63.9185	62.3279	62.0304	60.6450	60.6450	60.3885	61.1786	62.0304	62.6324	63.2618	(38)
Heat transfer coeff	164.3965	164.0510	163.7123	162.1218	161.8242	160.4388	160.4388	160.1823	160.9724	161.8242	162.4262	163.0556	(39)

Average = Sum(39)m / 12 = 162.1203

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.7043	1.7007	1.6972	1.6807	1.6776	1.6633	1.6633	1.6606	1.6688	1.6776	1.6839	1.6904	(40)
HLP (average)												1.6807	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.7042 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	89.3668	88.0238	86.0668	82.3223	79.5591	76.4775	74.7259	76.6681	78.7971	82.1058	85.9307	89.0244	(42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Hot water usage for other uses	42.3242	40.7852	39.2461	37.7070	36.1680	34.6289	34.6289	36.1680	37.7070	39.2461	40.7852	42.3242	(42c)

Average daily hot water use (litres/day) 120.8698 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	131.6910	128.8089	125.3128	120.0294	115.7270	111.1064	109.3548	112.8361	116.5042	121.3519	126.7158	131.3486	(44)
Energy conte	208.5664	183.4222	192.6012	164.3142	155.7908	136.6182	132.2551	139.7146	143.6613	164.6734	180.5299	205.6602	(45)
Energy content (annual)										Total = Sum(45)m =		2007.8076	
Distribution loss (46)m = 0.15 x (45)m	31.2850	27.5133	28.8902	24.6471	23.3686	20.4927	19.8383	20.9572	21.5492	24.7010	27.0795	30.8490	(46)
Water storage loss:													
Store volume												400.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.5234	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.3626	(55)
Total storage loss	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(56)
If cylinder contains dedicated solar storage	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(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	274.0705	242.5872	258.1053	227.7053	221.2949	200.0093	197.7593	205.2187	207.0524	230.1775	243.9210	271.1643	(62)
WWHRS	-40.8548	-36.1323	-37.8357	-31.3294	-29.1979	-24.9848	-23.4193	-24.9041	-25.8503	-30.4746	-34.5241	-40.0982	(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	233.2157	206.4549	220.2697	196.3759	192.0970	175.0245	174.3400	180.3147	181.2021	199.7029	209.3970	231.0661	(64)
										Total per year (kWh/year) = Sum(64)m =		2399.4603	(64)
12Total per year (kWh/year)												2399	(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	121.7516	108.3199	116.4432	105.3473	104.2037	96.1384	96.3781	98.8584	98.4802	107.1572	110.7391	120.7853	(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	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	135.2125	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	126.3356	139.8716	126.3356	130.5468	126.3356	130.5468	126.3356	126.3356	130.5468	126.3356	130.5468	126.3356	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	250.4746	253.0737	246.5239	232.5803	214.9789	198.4361	187.3845	184.7854	191.3352	205.2788	222.8802	239.4230	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	36.5212	(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)	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	-108.1700	(71)
Water heating gains (Table 5)	163.6446	161.1903	156.5097	146.3157	140.0588	133.5256	129.5405	132.8742	136.7781	144.0285	153.8043	162.3458	(72)
Total internal gains	607.0186	620.6994	595.9330	576.0066	547.9371	526.0723	506.8244	507.5590	522.2238	542.2067	573.7950	594.6682	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	21.9000	11.2829	0.6300	0.7000	0.7700	75.5159	(75)
Southwest	1.8400	36.7938	0.6300	0.7000	0.7700	20.6902	(79)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	96.2061	188.9578	325.1662	514.5717	678.2949	718.2262	673.7879	544.7883	389.6752	226.8027	119.8006	79.3766	(83)
Total gains	703.2247	809.6572	921.0992	1090.5783	1226.2321	1244.2986	1180.6123	1052.3473	911.8990	769.0094	693.5956	674.0447	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	40.7467	40.8325	40.9170	41.3184	41.3944	41.7518	41.7518	41.8187	41.6134	41.3944	41.2410	41.0818	
alpha	3.7164	3.7222	3.7278	3.7546	3.7596	3.7835	3.7835	3.7879	3.7742	3.7596	3.7494	3.7388	
util living area	0.9953	0.9915	0.9818	0.9478	0.8623	0.7092	0.5604	0.6337	0.8606	0.9707	0.9917	0.9960	(86)
MIT	18.9353	19.1431	19.5150	20.0596	20.5462	20.8533	20.9549	20.9289	20.6691	20.0505	19.4100	18.9078	(87)
Th 2	19.5378	19.5403	19.5428	19.5547	19.5569	19.5673	19.5673	19.5692	19.5633	19.5569	19.5524	19.5477	(88)
util rest of house	0.9936	0.9884	0.9748	0.9261	0.8040	0.5921	0.3954	0.4661	0.7760	0.9545	0.9880	0.9946	(89)
MIT 2	17.1981	17.4647	17.9382	18.6219	19.1853	19.4887	19.5552	19.5468	19.3394	18.6261	17.8144	17.1692	(90)
Living area fraction									fLA = Living area / (4) =			0.2168	(91)
MIT	17.5747	17.8285	18.2800	18.9336	19.4803	19.7845	19.8586	19.8464	19.6276	18.9349	18.1603	17.5460	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.5747	17.8285	18.2800	18.9336	19.4803	19.7845	19.8586	19.8464	19.6276	18.9349	18.1603	17.5460	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9899	0.9827	0.9657	0.9136	0.8002	0.6120	0.4313	0.5019	0.7807	0.9442	0.9825	0.9913	(94)
Useful gains	696.1056	795.6167	889.5220	996.4031	981.2319	761.4680	509.1694	528.1777	711.9525	726.0665	681.4538	668.2057	(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	2182.3104	2120.9403	1928.5320	1626.6590	1259.0473	831.7968	522.8087	552.0568	889.7984	1348.7845	1796.4796	2176.1477	(97)
Space heating kWh	1105.7364	890.6175	773.0234	453.7843	206.6946	0.0000	0.0000	0.0000	0.0000	463.3021	802.8186	1121.9089	(98a)
Space heating requirement - total per year (kWh/year)												5817.8858	
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	1105.7364	890.6175	773.0234	453.7843	206.6946	0.0000	0.0000	0.0000	0.0000	463.3021	802.8186	1121.9089	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												5817.8858	
Space heating per m2											(98c) / (4) =	60.3140	(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	1105.7364	890.6175	773.0234	453.7843	206.6946	0.0000	0.0000	0.0000	0.0000	463.3021	802.8186	1121.9089	(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)	1197.9809	964.9160	837.5118	491.6406	223.9379	0.0000	0.0000	0.0000	0.0000	501.9525	869.7926	1215.5026	(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	233.2157	206.4549	220.2697	196.3759	192.0970	175.0245	174.3400	180.3147	181.2021	199.7029	209.3970	231.0661	(64)
Efficiency of water heater												79.8000	(216)
(217)m	87.0892	86.9545	86.6333	85.8747	84.2244	79.8000	79.8000	79.8000	79.8000	85.8825	86.7754	87.1219	(217)
Fuel for water heating, kWh/month	267.7895	237.4288	254.2552	228.6773	228.0778	219.3289	218.4711	225.9582	227.0703	232.5304	241.3090	265.2216	(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	26.2501	21.0588	18.9611	13.8917	10.7304	8.7668	9.7886	12.7236	16.5267	21.6839	24.4919	26.9796	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-72.5681	-94.4876	-125.5626	-130.1893	-131.7774	-120.0188	-118.4299	-115.7559	-110.1864	-102.3517	-76.8942	-63.6916	(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	-68.6683	-140.0110	-270.5398	-395.7135	-513.4768	-512.5014	-506.5237	-433.2732	-323.5542	-196.5466	-90.4018	-54.6533	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	6303.2349	(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	2846.1180	(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)	211.8530	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-4767.7772	(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	4679.4287	(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	6303.2349	0.2100	1323.6793	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2846.1180	0.2100	597.6848	(264)
Space and water heating			1921.3641	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	211.8530	0.1443	30.5769	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1261.9135	0.1363	-172.0373	
PV Unit electricity exported	-3505.8637	0.1267	-444.1670	
Total			-616.2043	(269)
Total CO2, kg/year			1347.6660	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			13.9700	(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	6303.2349	1.1300	7122.6554	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2846.1180	1.1300	3216.1133	(278)
Space and water heating			10338.7688	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	211.8530	1.5338	324.9471	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1261.9135	1.5039	-1897.8535	
PV Unit electricity exported	-3505.8637	0.4651	-1630.5201	
Total			-3528.3736	(283)
Total Primary energy kWh/year			7265.4432	(286)
Target Primary Energy Rate (TPER)			75.3200	(287)

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Existing scheme (baseline) and Approved Extension scheme (Scenario 1)

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

Existing scheme (baseline)– DER from the DER SAP worksheet
Be Lean Approved Extension Scheme – DER from the Be Lean scenario DER SAP worksheet
Be Green Approved Extension Scheme – DER from the Be Green scenario DER SAP worksheet

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Existing scheme (baseline)– DER from the DER SAP worksheet

Full SAP Calculation Printout

Property Reference	Extension scheme	**Issued on Date**	19/11/2023
Assessment Reference	Extension scheme Baseline	**Prop Type Ref**	
Property			

SAP Rating	77 C	**DER**	22.22	**TER**	9.82
Environmental	71 C	**% DER < TER**			-126.27
CO_2 Emissions (t/year)	37.45	**DFEE**	93.69	**TFEE**	56.17
Compliance Check	See BREL	**% DFEE < TFEE**			-66.79
% DPER < TPER	-120.61	**DPER**	120.10	**TPER**	54.44

