ENERGY STATEMENT

330 Gray’s Inn Road

Produced by XCO2 for 330 Gray’s Inn Road Ltd.

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EXECUTIVE SUMMARY

The energy strategy for the proposed development has been developed in line with the energy policies of the London Plan and of the Camden Local Plan. The three-step Energy Hierarchy has been implemented and the estimated regulated CO_2 savings on site are 59.0% for the domestic part and 18.0% for the non-domestic part of the development, against a Part L 2021 compliant scheme; and 45.3% for the domestic part and 44.3% for the non-domestic part of the development, against a Part L 2013 compliant scheme with SAP10 carbon factors.

This report assesses the predicted energy performance and carbon dioxide emissions of the proposed development at 330 Gray's Inn Road located in the London Borough of Camden.

A S73 amendment application is being submitted for the proposed scheme at 330 Gray's Inn Road to reflect amendments to the previously consented scheme. The development description is outlined below:

Variation of Condition 2, 18, 31, 41 and 54 of planning permission ref 202/553/P for the 'Redevelopment of the former Royal National Throat, Nose and Ear Hospital site, comprising: Retention of 330 Gray's Inn Road and a two storey extension above for use as hotel (5 above ground storeys in total), demolition of all other buildings, the erection of a part 13 part 9 storey building plus upper and lower ground floors (maximum height of 15 storeys) for use as a hotel (including a cafe and restaurant); covered courtyard; external terraces; erection of a 7 storey building plus upper and lower ground floors (maximum height of 9 storeys) for use as office together with terraces; erection of a 10 storey building plus upper and lower ground floors (maximum height of 12 storeys) for use as residential on Wicklow Street and office space at lower ground and basement floors; erection of a 5 storey building plus upper and lower ground floors (maximum height of 7 storeys) for use as residential on Swinton Street and associated residential amenity space; together with a gymnasium; new basement; rooftop and basement plant; servicing; cycle storage and facilities; refuse storage; landscaping and other ancillary and associated works.' NAMELY to enable amendments to the approved drawings list to enable an uplift in office/labs floorspace, a reduction in affordable workspace, amendments to the landscape design of the residential garden, a revised entrances on Wicklow Street, a revised arrangement to the loading bay on Wicklow Street, reconfiguration at basement level of the office/labs building, and increased cycle parking provision, and additional basement level, reconfiguration of the roof level plant and enclosures, the addition of flues in addition to other associated works

In line with current GLA guidance and London Plan Policy SI 2 "Minimising greenhouse gas emissions" the development would need to achieve a 'zero carbon' target with a minimum of 35% reduction on site for regulated CO2 emissions against a Building Regulations (Part L 2021) compliant scheme on site. Residential developments should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures.

The energy strategy outlined in this report has been updated using the latest Building Regulations Part L 2021 and SAP 10.2 emissions factors as per current GLA Guidance. These carbon emission factors reflect the grid decarbonisation of recent years and ensure that the assessment of new developments better reflect the actual carbon emissions associated with their expected operation. For this, the current Building Regulations methodology for estimating energy performance against Part L 2021 requirements was used.

Due to the fact that the new Part L 2021 for non-domestic buildings already includes low carbon technologies, it is very challenging to meet the required reduction of London Plan. This has been recognised by the GLA on their EAG Cover Note[1] updated in November 2022. For comparison purposes and to demonstrate that the updated design is working in regards to Energy and Sustainability, additional results based on previous Part L 2013 where incorporated in the report. The outputs were manually converted for the SAP 10 emission factors, in line with GLA guidance.

The results show that although under the new Part L 2021 Regulations, the development is not meeting the GLA and the Camden Planning Guidance reduction, in reality, it fully complies when the design is assessed under previous regulations (Part L 2013) with SAP10 carbon factors, as per the methodology used for the consented scheme (GLA recommended a approach at the time). Additionally, the report demonstrates that with the updated energy strategy assessed under new regulations, the development is expected to have a reduction on its energy demand by an additional 7.1% comparing to the consented scheme.

The methodology used to determine the expected operational CO_2 emissions for the development is in accordance with the London Plan's three-step Energy Hierarchy (Policy SI2) and the CO_2 savings achieved for each step are outlined in the following sections:

BE LEAN – USE LESS ENERGY

The first step addresses reduction in energy demand, through the adoption of passive and active design measures.

The proposed energy efficiency measures include:

- Maximised building fabric efficiency through low u-values and improved air permeability to minimise energy demand and occupant fuel bills;
- Improvement of existing building fabric and air permeability to further minimised energy demand;
- Improvement to thermal bridges, and detailed modelling of the junctions will be carried out early on to ensure exceptional fabric performance;
- Optimised façade design to reduce energy demand whilst achieving good internal daylight and sunlight, and mitigating overheating risk in the summer months;
- External balconies in the residential blocks to support solar shading strategy and provide private amenity space; and
- External shading across the office and hotel buildings to further ensure sufficient solar shading and limit solar gain.

By means of energy efficiency measures alone, regulated CO_2 emissions are shown to reduce by:

Regulated CO_2 Savings at Be Lean Stage				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Domestic	17.2	12.6	32.2	22.1
Non-domestic	31.6	152.1	13.7	32.7
Site wide	29.7	164.8	17.8	54.8

BE CLEAN – SUPPLY ENERGY EFFICIENTLY

The application site is located in an area where district heating is not expected to be implemented in the future.

A site heat network is proposed; this will comprise a single energy centre supplied by air source heat

[1] GLA "Part L 2021 and the Energy Assessment Guidance 2022 - Cover Note", accessed in January 2023 https://www.london.gov.uk/programmes-strategies/planning/planning-applications-and-decisions/pre-planning-application-meeting-service/energy-planning-guidance

pumps (ASHPs) and high efficiency electric boilers and will be connected to all uses on site.

BE GREEN – USE RENEWABLE ENERGY

The renewable technologies feasibility study carried out for the development identified photovoltaics and ASHPs as suitable technologies for the development.

The ASHPs will form part of a hybrid system (alongside electric boilers) in a centralised strategy for the supply of space heating and hot water to the whole development. For the commercial part of the development, it is assumed that ASHPs will supply 100% of the heating and cooling demand, with the domestic hot water demand served by 50% ASHPs and 50% electric boilers. For the domestic part of the development the heating and domestic hot water load will be supplied via 50% ASHPs and 50% electric boilers.

The incorporation of renewable technologies will reduce CO_2 emissions by a further:

Regulated CO_2 Savings at Be Green Stage				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Domestic	28.1	20.5	27	18.7
Non-domestic	12.6	60.6	4	10.4
Site wide	14.7	81.2	9.0	29.1

REFURBISHMENT ONLY SAVINGS

The regulated CO_2 savings for the refurbishment are:

Refurbishment Regulated CO2 Savings				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Be Lean	60.67	51.76	53.77	40.29
Be Clean	0.00	0	0	0
Be Green	4.00	3.41	5.63	4.22
Total	64.67	55.17	59.40	44.51

CUMULATIVE ON SITE SAVINGS

The overall regulated CO_2 savings on site against a Part L 2021 compliant scheme are therefore:

Cumulative Regulated CO2 Savings				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Domestic	45.3	20.5	59.0	40.8
Non-domestic	44.3	171.5	18	43.1
Site wide	44.4	204.6	27	83.9

CARBON OFF-SETTING

According to the London Plan and Camden Local Plan CO_2 the savings target of 35% overall, needs to be met. In accordance with Camden Planning Guidance on Energy Efficiency and Adaption, the proposed development also needs to meet the target of 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.

Taking into consideration the improved performance that the buildings need to demonstrate just to meet the new Part L 2021 Regulations, the development performs exceptionally. It achieves a 27% of total CO_2 emissions savings, of which 9% reduction is generated from on-site renewable technologies, against Part L 2021.

With the SAP 10.2 carbon factors, to achieve 'zero carbon' for the residential portion of the scheme, 27.8 tonnes per annum of regulated CO_2, equivalent to 834 tonnes over 30 years, from the new-build domestic portion should be offset offsite. The shortfall to a zero carbon reduction from baseline for the new build non-domestic portion of the scheme would be 195.3 tonnes per annum of regulated CO_2, equivalent to 5,858 tonnes over 30 years, to be offset offsite.

Any carbon offset contributions will be subject to viability discussions and detailed design stage calculations.

BE SEEN

The proposed development integrates a metering strategy to allow for the measure of energy consumption during the operation of the building. Metering will be split into lighting, small power and HVAC, in line with current Part L requirements. The office will have utility meters on each floor for each tenant.

Furthermore, residential dwellings will be provided with smart meters to monitor the heat and electricity consumption of each dwelling; the display board will demonstrate real-time and historical energy use data and will be installed at an accessible location within the dwellings.