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700	(1a)	x 3.3000	(2a) =	3052.0710	(1a) - (3a)
Ground floor	492.0700	(1b)	x 3.9000	(2b) =	1919.0730	(1b) - (3b)
First floor	371.3000	(1c)	x 3.8700	(2c) =	1436.9310	(1c) - (3c)
Second floor	229.8300	(1d)	x 2.7000	(2d) =	620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7028.6160	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	16 * 10 =	160.0000	(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) =	160.0000 / (5) =	0.0228	(8)
Pressure test		No	
Pressure Test Method		Blower Door	
Measured/design AP50		15.0000	(17)
Infiltration rate		0.7728	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.7728	(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	0.9853	0.9660	0.9466	0.8500	0.8307	0.7341	0.7341	0.7148	0.7728	0.8307	0.8694	0.9080	(22b)
Effective ac	0.9854	0.9665	0.9481	0.8613	0.8450	0.7695	0.7695	0.7555	0.7986	0.8450	0.8779	0.9122	(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	
Existing window (Uw = 1.40)			122.4200	1.3258	162.2992			(27)
New window (Uw = 1.40)			102.3900	1.3258	135.7443			(27)
Existing rooflight			14.8700	1.3258	19.7140			(27a)
New Rooflight			15.3100	1.3258	20.2973			(27a)
New rooflight			3.6000	1.3258	4.7727			(27a)
New basement floor			707.7400	0.1800	127.3932			(28a)
New exposed floor			217.1300	0.1708	37.0810			(28b)
Basement wall	600.3600		600.3600	0.1800	108.0648			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1800	66.4506			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1800	0.7686			(29a)
Existing walls	631.7700	115.1600	516.6100	0.3000	154.9830			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.3000	5.8860			(29a)
New pitched roof	150.8600	3.6000	147.2600	0.1500	22.0890			(30)
New flat roof	630.8100	15.3100	615.5000	0.1500	92.3250			(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1600	14.5696			(30)
Existing pitched roof	129.5900		129.5900	0.1600	20.7344			(30)
Total net area of external elements Aum(A, m2)			3676.9000					(31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 993.1729 (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (Default value 0.200 * total exposed area) 735.3800 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 1728.5529 (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	2285.5391	2241.8223	2198.9711	1997.7004	1960.0433	1784.7430	1784.7430	1752.2799	1852.2660	1960.0433	2036.2231	2115.8657	(38)
Heat transfer coeff	4014.0920	3970.3751	3927.5239	3726.2532	3688.5961	3513.2958	3513.2958	3480.8328	3580.8189	3688.5961	3764.7760	3844.4186	(39)
Average = Sum(39)m / 12 =												3726.0729	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.9891	1.9674	1.9462	1.8464	1.8278	1.7409	1.7409	1.7248	1.7744	1.8278	1.8655	1.9050	(40)
HLP (average)												1.8464	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 5.3654 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	114.1810	112.4651	109.9647	105.1805	101.6500	97.7127	95.4748	97.9563	100.6765	104.9039	109.7908	113.7435	(42a)
Hot water usage for baths	49.2248	48.4937	47.4642	45.5661	44.1447	42.5687	41.7174	42.7397	43.8528	45.5392	47.4764	49.0584	(42b)
Hot water usage for other uses	69.5773	67.0472	64.5171	61.9870	59.4569	56.9269	56.9269	59.4569	61.9870	64.5171	67.0472	69.5773	(42c)
Average daily hot water use (litres/day)												214.1623	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5400	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8316	(55)
Total storage loss	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(56)
If cylinder contains dedicated solar storage	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(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	418.0302	368.9735	390.1648	338.6817	325.3502	289.9506	283.8122	296.8731	302.1152	340.7409	367.0370	412.8916	(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	418.0302	368.9735	390.1648	338.6817	325.3502	289.9506	283.8122	296.8731	302.1152	340.7409	367.0370	412.8916	(64)
										Total per year (kWh/year) = Sum(64)m =		4134.6211	(64)
12Total per year (kWh/year)												4135	(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	161.9222	143.3921	152.6569	134.7992	131.1061	118.5961	117.2947	121.6375	122.6409	136.2235	144.2274	160.2136	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	795.7390	880.9968	795.7390	822.2637	795.7390	822.2637	795.7390	795.7390	822.2637	795.7390	822.2637	795.7390	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)	217.6373	213.3811	205.1840	187.2211	176.2178	164.7168	157.6541	163.4912	170.3345	183.0961	200.3158	215.3409	(72)
Total internal gains	2570.4910	2666.5455	2535.1575	2462.9641	2323.4972	2239.7126	2142.1195	2132.9035	2204.2046	2274.1968	2419.8800	2504.1887	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	24.3000	11.2829	0.6300	0.7000	0.7700	83.7916	(75)
Southeast	56.7500	36.7938	0.6300	0.7000	0.7700	638.1352	(77)
Southwest	23.3700	36.7938	0.6300	0.7000	0.7700	262.7880	(79)
Northwest	18.0000	11.2829	0.6300	0.7000	0.7700	62.0678	(81)
North	39.1500	10.6334	0.6300	0.7000	0.7700	127.2259	(74)
Northeast	2.4200	11.2829	0.6300	0.7000	0.7700	8.3447	(75)
East	5.2800	19.6403	0.6300	0.7000	0.7700	31.6922	(76)
Southeast	6.6500	36.7938	0.6300	0.7000	0.7700	74.7771	(77)
South	6.2100	46.7521	0.6300	0.7000	0.7700	88.7287	(78)
Southwest	3.6300	36.7938	0.6300	0.7000	0.7700	40.8182	(79)
West	21.0100	19.6403	0.6300	0.7000	0.7700	126.1087	(80)
Northwest	18.0400	11.2829	0.6300	0.7000	0.7700	62.2058	(81)

North			14.8700	26.0000	0.6300	0.7000	1.0000					153.4495	(82)
North			18.9100	26.0000	0.6300	0.7000	1.0000					181.9907	(82)
Solar gains	1942.1241	3561.9791	5503.8649	7804.0191	9587.7098	9876.8594	9374.1859	7997.8547	6298.0592	4110.9159	2373.5070	1630.8761	(83)
Total gains	4512.6151	6228.5246	8039.0225	10266.9831	11911.2070	12116.5720	11516.3054	10130.7582	8502.2638	6385.1127	4793.3870	4135.0648	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	34.9129	35.2974	35.6825	37.6098	37.9938	39.8895	39.8895	40.2616	39.1373	37.9938	37.2250	36.4538	
alpha	3.3275	3.3532	3.3788	3.5073	3.5329	3.6593	3.6593	3.6841	3.6092	3.5329	3.4817	3.4303	
util living area	0.9999	0.9996	0.9988	0.9957	0.9843	0.9491	0.8836	0.9230	0.9859	0.9985	0.9998	0.9999	(86)
MIT	18.7469	18.9075	19.2068	19.6796	20.1121	20.5207	20.7258	20.6761	20.3307	19.7785	19.2360	18.7931	(87)
Th 2	19.3406	19.3551	19.3695	19.4377	19.4506	19.5116	19.5116	19.5231	19.4880	19.4506	19.4245	19.3974	(88)
util rest of house	0.9998	0.9995	0.9983	0.9933	0.9730	0.8989	0.7366	0.8133	0.9703	0.9975	0.9997	0.9999	(89)
MIT 2	16.7448	16.9606	17.3542	18.0063	18.5652	19.1098	19.3229	19.2939	18.8715	18.1430	17.4292	16.8424	(90)
Living area fraction										fLA = Living area / (4) =		0.0208	(91)
MIT	16.7865	17.0012	17.3928	18.0411	18.5974	19.1391	19.3521	19.3227	18.9019	18.1771	17.4668	16.8830	(92)
Temperature adjustment												-0.1500	
adjusted MIT	16.6365	16.8512	17.2428	17.8911	18.4474	18.9891	19.2021	19.1727	18.7519	18.0271	17.3168	16.7330	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9997	0.9990	0.9970	0.9890	0.9600	0.8686	0.6871	0.7670	0.9547	0.9955	0.9994	0.9998	(94)
Useful gains	4511.1988	6222.5496	8014.9875	10153.9725	11434.6445	10524.6727	7913.2629	7770.7657	8117.4569	6356.5427	4790.4084	4134.2341	(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	49519.7247	47450.5697	42192.4732	33503.1242	24888.4581	15420.3693	9142.0986	9651.3121	16657.4531	27395.3949	38464.0774	48182.0090	(97)
Space heating kWh	33486.3433	27705.2295	25428.0493	16811.3892	10009.6373	0.0000	0.0000	0.0000	0.0000	15652.9060	24245.0417	32771.5445	(98a)
Space heating requirement - total per year (kWh/year)												186110.1409	
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	33486.3433	27705.2295	25428.0493	16811.3892	10009.6373	0.0000	0.0000	0.0000	0.0000	15652.9060	24245.0417	32771.5445	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												186110.1409	
Space heating per m2											(98c) / (4) =	92.2218	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	89.5000 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	33486.3433	27705.2295	25428.0493	16811.3892	10009.6373	0.0000	0.0000	0.0000	0.0000	15652.9060	24245.0417	32771.5445	(98)
Space heating efficiency (main heating system 1)	89.5000	89.5000	89.5000	89.5000	89.5000	0.0000	0.0000	0.0000	0.0000	89.5000	89.5000	89.5000	(210)
Space heating fuel (main heating system)	37414.9087	30955.5637	28411.2283	18783.6751	11183.9523	0.0000	0.0000	0.0000	0.0000	17489.2805	27089.4321	36616.2509	(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	418.0302	368.9735	390.1648	338.6817	325.3502	289.9506	283.8122	296.8731	302.1152	340.7409	367.0370	412.8916	(64)
Efficiency of water heater												89.5000	(216)
(217)m	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	89.5000	(217)
Fuel for water heating, kWh/month	467.0729	412.2609	435.9383	378.4153	363.5197	323.9671	317.1086	331.7018	337.5589	380.7161	410.0972	461.3314	(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	165.3389	132.6410	119.4285	87.4984	67.5863	55.2186	61.6545	80.1408	104.0950	136.5783	154.2649	169.9341	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year	
Space heating fuel - main system 1	207944.2915 (211)
Space heating fuel - main system 2	0.0000 (213)
Space heating fuel - secondary	0.0000 (215)
Efficiency of water heater	89.5000
Water heating fuel used	4619.6883 (219)
Space cooling fuel	0.0000 (221)