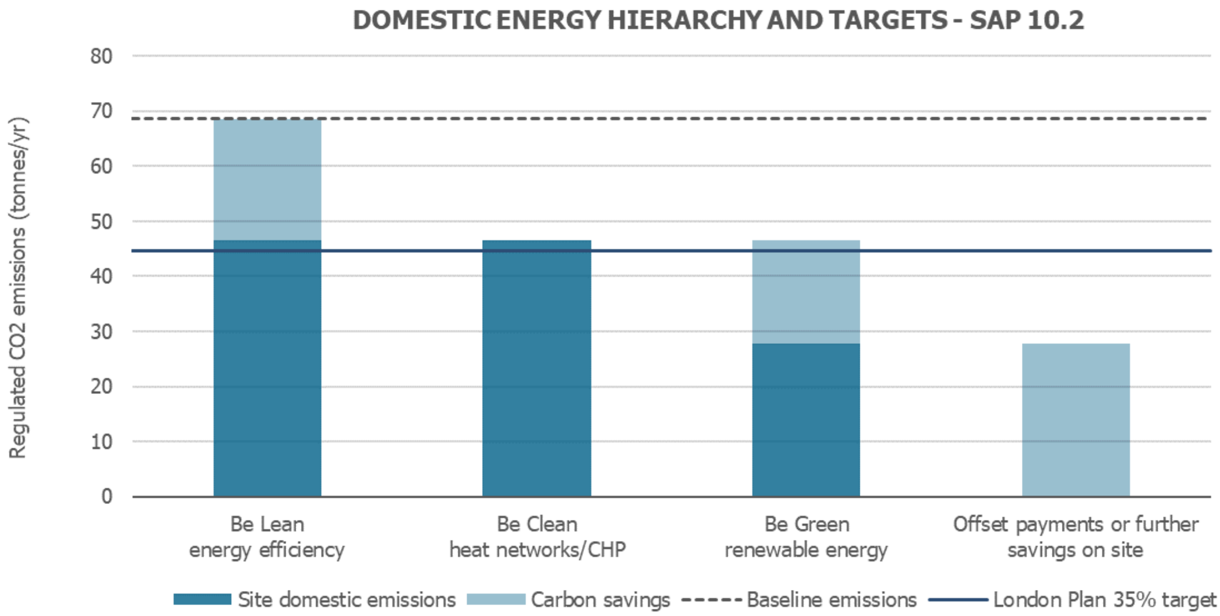


Figure 1: The Domestic Energy Hierarchy (SAP10.2 carbon factors)

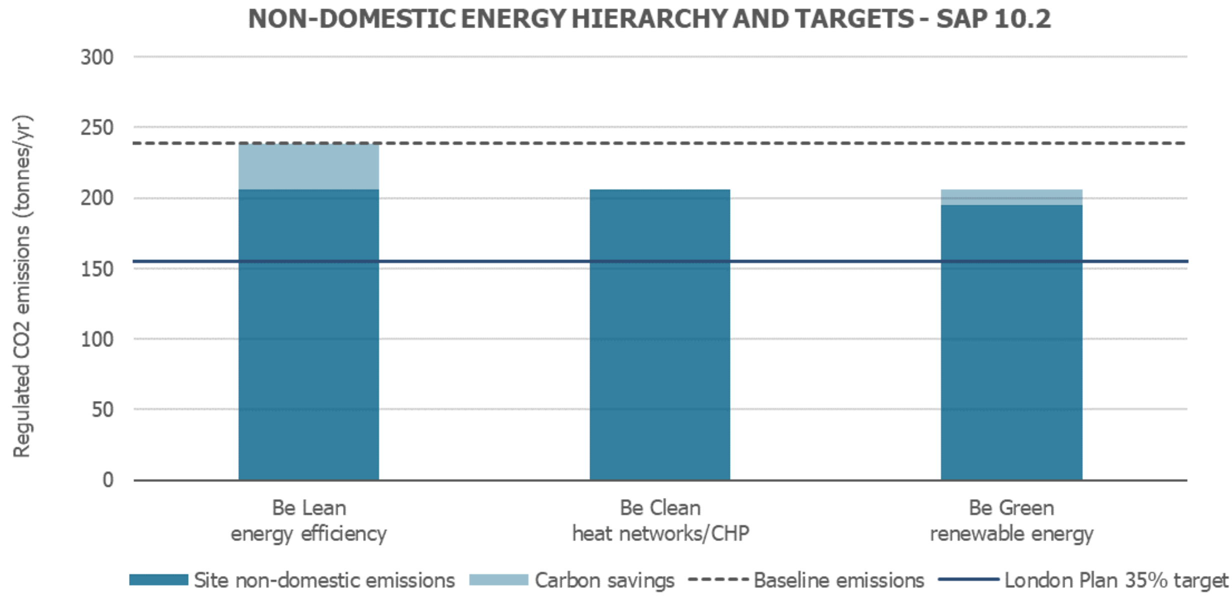


Figure 2: The Non-Domestic Energy Hierarchy (SAP10.2 carbon factors)

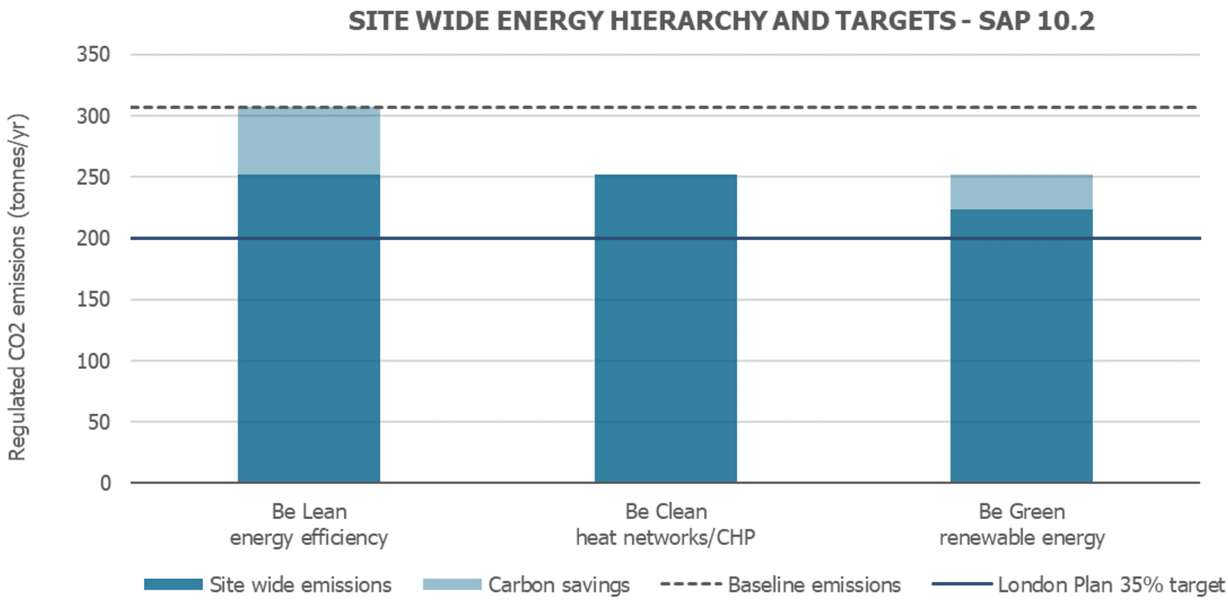


Figure 3: The Site Wide Energy Hierarchy (SAP10.2 carbon factors)

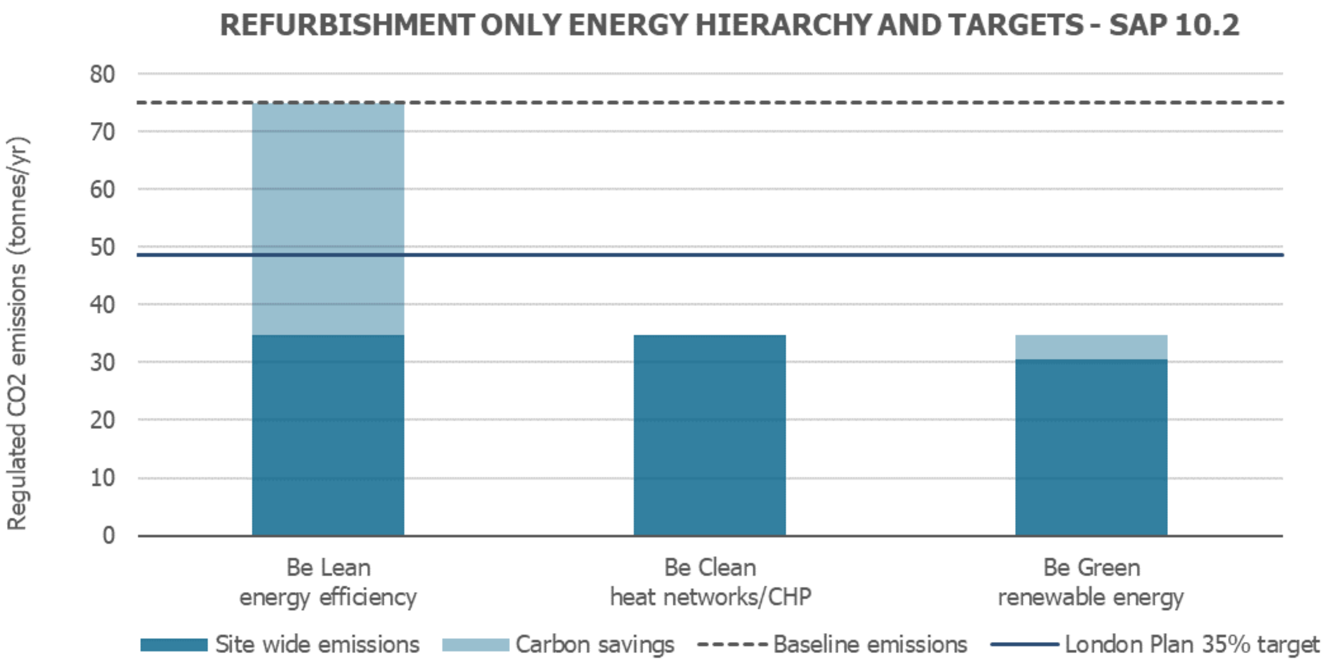


Figure 4: Refurbishment Energy hierarchy (SAP10.2 carbon factors)

INTRODUCTION

This Chapter presents the description of the site and of the development proposal, the energy policy framework and the methodology employed for the energy assessment.