Electricity for pumps and fans:		
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	1334.3793	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	213984.3591	(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	207944.2915	0.2100	43668.3012	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4619.6883	0.2100	970.1345	(264)
Space and water heating			44638.4358	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1334.3793	0.1443	192.5922	(268)
Total CO2, kg/year			44842.9572	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			22.2200	(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	207944.2915	1.1300	234977.0494	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4619.6883	1.1300	5220.2478	(278)
Space and water heating			240197.2972	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1334.3793	1.5338	2046.7155	(282)
Total Primary energy kWh/year			242374.1135	(286)
Dwelling Primary energy Rate (DPER)			120.1000	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700 (1a)	x	3.3000 (2a)	=	3052.0710	(1a) - (3a)
Ground floor	492.0700 (1b)	x	3.9000 (2b)	=	1919.0730	(1b) - (3b)
First floor	371.3000 (1c)	x	3.8700 (2c)	=	1436.9310	(1c) - (3c)
Second floor	229.8300 (1d)	x	2.7000 (2d)	=	620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7028.6160	(5)

2. Ventilation rate

	m3 per hour	
Number of open chimneys	0 * 80 = 0.0000	(6a)
Number of open flues	0 * 20 = 0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000	(6d)
Number of flues attached to other heater	0 * 35 = 0.0000	(6e)
Number of blocked chimneys	0 * 20 = 0.0000	(6f)
Number of intermittent extract fans	4 * 10 = 40.0000	(7a)
Number of passive vents	0 * 10 = 0.0000	(7b)
Number of flueless gas fires	0 * 40 = 0.0000	(7c)
	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) = 0.0057	(8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.2557	(18)
Number of sides sheltered	0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] = 1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) = 0.2557	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			224.8100	1.1450	257.4160			(27)
New Rooflight			15.3100	2.0221	30.9577			(27a)
New rooflight			3.6000	2.0221	7.2794			(27a)
Existing rooflight			14.8700	2.0221	30.0680			(27a)
New basement floor			707.7400	0.1300	92.0062			(28a)
New exposed floor			217.1300	0.1300	28.2269			(28b)
Basement wall	600.3600		600.3600	0.1800	108.0648			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1800	66.4506			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1800	0.7686			(29a)
Existing walls	631.7700	115.1600	516.6100	0.1800	92.9898			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.1800	3.5316			(29a)
New pitched roof	150.8600	3.6000	147.2600	0.1100	16.1986			(30)
New flat roof	630.8100	15.3100	615.5000	0.1100	67.7050			(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1100	10.0166			(30)
Existing pitched roof	129.5900		129.5900	0.1100	14.2549			(30)
Total net area of external elements Aum(A, m2)			3676.9000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		825.9348			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.050 * total exposed area)		183.8450 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	1009.7798 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	1282.9768	1278.1906	1273.4993	1251.4640	1247.3413	1228.1493	1228.1493	1224.5953	1235.5418	1247.3413	1255.6815	1264.4009	(38)
Heat transfer coeff	2292.7566	2287.9704	2283.2791	2261.2438	2257.1211	2237.9291	2237.9291	2234.3750	2245.3216	2257.1211	2265.4613	2274.1806	(39)
Average = Sum(39)m / 12 =												2261.2241	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1361	1.1337	1.1314	1.1205	1.1185	1.1089	1.1089	1.1072	1.1126	1.1185	1.1226	1.1269	(40)
HLP (average)												1.1205	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy		5.3654 (42)
Hot water usage for mixer showers	114.1810 112.4651 109.9647 105.1805 101.6500 97.7127 95.4748 97.9563 100.6765 104.9039 109.7908	113.7435 (42a)
Hot water usage for baths	49.2248 48.4937 47.4642 45.5661 44.1447 42.5687 41.7174 42.7397 43.8528 45.5392 47.4764	49.0584 (42b)
Hot water usage for other uses	69.5773 67.0472 64.5171 61.9870 59.4569 56.9269 56.9269 59.4569 61.9870 64.5171 67.0472	69.5773 (42c)
Average daily hot water use (litres/day)		214.1623 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	427.6170	377.6326	399.7516	347.9593	334.9370	299.2282	293.3990	306.4599	311.3928	350.3277	376.3146	422.4784	(62)
WWHRS	-52.1988	-46.1650	-48.3414	-40.0286	-37.3052	-31.9223	-29.9221	-31.8191	-33.0281	-38.9364	-44.1103	-51.2321	(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	375.4182	331.4675	351.4102	307.9307	297.6318	267.3058	263.4769	274.6408	278.3647	311.3913	332.2043	371.2463	(64)
									Total per year (kWh/year) = Sum(64)m =			3762.4887	(64)
12Total per year (kWh/year)												3762	(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	169.5916	150.3193	160.3264	142.2213	138.7755	126.0182	124.9641	129.3069	130.0629	143.8929	151.6494	167.8831	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	795.7390	880.9968	795.7390	822.2637	795.7390	822.2637	795.7390	795.7390	822.2637	795.7390	822.2637	795.7390	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)	227.9457	223.6895	215.4924	197.5295	186.5262	175.0252	167.9625	173.7996	180.6429	193.4045	210.6242	225.6493	(72)
Total internal gains													

	2580.7994	2676.8539	2545.4659	2473.2725	2333.8056	2250.0210	2152.4279	2143.2119	2214.5130	2284.5052	2430.1884	2514.4971	(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	39.1500	10.6334	0.6300	0.7000	0.7700	127.2259	(74)
Northeast	26.7200	11.2829	0.6300	0.7000	0.7700	92.1363	(75)
East	5.2800	19.6403	0.6300	0.7000	0.7700	31.6922	(76)
Southeast	63.4000	36.7938	0.6300	0.7000	0.7700	712.9123	(77)
South	6.2100	46.7521	0.6300	0.7000	0.7700	88.7287	(78)
Southwest	27.0000	36.7938	0.6300	0.7000	0.7700	303.6062	(79)
West	21.0100	19.6403	0.6300	0.7000	0.7700	126.1087	(80)
Northwest	36.0400	11.2829	0.6300	0.7000	0.7700	124.2736	(81)
North	33.7800	26.0000	0.6300	0.7000	1.0000	335.4401	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	1942.1241	3561.9791	5503.8649	7804.0191	9587.7098	9876.8594	9374.1859	7997.8547	6298.0592	4110.9159	2373.5070	1630.8761	(83)
Total gains	4522.9235	6238.8330	8049.3309	10277.2915	11921.5154	12126.8804	11526.6138	10141.0666	8512.5722	6395.4211	4803.6954	4145.3732	(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	61.1246	61.2524	61.3783	61.9764	62.0896	62.6221	62.6221	62.7217	62.4159	62.0896	61.8610	61.6238	
alpha	5.0750	5.0835	5.0919	5.1318	5.1393	5.1748	5.1748	5.1814	5.1611	5.1393	5.1241	5.1083	
util living area	1.0000	0.9999	0.9994	0.9959	0.9757	0.8991	0.7657	0.8438	0.9790	0.9991	0.9999	1.0000	(86)
MIT	19.2018	19.3698	19.6642	20.0854	20.4999	20.8170	20.9453	20.9079	20.6171	20.0873	19.5753	19.1831	(87)
Th 2	19.9714	19.9734	19.9753	19.9841	19.9858	19.9935	19.9935	19.9950	19.9905	19.9858	19.9824	19.9789	(88)
util rest of house	1.0000	0.9999	0.9992	0.9939	0.9618	0.8361	0.6308	0.7276	0.9607	0.9985	0.9999	1.0000	(89)
MIT 2	17.8252	18.0421	18.4210	18.9665	19.4897	19.8609	19.9713	19.9500	19.6441	18.9713	18.3122	17.8064	(90)
Living area fraction									fLA = Living area / (4) =			0.0208	(91)
MIT	17.8539	18.0698	18.4469	18.9898	19.5107	19.8808	19.9916	19.9700	19.6644	18.9945	18.3385	17.8351	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8539	18.0698	18.4469	18.9898	19.5107	19.8808	19.9916	19.9700	19.6644	18.9945	18.3385	17.8351	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9997	0.9986	0.9908	0.9523	0.8271	0.6305	0.7240	0.9514	0.9975	0.9998	1.0000	(94)
Useful gains	4522.7050	6237.1823	8037.9762	10182.2810	11353.2370	10029.5626	7267.3420	7342.0503	8099.2668	6379.4447	4802.9378	4145.2499	(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	31075.7219	30132.0516	27278.1473	22815.4895	17629.7361	11818.0718	7590.1139	7976.6758	12493.8106	18947.3509	25460.4330	31008.6406	(97)
Space heating kWh	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(98a)
Space heating requirement - total per year (kWh/year)												108103.3910	
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	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												108103.3910	
Space heating per m2											(98c) / (4) =	53.5677	(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	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(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)	21403.5153	17396.9146	15508.8703	9854.7239	5059.2799	0.0000	0.0000	0.0000	0.0000	10130.5766	16114.1891	21653.6974	(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	375.4182	331.4675	351.4102	307.9307	297.6318	267.3058	263.4769	274.6408	278.3647	311.3913	332.2043	371.2463	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.6136	88.5979	88.5607	88.4733	88.2040	79.8000	79.8000	79.8000	79.8000	88.4784	88.5817	88.6177	(217)
Fuel for water heating, kWh/month	423.6575	374.1257	396.8016	348.0494	337.4359	334.9697	330.1716	344.1614	348.8280	351.9405	375.0258	418.9300	(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	165.3389	132.6410	119.4285	87.4984	67.5863	55.2186	61.6545	80.1408	104.0950	136.5783	154.2649	169.9341	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-558.2468	-670.3722	-820.6138	-779.3383	-733.7342	-646.8526	-635.3902	-645.4125	-658.9289	-682.0196	-568.2226	-497.1461	(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	-795.9450	-1578.0284	-2977.2636	-4263.0805	-5453.0401	-5417.8273	-5356.7391	-4618.7447	-3499.8273	-2183.8533	-1035.8315	-637.5585	(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	117121.7671	(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	4384.0971	(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)	1334.3793	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-45714.0169	(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	77212.2265	(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	117121.7671	0.2100	24595.5711	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4384.0971	0.2100	920.6604	(264)
Space and water heating			25516.2315	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1334.3793	0.1443	192.5922	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	0.1384	-1092.5232	
PV Unit electricity exported	-37817.7393	0.1274	-4816.2055	
Total			-5908.7287	(269)
Total CO2, kg/year			19812.0242	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.8200	(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	117121.7671	1.1300	132347.5968	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4384.0971	1.1300	4954.0297	(278)
Space and water heating			137301.6265	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1334.3793	1.5338	2046.7155	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	1.5116	-11935.6281	
PV Unit electricity exported	-37817.7393	0.4675	-17681.0351	
Total			-29616.6632	(283)
Total Primary energy kWh/year			109861.7796	(286)
Target Primary Energy Rate (TPER)			54.4400	(287)