SITE & PROPOSAL

A S73 amendment application is being submitted for the proposed scheme at 330 Gray's Inn Road to reflect amendments to the previously consented scheme. The development description is outlined below.

Variation of Condition 2, 18, 31, 41 and 54 of planning permission ref 202/553/P for the 'Redevelopment of the former Royal National Throat, Nose and Ear Hospital site, comprising: Retention of 330 Gray's Inn Road and a two storey extension above for use as hotel (5 above ground storeys in total), demolition of all other buildings, the erection of a part 13 part 9 storey building plus upper and lower ground floors (maximum height of 15 storeys) for use as a hotel (including a cafe and restaurant); covered courtyard; external terraces; erection of a 7 storey building plus upper and lower ground floors (maximum height of 9 storeys) for use as office together with terraces; erection of a 10 storey building plus upper and lower ground floors (maximum height of 12 storeys) for use as residential on Wicklow Street and office space at lower ground and basement floors; erection of a 5 storey building plus upper and lower ground floors (maximum height of 7 storeys) for use as residential on Swinton Street and associated residential amenity space; together with a gymnasium; new basement; rooftop and basement plant; servicing; cycle storage and facilities; refuse storage; landscaping and other ancillary and associated works.' NAMELY to enable amendments to the approved drawings list to enable an uplift in office/labs floorspace, a reduction in affordable workspace, amendments to the landscape design of the residential garden, a revised entrances on Wicklow Street, a revised arrangement to the loading bay on Wicklow Street, reconfiguration at basement level of the office/labs building, and increased cycle parking provision, and additional basement level, reconfiguration of the roof level plant and enclosures, the addition of flues in addition to other associated works

The site is bound to the north in part by the UCL Ear Institute and in part by Wicklow Street and railway cuttings to the east; Swinton Street to the south and Gray's Inn Road runs along the site's western boundary. The site sits towards the centre of the growing Knowledge Quarter within the eastern section of the area. Within the immediate vicinity the prevailing development is characterised by a mix of commercial, residential and hotel uses.

The site is currently occupied a number of buildings which make up the Royal National Throat, Nose and Ear (RNTNE) Hospital. The hospital closed in October 2019 when services transferred to the new Royal National ENT and Eastman Dental Hospitals on Huntley Street, London, WC1E 6DG.

The approximate location and boundary of the application site is shown in the following figure.

Figure 5: Approximate location of the application site.

POLICY FRAMEWORK

The proposal responds to the energy policies of the London Plan and of the policies within the Camden Local Plan and relevant supplementary planning guidance.

The most relevant applicable energy policies in the context of the proposed development are presented below.

THE LONDON PLAN (2021)

The London Plan (2021) published 2nd March 2021 sets out the Mayor's overarching strategic spatial development strategy for greater London and underpins the planning framework from 2019 up to 2041. This document replaced the London Plan 2016.

The new Plan has a strong sustainability focus with many new policies addressing the concern to deliver a sustainable and zero carbon London, particularly addressed in chapter 9 Sustainable Infrastructure.

The following policies, related to Energy, are of relevance for the proposed development:

POLICY SI2 MINIMISING GREENHOUSE GAS EMISSIONS

This policy sets the requirements for all major developments to follow the energy hierarchy and achieve net-zero-carbon for both residential and non-residential schemes (via on-site carbon reductions and offset payments) and introduces new targets at Lean stage:

> "…
> *This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:*
> *1) be lean: use less energy and manage demand during operation*
> *2) be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly*
> *3) be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site*
> *4) be seen: monitor, verify and report on energy performance.*
> …"

> "…
> *A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. 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:*
> *1) through a cash in lieu contribution to the borough's carbon offset fund, or*
> *2) off-site provided that an alternative proposal is identified and delivery is certain.*
> …"

This policy also sets the requirements to consider whole-life carbon emissions, including embodied carbon and unregulated emissions:

> "…
> *Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.*
>
> *Development proposals referable to the Mayor should calculate whole lifecycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.*
> …"

The policy supporting text provides additional clarifications on the requirements for major developments:

- Developments including major refurbishments should also aim to meet the net-zero carbon target.

- All developments should maximise opportunities for on-site electricity and heat production from solar technologies (photovoltaic and thermal), use innovative building materials and smart technologies.
- Recommendation to use SAP10 carbon factors as per GLA Energy Guidance.
- Recommended carbon offset price of £95 per tonne CO_2.
- Requirement for major developments to monitor and report operational energy performance to the GLA.

POLICY SI 3 ENERGY INFRASTRUCTURE

This policy requires all major developments within Heat Network Priority Areas will need to utilise a communal low-temperature heating system and follow the energy hierarchy to determine the most suitable system Where developments are utilising CHP this policy also requires them to demonstrate that 'the emissions relating to energy generation will be equivalent or lower than those of an ultra-low NOx gas boiler'. Any combustion on site should meet the requirements of part B of Policy SI1.

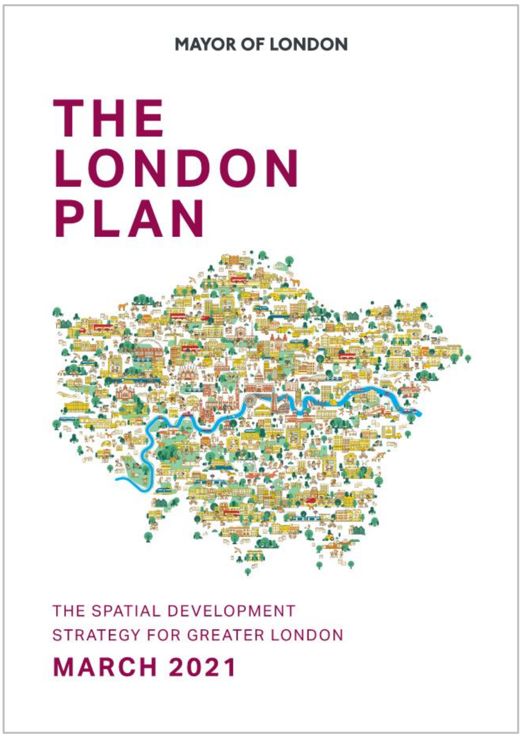
POLICY SI 4 MANAGING HEAT RISK

This policy requires:

A Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

B Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:
1) reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure
2) minimise internal heat generation through energy efficient design
3) manage the heat within the building through exposed internal thermal mass and high ceilings
4) provide passive ventilation
5) provide mechanical ventilation
6) provide active cooling systems.

The London Plan also consists of a suite of guidance documents, such as the Energy Assessment Guidance: Greater London Authority guidance on preparing energy assessments as part of planning applications (April 2020)



GLA GUIDANCE ON PREPARING ENERGY ASSESSMENTS

This document (last updated in June 2022) provides guidance on preparing energy assessments to accompany strategic planning applications; it contains clarifications on Policy SI 2, of the London Plan, carbon reduction targets in the context of zero carbon policy, as well as detailed guidelines on the content of the Energy Assessments undertaken for planning.

The guidance document specifies the emission reduction targets the GLA will apply to applications as follows:

Major developments are required to achieve *net zero-carbon by following the energy hierarchy (Policy SI 2). This means that regulated carbon emissions should be reduced so they are as close as possible to zero. Once on-site reductions have been maximised, the residual emissions should be offset via a payment into the relevant borough's carbon offset fund.*

Major developments are required to achieve a minimum 35 per cent on-site carbon reduction over Part L 2021. Residential developments are expected to be able to exceed this, and so an additional benchmark has been set that residential developments should be aiming to achieve. See Table below. The benchmarks may be updated periodically to include additional building types and to reflect improvements in performance over time.

Building type	Minimum on-site improvement over Part L 2021(per cent)	Benchmark improvement over Part L 2021 (per cent)
Residential	35 per cent	50 per cent+

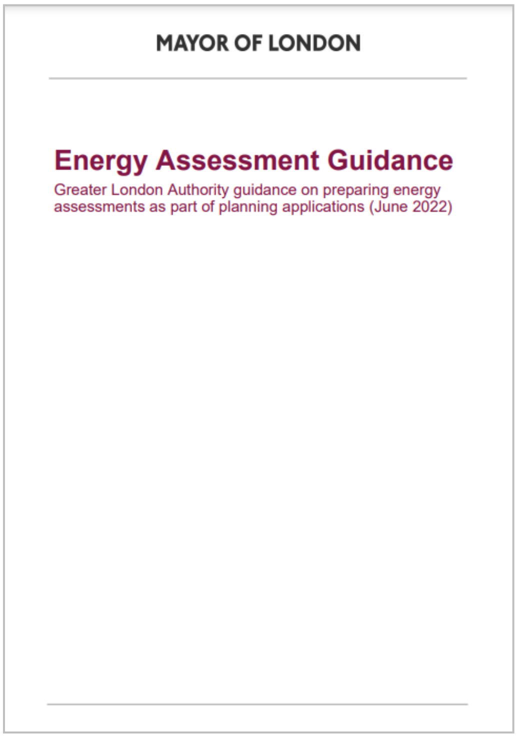
Energy efficiency is the first stage of the energy hierarchy. Energy demand should be reduced as far as possible before the heating strategy and installation of low carbon and renewable technologies is considered. This is important in protecting consumers from high prices. Developments are expected to achieve carbon reductions beyond Part L 2021 of 10 per cent for residential developments and 15 per cent for non-residential developments through energy efficiency measures alone, before other measures are applied.

The definition of zero carbon homes is provided on Page 54 of the guidance:

> *Zero carbon homes - homes forming part of major development applications (i.e. those with 10 or more units) where the residential element of the application achieves at least a 35 per cent reduction in regulated carbon dioxide emissions (beyond Part L 2021) on-site. The remaining regulated carbon dioxide emissions, to 100 per cent, are to be offset through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.*

It should be noted that the GLA, on their EAG Cover Note updated in November 2022, noted that *"initially, non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35 per cent improvement. This is because the new Part L baseline now includes low carbon heating for non-residential developments but not for residential developments. However, planning applicants will still be expected to follow the energy hierarchy to maximise carbon savings before offsetting is considered."*

The structure of this report and the presentation of the carbon emission information for the development follows the guidance in this document.


MAYOR OF LONDON

Energy Assessment Guidance

Greater London Authority guidance on preparing energy assessments as part of planning applications (June 2022)

CAMDEN LOCAL PLAN (2017)

The Camden Local Plan, adopted in 2017, sets out the following policies for energy:

Policy CC1: Climate change mitigation

The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.

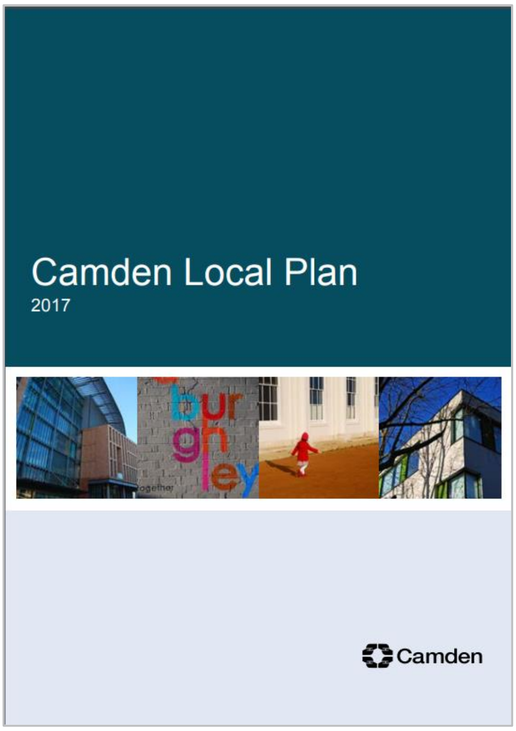
We will:

- *a) promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;*
- *b) require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;*
- *c) ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;*
- *d) support and encourage sensitive energy efficiency improvements to existing buildings;*
- *e) require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building;*
- *f) expect all developments to optimise resource efficiency.*

For decentralised energy networks, we will promote decentralised energy by:

- *g) working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;*
- *h) protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and*
- *i) requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.*

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.



CAMDEN PLANNING GUIDANCE – ENERGY EFFICIENCY AND ADAPTION

The Camden Planning Guidance for Energy Efficiency and Adaption has been prepared to support the policies within the Camden Local Plan (2017). The guidance provides most specific information on the key energy and resource issues within the Borough. The document was updated in January 2021 and replaces the previous version (adopted March 2019).

The sections of the current version of the document that will be covered by the following sections of this Energy Statement are listed below :

The energy hierarchy

- *All developments in Camden is expected to reduce carbon dioxide emissions by following the energy hierarchy in accordance with Local Plan policy CC1.*
- *Energy strategies are to be designed following the steps set out in the energy hierarchy.*

Making buildings more energy efficient

- *Natural 'passive' measures should be prioritised over active measures to reduce energy.*
- *Major residential development to achieve 10%, and nonresidential development to achieve 15% reduction (beyond part L Building regulations), in accordance with the new London Plan, through on-site energy efficient measures (Be lean stage)*

Decentralised energy

- *All new major developments in Camden are expected to assess the feasibility of decentralised energy network growth.*

Renewable energy technologies

- *There are a variety of renewable energy technologies that can be installed to supplement a development's energy needs.*
- *Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.*

Energy statements

- *Energy statements are required for all developments involving 5 or more dwellings and/or 500sqm or more of any (gross internal) floorspace.*
- *Energy statements should demonstrate how a development has been designed following the steps in the energy hierarchy.*
- *The energy reductions should accord to those set out in the following chapter 'Energy reduction'.*

Energy reduction

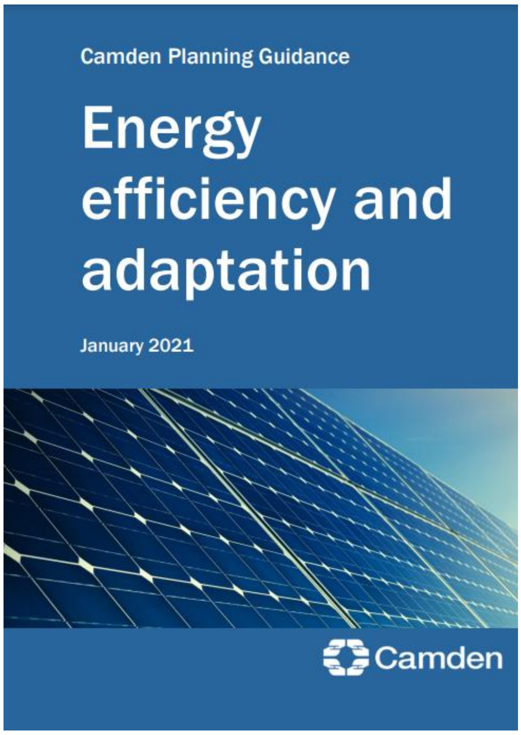
- *All development in Camden is expected to reduce carbon dioxide emissions through the application of the energy hierarchy.*
- *All new build major development to demonstrate compliance with London Plan targets for carbon dioxide emissions.*
- *Deep refurbishments (i.e. refurbishments assessed under Building Regulations Part L1A/L2A) should also meet the London Plan carbon reduction targets for new buildings.*
- *All new build residential development (of 1 – 9 dwellings) must meet 19% carbon dioxide reduction.*
- *Developments of five or more dwellings and/or more than 500sqm of any gross internal floorspace to achieve 20% reduction in carbon dioxide emissions from on-site renewable energy generation.*

Energy efficiency in existing buildings

- *All developments should demonstrate how sustainable design principles have been considered and incorporated.*
- *Sensitive improvements can be made to historic buildings to reduce carbon dioxide emissions.*
- *Warm homes and buildings are key to good health and wellbeing. As a guide, at least 10% of the project cost should be spent on environmental improvements.*
- *The 20% carbon reduction target (using on-site renewable energy technologies) applies for developments of five or more dwellings and/or more than 500sqm of any gross internal floorspace.*

Reuse and optimising resource efficiency

- *We will expect creative and innovative solutions to repurposing existing buildings, and avoiding demolition where feasible;*
- *All development should seek to optimise resource efficiency and use circular economy principles*



Sustainable design and construction measures

- *All developments involving 500 sqm or more should address sustainable design and construction measures (proposed in design and implementation) in a Sustainability Statement (Local Plan policy CC2).*
- *Active cooling (air conditioning) will only be permitted where its need is demonstrated and the steps in the cooling hierarchy are followed (Local Plan policy CC2).*
- *Development is expected to reduce overheating risk through following the steps in the cooling hierarchy. All new development should submit a statement demonstrating how the cooling hierarchy has been followed (Local Plan policy CC2).*
- *All developments should seek opportunities to make a positive contribution to green space provision or greening.*

Sustainable Assessment tools

- BREEAM Excellent is required for all non-residential development of 500sqm or more floorspace
- Other assessment tools such as Home Quality Mark and Passivhaus are encouraged, they can serve to demonstrate the incorporation of sustainable design principles.

METHODOLOGY

The sections below present the methodology followed in determining the on-site and off-site carbon savings for the proposed scheme.