Energy Assessment
Radlett House

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Be Lean Approved Extension scheme – DER from the Be Lean scenario DER SAP worksheet

Full SAP Calculation Printout

Property Reference	Extension scheme	**Issued on Date**	19/11/2023
Assessment Reference	Extension scheme Lean	**Prop Type Ref**	
Property			

SAP Rating	76 C	**DER**	18.40	**TER**	9.82
Environmental	76 C	**% DER < TER**			-87.37
CO_2 Emissions (t/year)	31.7	**DFEE**	74.14	**TFEE**	56.17
Compliance Check	See BREL	**% DFEE < TFEE**			-32.00
% DPER < TPER	-91.62	**DPER**	104.32	**TPER**	54.44

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700	(1a)	x 3.3000	(2a) =	3052.0710	(1a) - (3a)
Ground floor	492.0700	(1b)	x 3.9000	(2b) =	1919.0730	(1b) - (3b)
First floor	371.3000	(1c)	x 3.8700	(2c) =	1436.9310	(1c) - (3c)
Second floor	229.8300	(1d)	x 2.7000	(2d) =	620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7028.6160	(5)

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2. Ventilation rate

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

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		7.0000 (17)
Infiltration rate		0.3500 (18)
Number of sides sheltered		0 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3500 (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	0.4462	0.4375	0.4288	0.3850	0.3762	0.3325	0.3325	0.3237	0.3500	0.3762	0.3937	0.4113	(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) =	81.9000 (23c)

Effective ac	0.5367	0.5280	0.5192	0.4755	0.4667	0.4230	0.4230	0.4142	0.4405	0.4667	0.4842	0.5017	(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	
Existing window (Uw = 0.85)			122.4200	0.8221	100.6354			(27)
New window (Uw = 0.85)			102.3900	0.8221	84.1697			(27)
Existing rooflight			14.8700	2.8369	42.1844			(27a)
New Rooflight			15.3100	0.9615	14.7212			(27a)
New rooflight			3.6000	0.9615	3.4615			(27a)
New basement floor			707.7400	0.1100	77.8514			(28a)
New exposed floor			217.1300	0.1065	23.1213			(28b)
Basement wall	600.3600		600.3600	0.1200	72.0432			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1200	44.3004			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1200	0.5124			(29a)
Existing walls	631.7700	115.1600	516.6100	0.3000	154.9830			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.3000	5.8860			(29a)

New pitched roof	150.8600	3.6000	147.2600	0.1100	16.1986		(30)
New flat roof	630.8100	15.3100	615.5000	0.1100	67.7050		(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1600	14.5696		(30)
Existing pitched roof	129.5900		129.5900	0.1600	20.7344		(30)
Total net area of external elements Aum(A, m2)			3676.9000				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		743.0775		(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K						250.0000	(35)
Thermal bridges (Default value 0.200 * total exposed area)						735.3800	(36)
Point Thermal bridges					(36a) =	0.0000	
Total fabric heat loss					(33) + (36) + (36a) =	1478.4575	(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	1244.9612	1224.6661	1204.3709	1102.8953	1082.6002	981.1245	981.1245	960.8294	1021.7148	1082.6002	1123.1904	1163.7807	(38)
Heat transfer coeff	2723.4187	2703.1236	2682.8284	2581.3528	2561.0577	2459.5820	2459.5820	2439.2869	2500.1723	2561.0577	2601.6479	2642.2382	(39)
Average = Sum(39)m / 12 =												2576.2790	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3495	1.3395	1.3294	1.2791	1.2691	1.2188	1.2188	1.2087	1.2389	1.2691	1.2892	1.3093	(40)
HLP (average)												1.2766	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												5.3654	(42)
Hot water usage for mixer showers	114.1810	112.4651	109.9647	105.1805	101.6500	97.7127	95.4748	97.9563	100.6765	104.9039	109.7908	113.7435	(42a)
Hot water usage for baths	49.2248	48.4937	47.4642	45.5661	44.1447	42.5687	41.7174	42.7397	43.8528	45.5392	47.4764	49.0584	(42b)
Hot water usage for other uses	69.5773	67.0472	64.5171	61.9870	59.4569	56.9269	56.9269	59.4569	61.9870	64.5171	67.0472	69.5773	(42c)
Average daily hot water use (litres/day)												214.1623	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5400	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8316	(55)
Total storage loss	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(56)
If cylinder contains dedicated solar storage	25.7796	23.2848	25.7796	24.9480	25.7796	24.9480	25.7796	25.7796	24.9480	25.7796	24.9480	25.7796	(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	418.0302	368.9735	390.1648	338.6817	325.3502	289.9506	283.8122	296.8731	302.1152	340.7409	367.0370	412.8916	(62)
WWHRS	-99.2487	-87.7764	-91.9144	-76.1087	-70.9306	-60.6958	-56.8927	-60.4996	-62.7982	-74.0322	-83.8695	-97.4108	(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	318.7815	281.1971	298.2504	262.5730	254.4196	229.2548	226.9195	236.3735	239.3170	266.7087	283.1675	315.4808	(64)
										Total per year (kWh/year) = Sum(64)m =		3212.4434	(64)
12Total per year (kWh/year)												3212	(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	161.9222	143.3921	152.6569	134.7992	131.1061	118.5961	117.2947	121.6375	122.6409	136.2235	144.2274	160.2136	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	817.8842	905.5146	817.8842	845.1470	817.8842	845.1470	817.8842	817.8842	845.1470	817.8842	845.1470	817.8842	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)	217.6373	213.3811	205.1840	187.2211	176.2178	164.7168	157.6541	163.4912	170.3345	183.0961	200.3158	215.3409	(72)
Total internal gains	2592.6361	2691.0633	2557.3027	2485.8474	2345.6423	2262.5959	2164.2646	2155.0486	2227.0879	2296.3419	2442.7633	2526.3339	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	24.3000	11.2829	0.4000	0.7000	0.7700	53.2010	(75)
Southeast	56.7500	36.7938	0.4000	0.7000	0.7700	405.1652	(77)
Southwest	23.3700	36.7938	0.4000	0.7000	0.7700	166.8495	(79)
Northwest	18.0000	11.2829	0.4000	0.7000	0.7700	39.4082	(81)
North	39.1500	10.6334	0.4000	0.7000	0.7700	80.7783	(74)
Northeast	2.4200	11.2829	0.4000	0.7000	0.7700	5.2982	(75)
East	5.2800	19.6403	0.4000	0.7000	0.7700	20.1221	(76)