ON-SITE CARBON SAVINGS – THE ENERGY HIERARCHY

The methodology employed to develop the energy strategy for the scheme and achieve on-site carbon savings is in line with the GLA's *Guidance on preparing energy assessments* (April2020) and is as follows:

The **baseline** CO_2 emissions are first established, i.e. the emissions of a scheme that is compliant with Part L 2021 of the Building Regulations for the new building elements. The baseline of the refurbished building was prepared in line with the assumptions stated in Appendix 4 of the GLA Guidance for Energy Statements (June 2022)

The software used to model and calculate the energy performance and carbon emissions of the domestic element is SAP10.2 and SBEM for the non-domestic elements. The emissions of the domestic element are established by modelling representative dwelling types and multiplying the Target Emission Rate (TER) of each type with the cumulative floor area for that type to establish the total emissions for the domestic element of the proposal. Similarly, the TER for each non-domestic element is multiplied by its floor area to establish the total emissions.

The same approach is followed to determine the energy performance and CO_2 emissions of the proposed scheme for each of the steps of the **Energy Hierarchy**. The CO_2 emissions are estimated based on the SAP Dwelling Emission Rate (DER) and SBEM Building Emission Rate (BER) figures for the domestic and non-domestic elements, respectively. The Energy Hierarchy aims at delivering significant carbon savings on-site.

The three consecutive steps of the Energy Hierarchy are:

- **Be Lean** whereby the demand for energy is reduced through a range of passive and active energy efficiency measures; as part of this step the Cooling Hierarchy (see Policy SI4) is implemented and measures are proposed to reduce the demand for active cooling;
- **Be Clean** whereby as much of the remaining energy demand is supplied as efficiently as possible (e.g. by connecting to a district energy network or developing a site-wide CHP network), and,
- **Be Green** whereby renewable technologies are incorporated to offset part of the carbon emissions of the development. The uptake of renewable technologies is based on feasibility and viability considerations, including their compatibility with the energy system determined in the previous step.

The implementation of the Energy Hierarchy determines the total regulated carbon savings that can be feasibly and viably achieved on site.

The % improvement against the baseline emissions is compared to the relevant targets for each element and in case of a shortfall, savings through off-site measures should be achieved.

An additional fourth step **Be Seen** has been recently introduced that requires that the actual energy performance of the development can be monitored and reported post-occupation.

OFF-SITE CARBON SAVINGS – CARBON OFFSETTING

The GLA and the London Borough of Camden has an established provision to ensure that the shortfall in carbon savings is met off-site; this comprises a carbon offset payment with a figure of £95/tonne for a period of 30 years.

The cash in lieu contribution for the domestic and non-domestic elements of the proposal is calculated and summed to provide the total carbon offset payment to be made to the Council. Any carbon offset contributions will be subject to viability discussions and detailed design stage calculations.

The structure of the main body of the assessment follows the Methodology presented above and comprises the sections:

- Be Lean;
- Be Clean;
- Be Green.

The Conclusions section summarises the energy strategy and associated carbon savings for the proposed development. This report presents the figures in line with the SAP10.2 carbon factors in line with the GLA guidance for Energy Statements.

BE LEAN – USE LESS ENERGY

The proposals incorporate a range of passive and active design measures that will reduce the energy demand for space conditioning, hot water and lighting. Measures will also be put in place to reduce the risk of overheating. The regulated carbon saving achieved in this step of the Energy Hierarchy is 18.0% over the site wide baseline level with SAP10.2 emission factors.

In line with GLA guidance (2022) an air-source heat pump with heating efficiency 2.64 and cooling efficiency of 6.2 has been included for supply of space heating and cooling for all spaces. For the provision of hot water, based on the proposed system of the actual development, a bivalent system that combines an air-source heat pump with efficiency of 2.85 and electric boilers has been included for all spaces within the scheme in the SAP and SBEM calculations.

PASSIVE DESIGN MEASURES

ENHANCED U-VALUES

The heat loss of different building fabric elements is dependent upon their U-value. A building with low U-values provides better levels of insulation and reduced heating demand during the cooler months.

The proposed development will incorporate high levels of insulation and high-performance glazing beyond Part L 2021 targets for the new build elements and beyond refurbishment notional building specifications for the refurbished building at 330 Gray's Inn Road, in order to reduce the demand for space heating and cooling.

The tables to the right demonstrate the improved performance of the proposed building fabric beyond the Building Regulations requirements for both domestic and non-domestic uses.

AIR PERMEABILITY IMPROVEMENT

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

The proposed development will aim to improve upon the Part L 2021 minimum standards for air tightness by targeting air permeability rates of 3m^3/m^2.h at 50Pa for all new build residential units and non-domestic areas. An air permeability rate of 3m^3/m^2.h at 50Pa is targeted for the refurbished part of the proposed development. An air permeability rate of 25m^3/m^2.h at 50Pa is included for the baseline of the refurbished building.

Table 1: Thermal Envelope U-values

Domestic (U-values in W/m^2.K)			
Element	**Building Regulations**	**Proposed**	**Improvement**
Walls	0.26	0.15	57%
Floor	0.18	0.10	44%
Roof	0.16	0.10	38%
Windows	1.60	1.20	25%

Non-domestic (U-values in W/m^2.K)			
Element	**Building Regulations**	**Proposed**	**Improvement**
Walls	0.26	0.15	57%
Floor	0.18	0.10	44%
Roof	0.16	0.10	38%
Windows	1.60	1.20	25%

Refurbished Building (U-values in W/m².K)			
Element	**Building Regulations**	**Proposed**	**Improvement**
Walls	0.55	0.15	72%
Floor	0.25	0.10	60%
Roof	0.18	0.10	44%
Windows	1.8	1.20	33%

THERMAL BRIDGING

Thermal bridging can cause significant heat loss within buildings, whereby junctions between insulated building fabric elements provide less thermal resistance than the surrounding envelope. While repeating thermal bridges such as timber studs, rafters and wall ties are accounted for within u-value calculations, linear thermal bridges such as floor junctions, corners, roof junctions and window reveals must be included separately within the SAP and SBEM calculations.

Heat loss from linear thermal bridges is known as the Psi-value (Ψ). Psi-values can be obtained through the modelling of specific junctions based on the proposed construction details is measured in W/mK. The cumulative impact of the total heat loss expected from all the thermal bridges combined is known as the y-value. The Building Regulations Part L 2021 uses a reference y-value of 0.08 for the notional building.

The proposed development will aim to exceed the Part L 2021 target for each building envelope as a whole, by achieving a y-value of 0.04.

As the technical design of the building fabric is developed, consideration will be given to thermal bridges, and detailed modelling of the junctions will be carried out early on to ensure that these targets can be achieved.

REDUCING THE NEED FOR ARTIFICIAL LIGHTING

The development has been designed to maximise daylight in all habitable spaces as a way of improving the health and wellbeing of its occupants.

All of the habitable areas will benefit from large areas of glazing to increase the amount of daylight within the internal spaces where possible. This is expected to reduce the need for artificial lighting whilst delivering pleasant, healthy spaces for occupants.

In addition, it is proposed to install photoelectric controls, by providing dimming to all office spaces, further reducing the need for artificial lighting.

FABRIC ENERGY EFFICIENCY

The predicted performance of the dwellings was also assessed based on comfortable internal temperatures being maintained. The energy demand of the dwelling per square metre is represented by the Dwelling Fabric Energy Efficiency (DFEE) and in order to reach Part L1A compliance this must not exceed the Target Fabric Energy Efficiency (TFEE). In Table 2 below a summary of the findings from the assessment is presented and it demonstrates that the DFEE does not exceed the TFEE.

Table 2: Area Averaged Target and Dwelling Fabric Energy Efficiency for the residential portion of the scheme

Fabric Energy Efficiency		
TFEE (kWh/m².yr)	**DFEE (kWh/m².yr)**	**Improvement**
17.66	15.67	11.0%

XCO2

GLAZING PERCENTAGE

The glazing percentage for the development are as follows:

Table 3: Approximate percentage of glazed area for each façade orientation for the proposed hotel development

Glazed Area Percentage			
Orientation	**Total Façade Area (m²)**	**Glazed Area (m²)**	**Glazed Area (%)**
North	1300	126	10
East	1350	710	53
South	1380	240	17
West	1360	640	47

Table 4: Approximate percentage of glazed area for each façade orientation for the proposed office development

Glazed Area Percentage			
Orientation	**Total Façade Area (m²)**	**Glazed Area (m²)**	**Glazed Area (%)**
North	1500	649.3	43
East	1400	250	18
South	1500	732.1	49
West	1300	400	31

Table 5: Approximate percentage of glazed area for each façade orientation for the proposed Swinton Block residential development

Glazed Area Percentage			
Orientation	**Total Façade Area (m²)**	**Glazed Area (m²)**	**Glazed Area (%)**
North	975	185	19
East	234	30	13
South	975	183	19
West	238	6	3

Table 6: Approximate percentage of glazed area for each façade orientation for the proposed Wicklow Block residential development

Glazed Area Percentage			
Orientation	**Total Façade Area (m²)**	**Glazed Area (m²)**	**Glazed Area (%)**
North	1334	238	18
East	645	134	21
South	1195	304	25
West	650	77	12

ACTIVE DESIGN MEASURES

HIGH EFFICACY LIGHTING

The development intends to incorporate low energy lighting fittings throughout the residential and non-residential spaces. All light fittings will be specified as low energy lighting and will accommodate LEDs only.