Southeast				6.6500	36.7938	0.4000	0.7000	0.7700	47.4775	(77)			
South				6.2100	46.7521	0.4000	0.7000	0.7700	56.3357	(78)			
Southwest				3.6300	36.7938	0.4000	0.7000	0.7700	25.9163	(79)			
West				21.0100	19.6403	0.4000	0.7000	0.7700	80.0690	(80)			
Northwest				18.0400	11.2829	0.4000	0.7000	0.7700	39.4957	(81)			
North				14.8700	26.0000	0.7600	0.7000	1.0000	185.1137	(82)			
North				18.9100	26.0000	0.4000	0.7000	1.0000	115.5496	(82)			
Solar gains	1320.7801	2443.6899	3818.2789	5460.8101	6734.9579	6945.5251	6589.2696	5607.4880	4386.6071	2832.6914	1618.2816	1106.2997	(83)
Total gains	3913.4162	5134.7532	6375.5816	7946.6575	9080.6002	9208.1210	8753.5342	7762.5366	6613.6950	5129.0333	4061.0449	3632.6336	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	51.4588	51.8451	52.2373	54.2908	54.7210	56.9787	56.9787	57.4528	56.0536	54.7210	53.8673	53.0398	
alpha	4.4306	4.4563	4.4825	4.6194	4.6481	4.7986	4.7986	4.8302	4.7369	4.6481	4.5912	4.5360	
util living area	1.0000	0.9999	0.9997	0.9987	0.9930	0.9669	0.9024	0.9411	0.9934	0.9996	1.0000	1.0000	(86)
MIT	19.3323	19.4524	19.6762	20.0262	20.3563	20.6664	20.8205	20.7816	20.5159	20.0948	19.6853	19.3539	(87)
Th 2	19.8022	19.8101	19.8179	19.8572	19.8651	19.9050	19.9050	19.9130	19.8890	19.8651	19.8493	19.8336	(88)
util rest of house	1.0000	0.9999	0.9996	0.9980	0.9882	0.9363	0.7956	0.8667	0.9866	0.9994	0.9999	1.0000	(89)
MIT 2	17.8231	17.9831	18.2761	18.7547	19.1824	19.5987	19.7634	19.7376	19.4053	18.8489	18.3116	17.8744	(90)
Living area fraction									fLA = Living area / (4) =			0.0208	(91)
MIT	17.8545	18.0137	18.3052	18.7811	19.2068	19.6210	19.7854	19.7594	19.4284	18.8748	18.3402	17.9052	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8545	18.0137	18.3052	18.7811	19.2068	19.6210	19.7854	19.7594	19.4284	18.8748	18.3402	17.9052	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9998	0.9994	0.9968	0.9836	0.9239	0.7787	0.8501	0.9814	0.9990	0.9999	1.0000	(94)
Useful gains	3913.2481	5133.9526	6371.7225	7921.5909	8931.7842	8507.7251	6816.3342	6599.0045	6490.7330	5123.7128	4060.6400	3632.5371	(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	36914.6901	35447.8556	31671.4373	25506.6822	19225.3841	12349.4451	7834.7469	8194.4538	13321.9287	21192.3479	29242.9938	36212.3266	(97)
Space heating kWh	24553.0729	20370.9428	18822.9879	12661.2658	7658.4383	0.0000	0.0000	0.0000	0.0000	11955.0646	18131.2947	24239.3634	(98a)
Space heating requirement - total per year (kWh/year)												138392.4303	
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	24553.0729	20370.9428	18822.9879	12661.2658	7658.4383	0.0000	0.0000	0.0000	0.0000	11955.0646	18131.2947	24239.3634	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												138392.4303	
Space heating per m2											(98c) / (4) =	68.5766	(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 %)												84.5000	(206)
Efficiency of main space heating system 2 (in %)												0.0000	(207)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement	24553.0729	20370.9428	18822.9879	12661.2658	7658.4383	0.0000	0.0000	0.0000	0.0000	11955.0646	18131.2947	24239.3634	(98)
Space heating efficiency (main heating system 1)	84.5000	84.5000	84.5000	84.5000	84.5000	0.0000	0.0000	0.0000	0.0000	84.5000	84.5000	84.5000	(210)
Space heating fuel (main heating system)	29056.8910	24107.6246	22275.7253	14983.7465	9063.2406	0.0000	0.0000	0.0000	0.0000	14148.0054	21457.1535	28685.6372	(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	318.7815	281.1971	298.2504	262.5730	254.4196	229.2548	226.9195	236.3735	239.3170	266.7087	283.1675	315.4808	(64)
Efficiency of water heater												89.5000	(216)
(217)m	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	84.5000	(217)
Fuel for water heating, kWh/month	377.2562	332.7777	352.9590	310.7372	301.0882	271.3074	268.5438	279.7319	283.2154	315.6316	335.1095	373.3501	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	1077.8759	973.5654	1077.8759	1043.1057	1077.8759	1043.1057	1077.8759	1077.8759	1043.1057	1077.8759	1043.1057	1077.8759	(231)
Lighting	158.1303	126.8580	114.2216	83.6836	64.6396	52.8111	58.9664	76.6468	99.5566	130.6237	147.5391	162.5252	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)
Annual totals kWh/year													
Space heating fuel - main system 1												163778.0240	(211)

Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	89.5000	
Water heating fuel used	3801.7082	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)		
mechanical ventilation fans (SFP = 1.4700)	12605.1199	(230a)
central heating pump	41.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	12691.1199	(231)
Electricity for lighting (calculated in Appendix L)	1276.2021	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	181547.0542	(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	163778.0240	0.2100	34393.3850	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3801.7082	0.2100	798.3587	(264)
Space and water heating			35191.7438	(265)
Pumps, fans and electric keep-hot	12691.1199	0.1387	1760.4148	(267)
Energy for lighting	1276.2021	0.1443	184.1954	(268)
Total CO2, kg/year			37136.3540	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			18.4000	(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	163778.0240	1.1300	185069.1671	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3801.7082	1.1300	4295.9303	(278)
Space and water heating			189365.0974	(279)
Pumps, fans and electric keep-hot	12691.1199	1.5128	19199.1262	(281)
Energy for lighting	1276.2021	1.5338	1957.4814	(282)
Total Primary energy kWh/year			210521.7050	(286)
Dwelling Primary energy Rate (DPER)			104.3200	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700	(1a)	x 3.3000	(2a)	= 3052.0710	(1a) - (3a)
Ground floor	492.0700	(1b)	x 3.9000	(2b)	= 1919.0730	(1b) - (3b)
First floor	371.3000	(1c)	x 3.8700	(2c)	= 1436.9310	(1c) - (3c)
Second floor	229.8300	(1d)	x 2.7000	(2d)	= 620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		= 7028.6160	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			224.8100	1.1450	257.4160			(27)
New Rooflight			15.3100	2.0221	30.9577			(27a)
New rooflight			3.6000	2.0221	7.2794			(27a)
Existing rooflight			14.8700	2.0221	30.0680			(27a)
New basement floor			707.7400	0.1300	92.0062			(28a)
New exposed floor			217.1300	0.1300	28.2269			(28b)
Basement wall	600.3600		600.3600	0.1800	108.0648			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1800	66.4506			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1800	0.7686			(29a)
Existing walls	631.7700	115.1600	516.6100	0.1800	92.9898			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.1800	3.5316			(29a)
New pitched roof	150.8600	3.6000	147.2600	0.1100	16.1986			(30)
New flat roof	630.8100	15.3100	615.5000	0.1100	67.7050			(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1100	10.0166			(30)
Existing pitched roof	129.5900		129.5900	0.1100	14.2549			(30)
Total net area of external elements Aum(A, m2)			3676.9000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	825.9348			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (User defined value 0.050 * total exposed area)							183.8450	(36)
Point Thermal bridges						(36a) =	0.0000	
Total fabric heat loss						(33) + (36) + (36a) =	1009.7798	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	1282.9768	1278.1906	1273.4993	1251.4640	1247.3413	1228.1493	1228.1493	1224.5953	1235.5418	1247.3413	1255.6815	1264.4009	(38)
Heat transfer coeff	2292.7566	2287.9704	2283.2791	2261.2438	2257.1211	2237.9291	2237.9291	2234.3750	2245.3216	2257.1211	2265.4613	2274.1806	(39)
Average = Sum(39)m / 12 =												2261.2241	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1361	1.1337	1.1314	1.1205	1.1185	1.1089	1.1089	1.1072	1.1126	1.1185	1.1226	1.1269	(40)
HLP (average)												1.1205	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy											5.3654	(42)
Hot water usage for mixer showers	114.1810	112.4651	109.9647	105.1805	101.6500	97.7127	95.4748	97.9563	100.6765	104.9039	109.7908	113.7435	(42a)
Hot water usage for baths	49.2248	48.4937	47.4642	45.5661	44.1447	42.5687	41.7174	42.7397	43.8528	45.5392	47.4764	49.0584	(42b)
Hot water usage for other uses	69.5773	67.0472	64.5171	61.9870	59.4569	56.9269	56.9269	59.4569	61.9870	64.5171	67.0472	69.5773	(42c)
Average daily hot water use (litres/day)												214.1623	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	427.6170	377.6326	399.7516	347.9593	334.9370	299.2282	293.3990	306.4599	311.3928	350.3277	376.3146	422.4784	(62)
WWHRS	-52.1988	-46.1650	-48.3414	-40.0286	-37.3052	-31.9223	-29.9221	-31.8191	-33.0281	-38.9364	-44.1103	-51.2321	(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	375.4182	331.4675	351.4102	307.9307	297.6318	267.3058	263.4769	274.6408	278.3647	311.3913	332.2043	371.2463	(64)
									Total per year (kWh/year) = Sum(64)m =			3762.4887	(64)
12Total per year (kWh/year)												3762	(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	169.5916	150.3193	160.3264	142.2213	138.7755	126.0182	124.9641	129.3069	130.0629	143.8929	151.6494	167.8831	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	795.7390	880.9968	795.7390	822.2637	795.7390	822.2637	795.7390	795.7390	822.2637	795.7390	822.2637	795.7390	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													

	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)													
	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)													
	227.9457	223.6895	215.4924	197.5295	186.5262	175.0252	167.9625	173.7996	180.6429	193.4045	210.6242	225.6493	(72)
Total internal gains													
	2580.7994	2676.8539	2545.4659	2473.2725	2333.8056	2250.0210	2152.4279	2143.2119	2214.5130	2284.5052	2430.1884	2514.4971	(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	39.1500	10.6334	0.6300	0.7000	0.7700	127.2259	(74)
Northeast	26.7200	11.2829	0.6300	0.7000	0.7700	92.1363	(75)
East	5.2800	19.6403	0.6300	0.7000	0.7700	31.6922	(76)
Southeast	63.4000	36.7938	0.6300	0.7000	0.7700	712.9123	(77)
South	6.2100	46.7521	0.6300	0.7000	0.7700	88.7287	(78)
Southwest	27.0000	36.7938	0.6300	0.7000	0.7700	303.6062	(79)
West	21.0100	19.6403	0.6300	0.7000	0.7700	126.1087	(80)
Northwest	36.0400	11.2829	0.6300	0.7000	0.7700	124.2736	(81)
North	33.7800	26.0000	0.6300	0.7000	1.0000	335.4401	(82)