HEAT RECOVERY VENTILATION

Mechanical ventilation with heat recovery (MVHR) is proposed for both the residential and non-residential portions of the development. The mechanical ventilation system will include heat recovery in order to achieve ventilation in the most energy-efficient way. Natural ventilation is proposed as a secondary method of ventilation for the residential dwellings.

COMFORT COOLING

Air source heat pumps with high energy efficiency ratios may be used for both heating and cooling in the non-residential portions of the development, therefore the impact of active cooling in terms of energy use and carbon emissions will be minimised.

CONTROLS

Advanced lighting and space conditioning controls will be incorporated, specifically:

- For non-residential areas of infrequent use, occupant sensors will be fitted for lighting, whereas day lit areas will incorporate daylight sensors where appropriate;

- Office spaces will incorporate daylight sensors for dimming purpose;
- Heating controls in dwellings will comprise programmers and thermostatic radiator valves (TRVs); and
- Space conditioning in the non-domestic areas will be controlled by local time and temperature controls.
- The energy centre will include an advanced control system to ensure the plant is working at high efficiency and load distribution between heat pumps and electrical boilers is optimised in line with the demand throughout the day.

MONITORING

Apart from the above design measures, the development will incorporate monitoring equipment and systems to enable occupiers to monitor and reduce their energy use.

Smart meters will be installed to monitor the heat and electricity consumption of each dwelling; the display board will demonstrate real-time and historical energy use data and will be installed at an accessible location within the dwellings.

WASTE WATER HEAT RECOVERY

The implementation of waste water heat recovery (WWHR) systems at the residential elements and non-domestic elements of the scheme have been evaluated for the scheme and considered suitable for the Residential and the Hotel building due to its high domestic hot water demand.

MINIMISING OVERHEATING

The potential risk of overheating will be mitigated by incorporating passive and active design measures, in line with the London Plan Policy SI4 and the Cooling Hierarchy, as follows.

THE COOLING HIERARCHY

REDUCING THE AMOUNT OF HEAT ENTERING THE BUILDING IN SUMMER

External shading elements (such as balconies, louvres and set back windows) are integrated across all elevations. These shall help to significantly reduce solar gains into occupied spaces. Internal blinds may be included to further reduce the amount of heat entering the building.

MINIMISING INTERNAL HEAT GENERATION THROUGH ENERGY EFFICIENT DESIGN

The distribution of heat infrastructure within the residential parts of the development will be designed to reduce the lateral pipework lengths within the communal corridors, reducing heat loss.

Heat sources and pipework will be sufficiently insulated following CIBSE CoP1 guidelines. CIBSE Code of Practice (Cop) 1 aims to raise standards for heat supply by identifying best practice options and promoting long-lasting, environmentally friendly heat networks. Please refer to Objective 3.9 to achieve an efficient heat distribution system within a residential building and reduce the risk of overheating.

PASSIVE VENTILATION

Passive ventilation will be employed as secondary strategy for providing fresh air and dissipating heat across the development. Openable windows in the residential part of the development will be available to occupants to use depending on the noise and air quality conditions.

MECHANICAL VENTILATION

Mechanical Ventilation with Heat Recovery (MVHR) is proposed across the whole development. The MVHR will be capable of operating in summer bypass mode allowing for the dissipation of any heat build-up during peak summer conditions.

OVERHEATING RISK ASSESSMENT

An overheating assessment was undertaken for representative 'worst case' dwellings in line with CIBSE TM59 and Approved Document Part O. Dynamic thermal modelling was conducted using three design weather years, also accounting for climate change scenarios.

Considering acoustic constraints across the development, the dwellings cannot rely solely on natural ventilation with openable windows for overheating mitigation throughout the summer. Therefore, the proposed scheme will use mechanical ventilation as the primary mechanism to mitigate overheating risk, as well as openable windows. The ventilation strategy will include openable windows during daytime, while being fully closed during night time.

All habitable rooms in dwellings are predicted to satisfy the overheating risk criteria for the TM49 probabilistic Design Summer Year DSY1 (2020s, high emissions, 50% percentile scenario) weather data for London Weather Centre through the incorporation of MVHR with air tempering and solar control strategies including internal blinds and recessed windows.

The Overheating Assessment can be seen in full in Appendix A – Overheating Risk Assessment

ACTIVE COOLING PROPOSALS

Considering the acoustic and air quality constraints of the site, the domestic portion of the development will include an air tempering system which will support the function of the MVHR in providing adequate ventilation to mitigate overheating. The control strategy and inherent efficiency of the system will ensure energy consumption is minimised in comparison to full active cooling system. Further details are provided in the Overheating Risk Assessment.

The non-domestic portion of the development, due to the nature of the building uses and site constraints, will be served by active cooling.

The following tables present the cooling demand figures for the non-domestic elements of the development.

Table 7: Non-domestic cooling demand – Refurbished Hotel

	Area weighted average non-domestic cooling demand (MJ/m²)	Total area weighted non-domestic cooling demand (MJ/year)
Actual	163.6	137,375
Notional	266.4	223,696

Table 8: Non-domestic cooling demand –Hotel

	Area weighted average non-domestic cooling demand (MJ/m²)	Total area weighted non-domestic cooling demand (MJ/year)
Actual	38.9	296,251
Notional	94.3	718,161

Table 9: Non-domestic cooling demand –Office

	Area weighted average non-domestic cooling demand (MJ/m²)	Total area weighted non-domestic cooling demand (MJ/year)
Actual	58.5	1,245,875
Notional	118.6	2,525,824

BE LEAN CO_2 EMISSIONS

At the 'Be Lean' stage, the proposed development will achieve the GLA target of 10% regulated CO2 emission reductions for the residential portion of the scheme.

Overall, the commercial portion of the development achieves a 14% reduction at lean stage, in contrast to the 15% target requirement, despite a lower heating and cooling demand compared to the notional building for all commercial areas. However, the energy consumption of the proposed commercial areas is reduced significantly in comparison to the previous application implementing SAP 10 carbon factor. This is due to the improved and very demanding requirements of the new Part L 2021, which the development now follows. As outlined in Table 1, the fabric efficiency has been maximised as far as feasible for the proposed scheme.

The savings achieved using SAP10.2 carbon factors are:

Table 10: Regulated CO_2 Savings at Be Lean Stage

Regulated CO_2 Savings at Be Lean Stage				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Domestic	17.2	12.6	32.2	22.1
Non-domestic	31.6	152.1	13.7	32.7
Site wide	29.7	164.8	17.8	54.8

Energy cost to residents is also reduced through the implementation of energy efficiency measures outlined within this section.

BE CLEAN – SUPPLY ENERGY EFFICIENTLY

The proposed development is not located within close proximity to an existing or proposed district heating networks. No regulated carbon savings are achieved for this step of the Energy Hierarchy.

ENERGY SYSTEM HIERARCHY

The energy system for the development has been selected in accordance with the London Plan decentralised energy hierarchy. The hierarchy listed in Policy SI3 states that energy systems should consider:

1. Connection to existing heating and cooling networks;
2. Site wide CHP network; and,
3. Communal heating and cooling.

Local heat and power sources minimise distribution losses and achieve greater efficiencies when compared to separate energy systems, thus reducing CO_2 emissions.

In a communal energy system, energy in the form of heat, cooling, and/or electricity is generated from a central source and distributed via a network of insulated pipes to surrounding residences.

CONNECTION TO AN EXISTING OR PROPOSED NETWORK

The London Heat Map identifies existing and potential opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study.

An excerpt from the London Heat Map can be seen on the following page which shows the energy demand for different areas. Darker shades of red signify areas where energy demand is high. The map also highlights any existing and proposed district heating networks within the vicinity of the development.

A review of the map shows that there are no existing networks in close proximity to the proposed development.

A review of the Borough's heat mapping report (Borough Wide Heat Demand and Heat Source Mapping Study by BuroHappold) has been undertaken. The proposed development site is located in a cluster area that has been identified for further assessment. The Russell Square cluster was identified as an area with potential for a district energy network (DEN). The report highlights that the cluster is adjacent to the existing Bloomsbury Heat and Power network, and to the proposed Great Ormond Street cluster. It is recommended that should any of these nearby networks expand towards this cluster the loads could be connected into a wider area DEN. However, the report concludes that the Russell Square cluster should not be progressed currently.

Moreover, there has been communication with the London Borough of Camden to ascertain if there were any plans to extend the King's Cross Network to the vicinity of the site. It was confirmed that there are no plans to extend that network, therefore that option has not been considered feasible – please refer to Appendix C – DHN Communication. The proposed development proposes a centralised energy centre that could be connected to a district energy network in the future, if considered feasible.

COMMUNAL HEATING AND COOLING

Communal ASHPs will form part of a centralised strategy (alongside electric boilers) for the supply of space heating and hot water to all uses across the development.

For the commercial part of the development, it is assumed that ASHPs will supply 100% of the heating and cooling demand, with the domestic hot water demand served by 50% ASHPs and 50% electric boilers. For the domestic part of the development the heating and domestic hot water load will be supplied via 50% ASHPs and 50% electric boilers.

BE CLEAN CO_2 EMISSIONS

Savings from the incorporation of ASHP, as it is a renewable technology, are presented in the Be Green section.

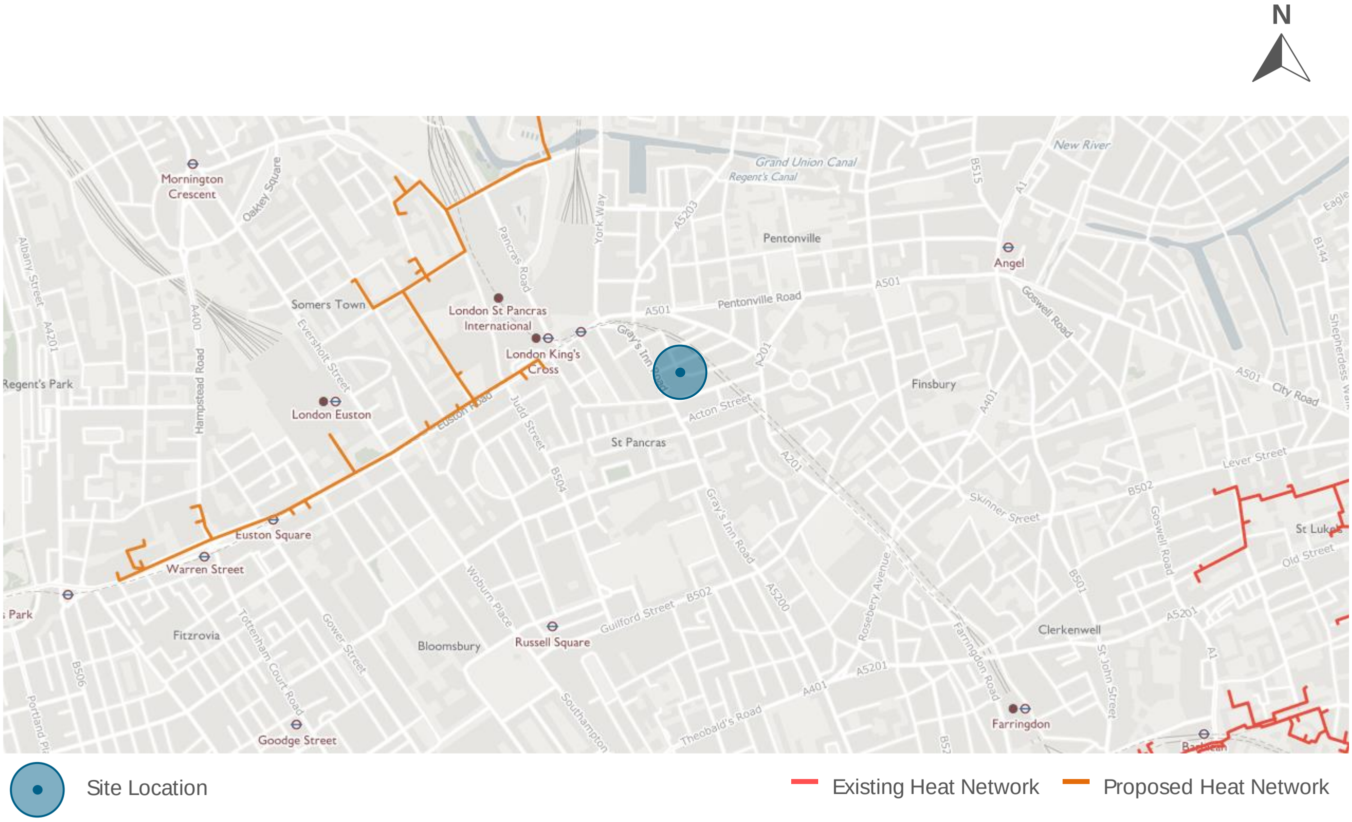


Figure 6: Excerpt from the London Heat Map. Existing district networks outlined in red, proposed networks in orange.

BE GREEN – USE RENEWABLE ENERGY

The renewable technologies feasibility study carried out for the development identified photovoltaics and air source heat pumps as suitable technologies for the development. The regulated carbon savings achieved in this step of the Energy Hierarchy is 27.0% over the site wide baseline level with SAP10.2 emission factors.

RENEWABLE TECHNOLOGIES FEASIBILITY STUDY

Methods of generating on-site renewable energy (Green) were assessed, once Lean and Clean measures were taken into account.

The proposed development will benefit from an energy efficient building fabric which will reduce the energy consumption of the proposed development in the first instance. A range of renewable technologies were subsequently considered including:

- Biomass;
- Ground/water source heat pumps;
- Air source heat pumps (ASHP);
- Wind energy;
- Photovoltaic panels (PV); and,
- Solar thermal panels.

In determining the appropriate renewable technology for the site, the following factors were considered:

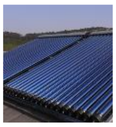
- CO_2 savings achieved;
- Site constraints; and
- Any potential visual impacts.

RENEWABLE ENERGY APPRAISAL SUMMARY

The table overleaf summarises the factors taken into account in determining the appropriate renewable technologies for this project. This includes estimated capital cost, lifetime, level of maintenance and level of impact on external appearance. The final column indicates the feasibility of the technology in relation to the site conditions (10 being the most feasible and 0 being infeasible). It is important to note that the information provided is indicative and based upon early project stage estimates.

The feasibility study demonstrates that ASHPs and photovoltaics would be the most feasible renewable technologies for the proposed development. Detailed assessments for the proposed technologies can be found in the following sections; site specific analysis data for the technologies not adopted can be found in appendix.

Table 11 Summary of renewable technologies feasibility study

		Comments	Lifetime	Maintenance	Impact on external appearance	Site feasibility
Biomass		Not adopted – burning of wood pellets releases high NOx emissions and there are limitations for their storage and delivery within an urban location.	20 yrs.	High	High	2
PV		**Adopted - PV panels can be integrated on available roof space and can provide additional CO_2 savings.**	25 yrs.	Low	Med	8
Solar thermal		Not adopted – Limited space on the roof, and PV panels provide a higher contribution towards CO_2 savings	25 yrs.	Low	Med	6
GSHP		Not adopted -the installation of ground loops requires significant space, additional time at the beginning of the construction process and very high capital costs.	20 yrs.	Med	Low	3
ASHP		**Adopted – ASHPs provide significant carbon savings.**	20 yrs.	Med	Med	9
Wind		Not adopted - Wind turbines located at the site will have a significant visual impact on the site and surroundings.	25 yrs.	Med	High	1

DETAILED ASSESSMENT OF PHOTOVOLTAIC PANELS

Four types of solar cells are available on the market at present and these are mono-crystalline, poly-crystalline, thin film and hybrid panels. Although mono-crystalline and hybrid cells are the most expensive, they are also the most efficient with an efficiency rate of 12-20%. Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but can be produced as thin and flexible sheets.

Photovoltaics are considered a suitable technology for this development for the following reasons:

- The development provides an extent of roof space for the installation of PV panels;
- PV arrays are relatively easy to install when compared to other renewable systems; and
- PV panels provide a significant amount of CO_2 savings.

The PV shall comprise 24.70kWp (130m^2) of roof mounted arrays on Block A of the residential development and the Hotel.

The table below summarises the technical data for the proposed PV array and estimated CO_2 savings from the application of this technology. In total the PV installation would produce regulated CO_2 savings of 0.6% for the development.

An indicative area for the installation of the PV panels on the roof can be found in figure on the following page. This PV area is combined with extensive green roofs and has been maximised wherever possible. As shown in the figure on the following page, the other roof area is either external plant space, accessible terrace space or unsuitable for PVs due to size or shading restrictions. Radiation analysis for the proposed scheme was carried out to determine the most suitable areas for PV. As shown in the figure on the following page, the roofs proposed for PVs are not expected to be overshadowed by surrounding buildings. The proposal is indicative at this stage, with further technical details to be considered post planning.