Solar gains	1942.1241	3561.9791	5503.8649	7804.0191	9587.7098	9876.8594	9374.1859	7997.8547	6298.0592	4110.9159	2373.5070	1630.8761	(83)
Total gains	4522.9235	6238.8330	8049.3309	10277.2915	11921.5154	12126.8804	11526.6138	10141.0666	8512.5722	6395.4211	4803.6954	4145.3732	(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	61.1246	61.2524	61.3783	61.9764	62.0896	62.6221	62.6221	62.7217	62.4159	62.0896	61.8610	61.6238	
alpha	5.0750	5.0835	5.0919	5.1318	5.1393	5.1748	5.1748	5.1814	5.1611	5.1393	5.1241	5.1083	
util living area													
	1.0000	0.9999	0.9994	0.9959	0.9757	0.8991	0.7657	0.8438	0.9790	0.9991	0.9999	1.0000	(86)
MIT	19.2018	19.3698	19.6642	20.0854	20.4999	20.8170	20.9453	20.9079	20.6171	20.0873	19.5753	19.1831	(87)
Th 2	19.9714	19.9734	19.9753	19.9841	19.9858	19.9935	19.9935	19.9950	19.9905	19.9858	19.9824	19.9789	(88)
util rest of house													
	1.0000	0.9999	0.9992	0.9939	0.9618	0.8361	0.6308	0.7276	0.9607	0.9985	0.9999	1.0000	(89)
MIT 2	17.8252	18.0421	18.4210	18.9665	19.4897	19.8609	19.9713	19.9500	19.6441	18.9713	18.3122	17.8064	(90)
Living area fraction									fLA = Living area / (4) =			0.0208	(91)
MIT	17.8539	18.0698	18.4469	18.9898	19.5107	19.8808	19.9916	19.9700	19.6644	18.9945	18.3385	17.8351	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8539	18.0698	18.4469	18.9898	19.5107	19.8808	19.9916	19.9700	19.6644	18.9945	18.3385	17.8351	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9997	0.9986	0.9908	0.9523	0.8271	0.6305	0.7240	0.9514	0.9975	0.9998	1.0000	(94)
Useful gains	4522.7050	6237.1823	8037.9762	10182.2810	11353.2370	10029.5626	7267.3420	7342.0503	8099.2668	6379.4447	4802.9378	4145.2499	(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													
	31075.7219	30132.0516	27278.1473	22815.4895	17629.7361	11818.0718	7590.1139	7976.6758	12493.8106	18947.3509	25460.4330	31008.6406	(97)
Space heating kWh													
	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(98a)
Space heating requirement - total per year (kWh/year)												108103.3910	
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													
	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												108103.3910	
Space heating per m2											(98c) / (4) =	53.5677	(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													
	19755.4446	16057.3521	14314.6873	9095.9101	4669.7154	0.0000	0.0000	0.0000	0.0000	9350.5222	14873.3966	19986.3627	(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)													
	21403.5153	17396.9146	15508.8703	9854.7239	5059.2799	0.0000	0.0000	0.0000	0.0000	10130.5766	16114.1891	21653.6974	(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													
	375.4182	331.4675	351.4102	307.9307	297.6318	267.3058	263.4769	274.6408	278.3647	311.3913	332.2043	371.2463	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.6136	88.5979	88.5607	88.4733	88.2040	79.8000	79.8000	79.8000	79.8000	88.4784	88.5817	88.6177	(217)
Fuel for water heating, kWh/month													
	423.6575	374.1257	396.8016	348.0494	337.4359	334.9697	330.1716	344.1614	348.8280	351.9405	375.0258	418.9300	(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	165.3389	132.6410	119.4285	87.4984	67.5863	55.2186	61.6545	80.1408	104.0950	136.5783	154.2649	169.9341	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-558.2468	-670.3722	-820.6138	-779.3383	-733.7342	-646.8526	-635.3902	-645.4125	-658.9289	-682.0196	-568.2226	-497.1461	(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	-795.9450	-1578.0284	-2977.2636	-4263.0805	-5453.0401	-5417.8273	-5356.7391	-4618.7447	-3499.8273	-2183.8533	-1035.8315	-637.5585	(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	117121.7671	(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	4384.0971	(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)	1334.3793	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-45714.0169	(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	77212.2265	(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	117121.7671	0.2100	24595.5711	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4384.0971	0.2100	920.6604	(264)
Space and water heating			25516.2315	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1334.3793	0.1443	192.5922	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	0.1384	-1092.5232	
PV Unit electricity exported	-37817.7393	0.1274	-4816.2055	
Total			-5908.7287	(269)
Total CO2, kg/year			19812.0242	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.8200	(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	117121.7671	1.1300	132347.5968	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4384.0971	1.1300	4954.0297	(278)
Space and water heating			137301.6265	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1334.3793	1.5338	2046.7155	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	1.5116	-11935.6281	
PV Unit electricity exported	-37817.7393	0.4675	-17681.0351	
Total			-29616.6632	(283)
Total Primary energy kWh/year			109861.7796	(286)
Target Primary Energy Rate (TPER)			54.4400	(287)

Energy Assessment
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Be Green Approved Extension scheme – DER from the Be Green scenario DER SAP worksheet

Full SAP Calculation Printout

Property Reference	Extension scheme	**Issued on Date**	19/11/2023
Assessment Reference	Extension scheme Green	**Prop Type Ref**	
Property			

SAP Rating	62 D	**DER**	6.34	**TER**	9.82
Environmental	92 A	**% DER < TER**			35.44
CO_2 Emissions (t/year)	10.08	**DFEE**	74.14	**TFEE**	56.17
Compliance Check	See BREL	**% DFEE < TFEE**			-32.00
% DPER < TPER	-17.71	**DPER**	64.11	**TPER**	54.47

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

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700	(1a)	x 3.3000	(2a) =	3052.0710	(1a) - (3a)
Ground floor	492.0700	(1b)	x 3.9000	(2b) =	1919.0730	(1b) - (3b)
First floor	371.3000	(1c)	x 3.8700	(2c) =	1436.9310	(1c) - (3c)
Second floor	229.8300	(1d)	x 2.7000	(2d) =	620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	7028.6160	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		7.0000	(17)
Infiltration rate		0.3500	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3500	(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	0.4462	0.4375	0.4288	0.3850	0.3762	0.3325	0.3325	0.3237	0.3500	0.3762	0.3937	0.4113	(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) =	81.9000	(23c)

Effective ac	0.5367	0.5280	0.5192	0.4755	0.4667	0.4230	0.4230	0.4142	0.4405	0.4667	0.4842	0.5017	(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	
Existing window (Uw = 0.85)			122.4200	0.8221	100.6354			(27)
New window (Uw = 0.85)			102.3900	0.8221	84.1697			(27)
Existing rooflight			14.8700	2.8369	42.1844			(27a)
New Rooflight			15.3100	0.9615	14.7212			(27a)
New rooflight			3.6000	0.9615	3.4615			(27a)
New basement floor			707.7400	0.1100	77.8514			(28a)
New exposed floor			217.1300	0.1065	23.1213			(28b)
Basement wall	600.3600		600.3600	0.1200	72.0432			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1200	44.3004			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1200	0.5124			(29a)
Existing walls	631.7700	115.1600	516.6100	0.3000	154.9830			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.3000	5.8860			(29a)

New pitched roof	150.8600	3.6000	147.2600	0.1100	16.1986		(30)
New flat roof	630.8100	15.3100	615.5000	0.1100	67.7050		(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1600	14.5696		(30)
Existing pitched roof	129.5900		129.5900	0.1600	20.7344		(30)
Total net area of external elements Aum(A, m2)			3676.9000				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		743.0775		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (Default value 0.200 * total exposed area)	735.3800	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	1478.4575	(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	1244.9612	1224.6661	1204.3709	1102.8953	1082.6002	981.1245	981.1245	960.8294	1021.7148	1082.6002	1123.1904	1163.7807	(38)
Heat transfer coeff	2723.4187	2703.1236	2682.8284	2581.3528	2561.0577	2459.5820	2459.5820	2439.2869	2500.1723	2561.0577	2601.6479	2642.2382	(39)
Average = Sum(39)m / 12 =												2576.2790	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3495	1.3395	1.3294	1.2791	1.2691	1.2188	1.2188	1.2087	1.2389	1.2691	1.2892	1.3093	(40)
HLP (average)												1.2766	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												5.3654	(42)
Hot water usage for mixer showers	114.1810	112.4651	109.9647	105.1805	101.6500	97.7127	95.4748	97.9563	100.6765	104.9039	109.7908	113.7435	(42a)
Hot water usage for baths	49.2248	48.4937	47.4642	45.5661	44.1447	42.5687	41.7174	42.7397	43.8528	45.5392	47.4764	49.0584	(42b)
Hot water usage for other uses	69.5773	67.0472	64.5171	61.9870	59.4569	56.9269	56.9269	59.4569	61.9870	64.5171	67.0472	69.5773	(42c)
Average daily hot water use (litres/day)												214.1623	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												400.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.5200	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.3608	(55)
Total storage loss	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(56)
If cylinder contains dedicated solar storage	42.1848	38.1024	42.1848	40.8240	42.1848	40.8240	42.1848	42.1848	40.8240	42.1848	40.8240	42.1848	(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	434.4354	383.7911	406.5700	354.5577	341.7554	305.8266	300.2174	313.2783	317.9912	357.1461	382.9130	429.2968	(62)
WWHRS	-99.2487	-87.7764	-91.9144	-76.1087	-70.9306	-60.6958	-56.8927	-60.4996	-62.7982	-74.0322	-83.8695	-97.4108	(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	335.1867	296.0147	314.6556	278.4490	270.8248	245.1308	243.3247	252.7787	255.1930	283.1139	299.0435	331.8860	(64)
										Total per year (kWh/year) = Sum(64)m =		3405.6014	(64)
12Total per year (kWh/year)												3406	(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	175.0463	155.2462	165.7811	147.5000	144.2302	131.2969	130.4188	134.7616	135.3417	149.3477	156.9282	173.3378	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	817.8842	905.5146	817.8842	845.1470	817.8842	845.1470	817.8842	817.8842	845.1470	817.8842	845.1470	817.8842	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)	235.2773	231.0211	222.8240	204.8611	193.8578	182.3568	175.2941	181.1312	187.9745	200.7361	217.9558	232.9809	(72)
Total internal gains	2607.2761	2705.7033	2571.9427	2500.4874	2360.2823	2280.2359	2181.9046	2172.6886	2244.7279	2310.9819	2457.4033	2540.9739	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	24.3000	11.2829	0.4000	0.7000	0.7700	53.2010	(75)
Southeast	56.7500	36.7938	0.4000	0.7000	0.7700	405.1652	(77)
Southwest	23.3700	36.7938	0.4000	0.7000	0.7700	166.8495	(79)
Northwest	18.0000	11.2829	0.4000	0.7000	0.7700	39.4082	(81)
North	39.1500	10.6334	0.4000	0.7000	0.7700	80.7783	(74)
Northeast	2.4200	11.2829	0.4000	0.7000	0.7700	5.2982	(75)
East	5.2800	19.6403	0.4000	0.7000	0.7700	20.1221	(76)

Southeast				6.6500	36.7938	0.4000	0.7000	0.7700	47.4775	(77)			
South				6.2100	46.7521	0.4000	0.7000	0.7700	56.3357	(78)			
Southwest				3.6300	36.7938	0.4000	0.7000	0.7700	25.9163	(79)			
West				21.0100	19.6403	0.4000	0.7000	0.7700	80.0690	(80)			
Northwest				18.0400	11.2829	0.4000	0.7000	0.7700	39.4957	(81)			
North				14.8700	26.0000	0.7600	0.7000	1.0000	185.1137	(82)			
North				18.9100	26.0000	0.4000	0.7000	1.0000	115.5496	(82)			
Solar gains	1320.7801	2443.6899	3818.2789	5460.8101	6734.9579	6945.5251	6589.2696	5607.4880	4386.6071	2832.6914	1618.2816	1106.2997	(83)
Total gains	3928.0562	5149.3932	6390.2216	7961.2975	9095.2402	9225.7610	8771.1742	7780.1766	6631.3350	5143.6733	4075.6849	3647.2736	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	51.4588	51.8451	52.2373	54.2908	54.7210	56.9787	56.9787	57.4528	56.0536	54.7210	53.8673	53.0398	
alpha	4.4306	4.4563	4.4825	4.6194	4.6481	4.7986	4.7986	4.8302	4.7369	4.6481	4.5912	4.5360	
util living area	1.0000	0.9999	0.9997	0.9987	0.9929	0.9666	0.9018	0.9407	0.9933	0.9996	1.0000	1.0000	(86)
Living	19.3328	19.4529	19.6767	20.0267	20.3568	20.6670	20.8209	20.7821	20.5166	20.0953	19.6859	19.3544	
Non living	17.8239	17.9838	18.2768	18.7554	19.1831	19.5994	19.7637	19.7381	19.4061	18.8496	18.3123	17.8751	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	0	0	0	0	0	5	30	31	
16 / 9	0	0	0	0	0	0	0	0	0	23	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	20.3568	20.6670	20.8209	20.7821	20.5166	20.5323	21.0000	21.0000	(87)
Th 2	19.8022	19.8101	19.8179	19.8572	19.8651	19.9050	19.9050	19.9130	19.8890	19.8651	19.8493	19.8336	(88)
util rest of house	1.0000	0.9999	0.9996	0.9979	0.9881	0.9359	0.7946	0.8659	0.9864	0.9994	0.9999	1.0000	(89)
MIT 2	19.8022	19.8101	19.8179	19.8572	19.1831	19.5994	19.7637	19.7381	19.4061	19.4343	19.8493	19.8336	(90)
Living area fraction									fLA = Living area / (4) =			0.0208	(91)
MIT	19.8272	19.8348	19.8425	19.8810	19.2075	19.6216	19.7857	19.7598	19.4292	19.4572	19.8733	19.8578	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8272	19.8348	19.8425	19.8810	19.2075	19.6216	19.7857	19.7598	19.4292	19.4572	19.8733	19.8578	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9999	0.9996	0.9980	0.9835	0.9235	0.7778	0.8493	0.9812	0.9992	0.9999	1.0000	(94)
Useful gains	3927.9608	5148.9285	6387.8997	7945.0599	8945.3132	8520.0557	6822.2545	6607.6082	6506.8470	5139.6528	4075.4509	3647.2189	(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	42287.0049	40370.6587	35795.5723	28345.8592	19227.1430	12351.0329	7835.5090	8195.5620	13323.9904	22683.7276	33231.5502	41371.7412	(97)
Space heating kWh	28539.1288	23669.0027	21879.3084	14688.5755	7649.6814	0.0000	0.0000	0.0000	0.0000	13052.7916	20992.3915	28067.0446	(98a)
Space heating requirement - total per year (kWh/year)												158537.9244	
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	28539.1288	23669.0027	21879.3084	14688.5755	7649.6814	0.0000	0.0000	0.0000	0.0000	13052.7916	20992.3915	28067.0446	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												158537.9244	
Space heating per m2											(98c) / (4) =	78.5592	(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 %)												187.2753	(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	28539.1288	23669.0027	21879.3084	14688.5755	7649.6814	0.0000	0.0000	0.0000	0.0000	13052.7916	20992.3915	28067.0446	(98)
Space heating efficiency (main heating system 1)	187.2753	187.2753	187.2753	187.2753	187.2753	0.0000	0.0000	0.0000	0.0000	187.2753	187.2753	187.2753	(210)
Space heating fuel (main heating system)	15239.1287	12638.6121	11682.9634	7843.3050	4084.7245	0.0000	0.0000	0.0000	0.0000	6969.8403	11209.3735	14987.0484	(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	335.1867	296.0147	314.6556	278.4490	270.8248	245.1308	243.3247	252.7787	255.1930	283.1139	299.0435	331.8860	(64)
Efficiency of water heater												313.3966	(216)
(217)m	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	313.3966	(217)
Fuel for water heating, kWh/month	106.9529	94.4537	100.4017	88.8487	86.4160	78.2174	77.6411	80.6578	81.4281	90.3373	95.4201	105.8997	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	1070.5718	966.9681	1070.5718	1036.0373	1070.5718	1036.0373	1070.5718	1070.5718	1036.0373	1070.5718	1036.0373	1070.5718	(231)
Lighting	158.1303	126.8580	114.2216	83.6836	64.6396	52.8111	58.9664	76.6468	99.5566	130.6237	147.5391	162.5252	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-475.6281	-815.3210	-1436.5485	-1978.7986	-2475.9033	-2411.1201	-2375.9150	-2062.2698	-1586.7074	-1056.0602	-568.6470	-394.8625	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-0.0110	-0.0681	-0.3660	-1.6259	-6.9163	-41.8981	-39.8180	-26.4315	-12.5990	-0.3280	-0.0295	-0.0067	(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	84654.9958	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	313.3966	
Water heating fuel used	1086.6745	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 1.4700)		
mechanical ventilation fans (SFP = 1.4700)	12605.1199	(230a)
Total electricity for the above, kWh/year	12605.1199	(231)
Electricity for lighting (calculated in Appendix L)	1276.2021	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-17767.8795	(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	81855.1130	(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	84654.9958	0.1540	13037.8281	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1086.6745	0.1407	152.9478	(264)
Space and water heating			13190.7759	(265)
Pumps, fans and electric keep-hot	12605.1199	0.1387	1748.4855	(267)
Energy for lighting	1276.2021	0.1443	184.1954	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-17637.7814	0.1309	-2309.0241	
PV Unit electricity exported	-130.0980	0.1016	-13.2201	
Total			-2322.2442	(269)
Total CO2, kg/year			12801.2126	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			6.3400	(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	84654.9958	1.5702	132925.5911	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1086.6745	1.5204	1652.2112	(278)
Space and water heating			134577.8023	(279)
Pumps, fans and electric keep-hot	12605.1199	1.5128	19069.0254	(281)
Energy for lighting	1276.2021	1.5338	1957.4814	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-17637.7814	1.4836	-26167.7170	
PV Unit electricity exported	-130.0980	0.3700	-48.1326	
Total			-26215.8496	(283)
Total Primary energy kWh/year			129388.4596	(286)
Dwelling Primary energy Rate (DPER)			64.1100	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	924.8700	(1a)	x 3.3000	(2a)	= 3052.0710	(1a) - (3a)
Ground floor	492.0700	(1b)	x 3.9000	(2b)	= 1919.0730	(1b) - (3b)
First floor	371.3000	(1c)	x 3.8700	(2c)	= 1436.9310	(1c) - (3c)
Second floor	229.8300	(1d)	x 2.7000	(2d)	= 620.5410	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	2018.0700					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		= 7028.6160	(5)

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2. Ventilation rate

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0057	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.2557	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2557	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3260	0.3196	0.3132	0.2813	0.2749	0.2429	0.2429	0.2365	0.2557	0.2749	0.2877	0.3004	(22b)
Effective ac	0.5531	0.5511	0.5491	0.5396	0.5378	0.5295	0.5295	0.5280	0.5327	0.5378	0.5414	0.5451	(25)

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 Opening Type (Uw = 1.20)			224.8100	1.1450	257.4160			(27)
New Rooflight			15.3100	2.0221	30.9577			(27a)
New rooflight			3.6000	2.0221	7.2794			(27a)
Existing rooflight			14.8700	2.0221	30.0680			(27a)
New basement floor			707.7400	0.1300	92.0062			(28a)
New exposed floor			217.1300	0.1300	28.2269			(28b)
Basement wall	600.3600		600.3600	0.1800	108.0648			(29a)
Newexternal walls	465.5100	96.3400	369.1700	0.1800	66.4506			(29a)
New dormer walls	10.3200	6.0500	4.2700	0.1800	0.7686			(29a)
Existing walls	631.7700	115.1600	516.6100	0.1800	92.9898			(29a)
Existing dormer	26.8800	7.2600	19.6200	0.1800	3.5316			(29a)
New pitched roof	150.8600	3.6000	147.2600	0.1100	16.1986			(30)
New flat roof	630.8100	15.3100	615.5000	0.1100	67.7050			(30)
Existing flat roof	105.9300	14.8700	91.0600	0.1100	10.0166			(30)
Existing pitched roof	129.5900		129.5900	0.1100	14.2549			(30)
Total net area of external elements Aum(A, m2)			3676.9000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		825.9348			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (User defined value 0.050 * total exposed area)	183.8450	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	1009.7798	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	1282.9768	1278.1906	1273.4993	1251.4640	1247.3413	1228.1493	1228.1493	1224.5953	1235.5418	1247.3413	1255.6815	1264.4009	(38)
Heat transfer coeff	2292.7566	2287.9704	2283.2791	2261.2438	2257.1211	2237.9291	2237.9291	2234.3750	2245.3216	2257.1211	2265.4613	2274.1806	(39)
Average = Sum(39)m / 12 =												2261.2241	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1361	1.1337	1.1314	1.1205	1.1185	1.1089	1.1089	1.1072	1.1126	1.1185	1.1226	1.1269	(40)
HLP (average)												1.1205	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy	5.3654	(42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	114.1810	112.4651	109.9647	105.1805	101.6500	97.7127	95.4748	97.9563	100.6765	104.9039	109.7908	113.7435	(42a)
Hot water usage for baths	49.2248	48.4937	47.4642	45.5661	44.1447	42.5687	41.7174	42.7397	43.8528	45.5392	47.4764	49.0584	(42b)
Hot water usage for other uses	69.5773	67.0472	64.5171	61.9870	59.4569	56.9269	56.9269	59.4569	61.9870	64.5171	67.0472	69.5773	(42c)
Average daily hot water use (litres/day)												214.1623	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	232.9831	228.0060	221.9460	212.7336	205.2516	197.2083	194.1191	200.1529	206.5163	214.9602	224.3144	232.3792	(44)
Energy conte	368.9882	324.6775	341.1228	291.2217	276.3082	242.4906	234.7702	247.8311	254.6552	291.6989	319.5770	363.8496	(45)
Energy content (annual)										Total = Sum(45)m =		3557.1911	
Distribution loss (46)m = 0.15 x (45)m	55.3482	48.7016	51.1684	43.6833	41.4462	36.3736	35.2155	37.1747	38.1983	43.7548	47.9366	54.5774	(46)
Water storage loss:													
Store volume												400.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.5234	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.3626	(55)
Total storage loss	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(56)
If cylinder contains dedicated solar storage	42.2417	38.1538	42.2417	40.8791	42.2417	40.8791	42.2417	42.2417	40.8791	42.2417	40.8791	42.2417	(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	434.4923	383.8425	406.6269	354.6128	341.8123	305.8817	300.2743	313.3352	318.0463	357.2031	382.9681	429.3538	(62)
WWHRS	-52.1988	-46.1650	-48.3414	-40.0286	-37.3052	-31.9223	-29.9221	-31.8191	-33.0281	-38.9364	-44.1103	-51.2321	(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	382.2935	337.6775	358.2855	314.5842	304.5071	273.9594	270.3522	281.5161	285.0182	318.2666	338.8578	378.1216	(64)
										Total per year (kWh/year) = Sum(64)m =		3843.4399	(64)
12Total per year (kWh/year)												3843	(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	175.0919	155.2873	165.8266	147.5441	144.2758	131.3410	130.4644	134.8071	135.3857	149.3932	156.9722	173.3833	(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	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	268.2711	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	795.7390	880.9968	795.7390	822.2637	795.7390	822.2637	795.7390	795.7390	822.2637	795.7390	822.2637	795.7390	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	1450.6333	1465.6863	1427.7532	1346.9980	1245.0590	1149.2508	1085.2450	1070.1920	1108.1251	1188.8803	1290.8193	1386.6275	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	49.8271	(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)													
	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	-214.6168	(71)
Water heating gains (Table 5)													
	235.3385	231.0823	222.8852	204.9223	193.9190	182.4180	175.3553	181.1924	188.0357	200.7973	218.0170	233.0421	(72)
Total internal gains													
	2588.1922	2684.2467	2552.8587	2480.6653	2341.1984	2257.4138	2159.8207	2150.6047	2221.9058	2291.8980	2437.5812	2521.8899	(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	39.1500	10.6334	0.6300	0.7000	0.7700	127.2259	(74)
Northeast	26.7200	11.2829	0.6300	0.7000	0.7700	92.1363	(75)
East	5.2800	19.6403	0.6300	0.7000	0.7700	31.6922	(76)
Southeast	63.4000	36.7938	0.6300	0.7000	0.7700	712.9123	(77)
South	6.2100	46.7521	0.6300	0.7000	0.7700	88.7287	(78)
Southwest	27.0000	36.7938	0.6300	0.7000	0.7700	303.6062	(79)
West	21.0100	19.6403	0.6300	0.7000	0.7700	126.1087	(80)
Northwest	36.0400	11.2829	0.6300	0.7000	0.7700	124.2736	(81)
North	33.7800	26.0000	0.6300	0.7000	1.0000	335.4401	(82)

Solar gains	1942.1241	3561.9791	5503.8649	7804.0191	9587.7098	9876.8594	9374.1859	7997.8547	6298.0592	4110.9159	2373.5070	1630.8761	(83)
Total gains	4530.3163	6246.2258	8056.7237	10284.6843	11928.9082	12134.2732	11534.0066	10148.4594	8519.9650	6402.8139	4811.0882	4152.7660	(84)

7. Mean internal temperature (heating season)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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)													
tau	61.1246	61.2524	61.3783	61.9764	62.0896	62.6221	62.6221	62.7217	62.4159	62.0896	61.8610	61.6238	
alpha	5.0750	5.0835	5.0919	5.1318	5.1393	5.1748	5.1748	5.1814	5.1611	5.1393	5.1241	5.1083	
util living area													
	1.0000	0.9999	0.9994	0.9959	0.9756	0.8989	0.7654	0.8435	0.9789	0.9991	0.9999	1.0000	(86)
MIT	19.2022	19.3702	19.6646	20.0858	20.5003	20.8172	20.9454	20.9080	20.6175	20.0876	19.5757	19.1835	(87)
Th 2	19.9714	19.9734	19.9753	19.9841	19.9858	19.9935	19.9935	19.9950	19.9905	19.9858	19.9824	19.9789	(88)
util rest of house													
	1.0000	0.9999	0.9992	0.9939	0.9617	0.8358	0.6304	0.7272	0.9606	0.9985	0.9999	1.0000	(89)
MIT 2	17.8257	18.0426	18.4215	18.9670	19.4901	19.8611	19.9714	19.9502	19.6445	18.9718	18.3127	17.8069	(90)
Living area fraction										fLA = Living area / (4) =		0.0208	(91)
MIT	17.8544	18.0703	18.4474	18.9903	19.5111	19.8810	19.9916	19.9701	19.6648	18.9950	18.3390	17.8356	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8544	18.0703	18.4474	18.9903	19.5111	19.8810	19.9916	19.9701	19.6648	18.9950	18.3390	17.8356	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	1.0000	0.9997	0.9986	0.9907	0.9522	0.8268	0.6302	0.7236	0.9513	0.9975	0.9998	1.0000	(94)
Useful gains	4530.0958	6244.5640	8045.3119	10189.3271	11359.0954	10032.6786	7268.2153	7343.7391	8105.0958	6386.7376	4810.3238	4152.6414	(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													
	31076.8747	30133.2017	27279.2912	22816.5919	17630.6669	11818.5433	7590.2360	7976.9191	12494.7324	18948.4800	25461.5745	31009.7861	(97)
Space heating kWh													
	19750.8035	16053.1645	14310.0806	9091.6307	4666.0492	0.0000	0.0000	0.0000	0.0000	9345.9364	14868.9005	19981.7156	(98a)
Space heating requirement - total per year (kWh/year)												108068.2810	
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													
	19750.8035	16053.1645	14310.0806	9091.6307	4666.0492	0.0000	0.0000	0.0000	0.0000	9345.9364	14868.9005	19981.7156	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												108068.2810	
Space heating per m2											(98c) / (4) =	53.5503	(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													
	19750.8035	16053.1645	14310.0806	9091.6307	4666.0492	0.0000	0.0000	0.0000	0.0000	9345.9364	14868.9005	19981.7156	(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)													
	21398.4870	17392.3776	15503.8793	9850.0874	5055.3080	0.0000	0.0000	0.0000	0.0000	10125.6082	16109.3179	21648.6626	(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

382.2935	337.6775	358.2855	314.5842	304.5071	273.9594	270.3522	281.5161	285.0182	318.2666	338.8578	378.1216	(64)

Efficiency of water heater

											79.8000	(216)
(217)m	88.6102	88.5942	88.5560	88.4663	88.1907	79.8000	79.8000	79.8000	79.8000	88.4714	88.5774	88.6144	(217)

Fuel for water heating, kWh/month

431.4327	381.1510	404.5861	355.5978	345.2827	343.3075	338.7872	352.7771	357.1657	359.7396	382.5556	426.7045	(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	165.3389	132.6410	119.4285	87.4984	67.5863	55.2186	61.6545	80.1408	104.0950	136.5783	154.2649	169.9341	(232)

Electricity generated by PVs (Appendix M) (negative quantity)

(233a)m	-558.2468	-670.3722	-820.6138	-779.3383	-733.7342	-646.8526	-635.3902	-645.4125	-658.9289	-682.0196	-568.2226	-497.1461	(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	-795.9450	-1578.0284	-2977.2636	-4263.0805	-5453.0401	-5417.8273	-5356.7391	-4618.7447	-3499.8273	-2183.8533	-1035.8315	-637.5585	(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	117083.7281	(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	4479.0875	(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)	1334.3793	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-45714.0169	(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	77269.1779	(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	117083.7281	0.2100	24587.5829	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	4479.0875	0.2100	940.6084	(264)
Space and water heating			25528.1913	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	1334.3793	0.1443	192.5922	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	0.1384	-1092.5232	
PV Unit electricity exported	-37817.7393	0.1274	-4816.2055	
Total			-5908.7287	(269)
Total CO2, kg/year			19823.9840	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			9.8200	(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	117083.7281	1.1300	132304.6127	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	4479.0875	1.1300	5061.3689	(278)
Space and water heating			137365.9816	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	1334.3793	1.5338	2046.7155	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-7896.2777	1.5116	-11935.6281	
PV Unit electricity exported	-37817.7393	0.4675	-17681.0351	
Total			-29616.6632	(283)
Total Primary energy kWh/year			109926.1347	(286)
Target Primary Energy Rate (TPER)			54.4700	(287)