Table 12: Summary of technical/operational data and estimated CO_2 savings for PVs

Photovoltaics		
Module efficiency	19	%
Orientation	South	
Predicted site solar energy	951	kWh/m^2.yr
System losses	20	%
System peak power	24.70	kWp
Array area	130	m^2
Primary energy offset by PV	18,784	kWh/yr.
Total CO_2 savings	4.4	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	0.6	%
% Total CO_2 reduction*	0.4	%

* % reduction from site baseline

Figure 7: Monocrystalline PV arrays

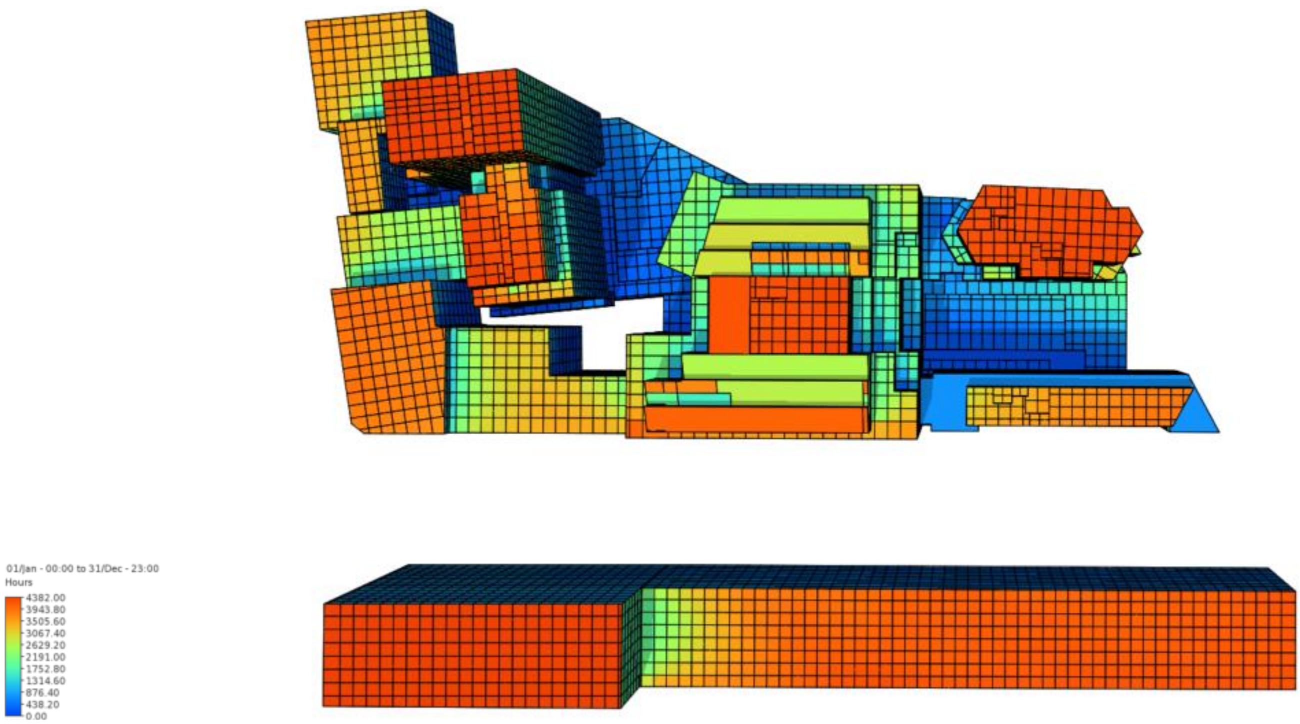


Figure 8: Radiation analysis for proposed scheme

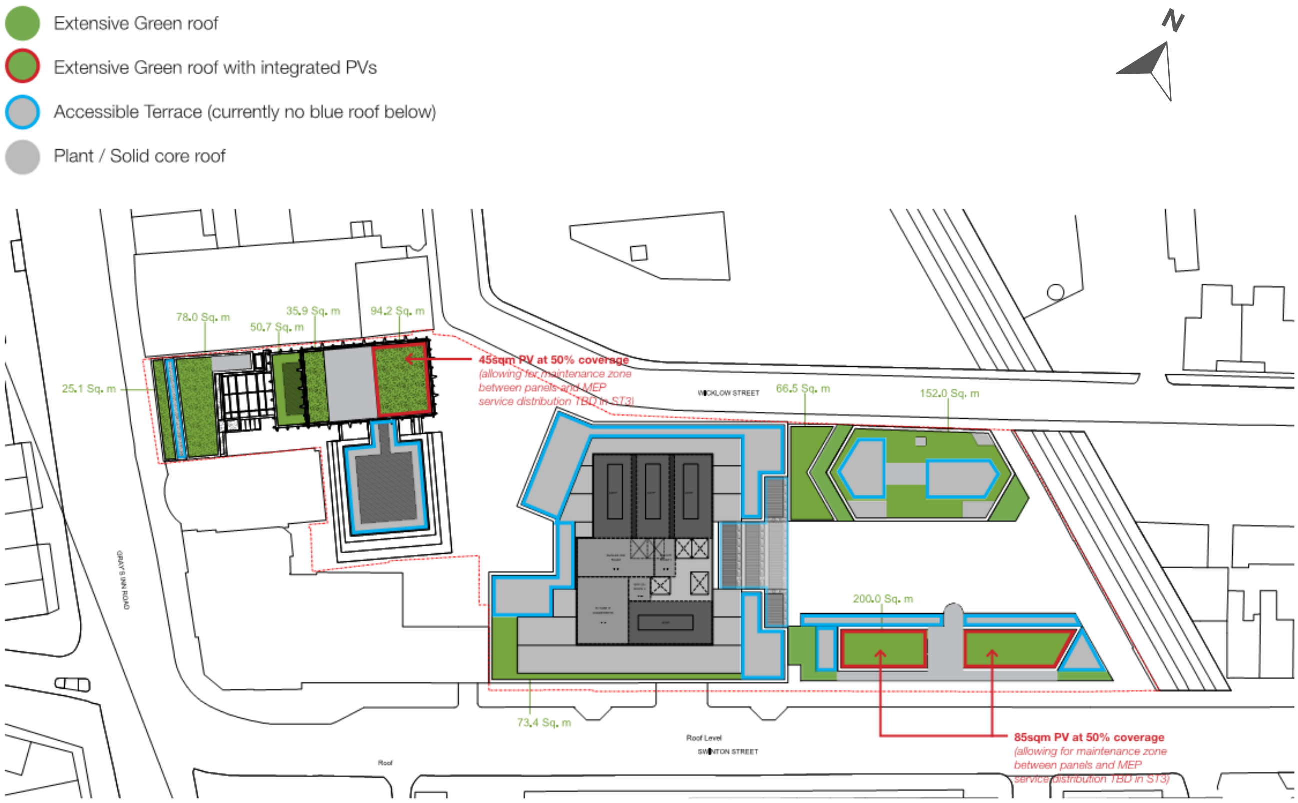


Figure 9. Proposed PV layout for the proposed development (Roof strategy sketch by AHMM).

DETAILED ASSESSMENT OF AIR SOURCE HEAT PUMPS

Air source heat pumps (ASHPs) employ the same technology as ground source heat pump (GSHPs). However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

The efficiency of heat pumps is very much dependent on the temperature difference between the heat source and the space required to be heated. As a result, ASHPs tend to have a lower COP than GSHPs. This is due to the varying levels of air temperature throughout the year when compared to the relatively stable ground temperature. The lower the difference between internal and external air temperature, the more efficient the system.

ASHP is considered a suitable technology for the development for the following reasons:

- It is a high efficiency system that can cater for the space heating and cooling of the most energy-intensive areas of the proposed development;
- Requires less capital cost than GSHP and other renewable technologies;
- It can be integrated with the proposed ventilation strategy; and,
- It is simple to install when compared to other renewable technologies and will work well alongside PV.

Communal ASHPs will form part of a hybrid system (alongside electric boilers) for the supply of space heating and hot water. For the commercial part of the development, it is assumed that ASHPs will supply 100% of the heating and cooling demand, with the domestic hot water demand served by 50% ASHPs and 50% electric boilers. For the domestic part of the development the heating and domestic hot water load will be supplied via 50% ASHPs and 50% electric boilers.

End-users will be supplied with regular information to control and operate the system e.g. at point of occupancy and maintenance visits.

The table on the following page summarises the technical data for the proposed ASHP and estimated CO_2 savings from the application of this technology. In total the ASHP technology would produce regulated CO_2 savings of 2.2% for the domestic part of the development and 23.1% for the non-domestic part of the development.

Further details for the heat pump system that could be installed to meet the targeted CO_2 emissions can be found in the table below.

Table 13: Summary of technical/operational data and estimated CO_2 savings for ASHP

ASHP for domestic spaces		
COP heating	3.10	
COP cooling	2.60	
Carbon intensity of electricity	0.233	kgCO2/kWh
Proportion of non-domestic space heating and hot water met by ASHP	50	%
Proportion of non-domestic space cooling met by ASHP	50	%
Energy met by ASHP	125,446	kWh/yr.
Energy used by ASHP	43,534	kWh/yr.
Total CO_2 savings	19.8	t/yr.
Regulated baseline CO_2 emissions	428.1	t/yr.
Total baseline CO_2 emissions	815.2	t/yr.
% Regulated CO_2 reduction*	4.2	%
% Total CO_2 reduction*	2.2	%
ASHP for non-domestic spaces		
COP heating	4.6	
COP cooling	5.9	
Carbon intensity of electricity	0.233	$kgCO_2/kWh$
Proportion of non-domestic hot water met by ASHP	50	%
Proportion of non-domestic space heating met by ASHP	100	
Proportion of non-domestic space cooling met by ASHP	100	%
Energy met by ASHP	756,990	kWh/yr.
Energy used by ASHP	148,691	kWh/yr.
Total CO_2 savings	197.0	t/yr.
Regulated baseline CO_2 emissions	428.1	t/yr.
Total baseline CO_2 emissions	815.2	t/yr.
% Regulated CO_2 reduction*	23.1	%
% Total CO_2 reduction*	12.1	%

* % reduction from site baseline

Figure 10: Outdoor units of ASHP

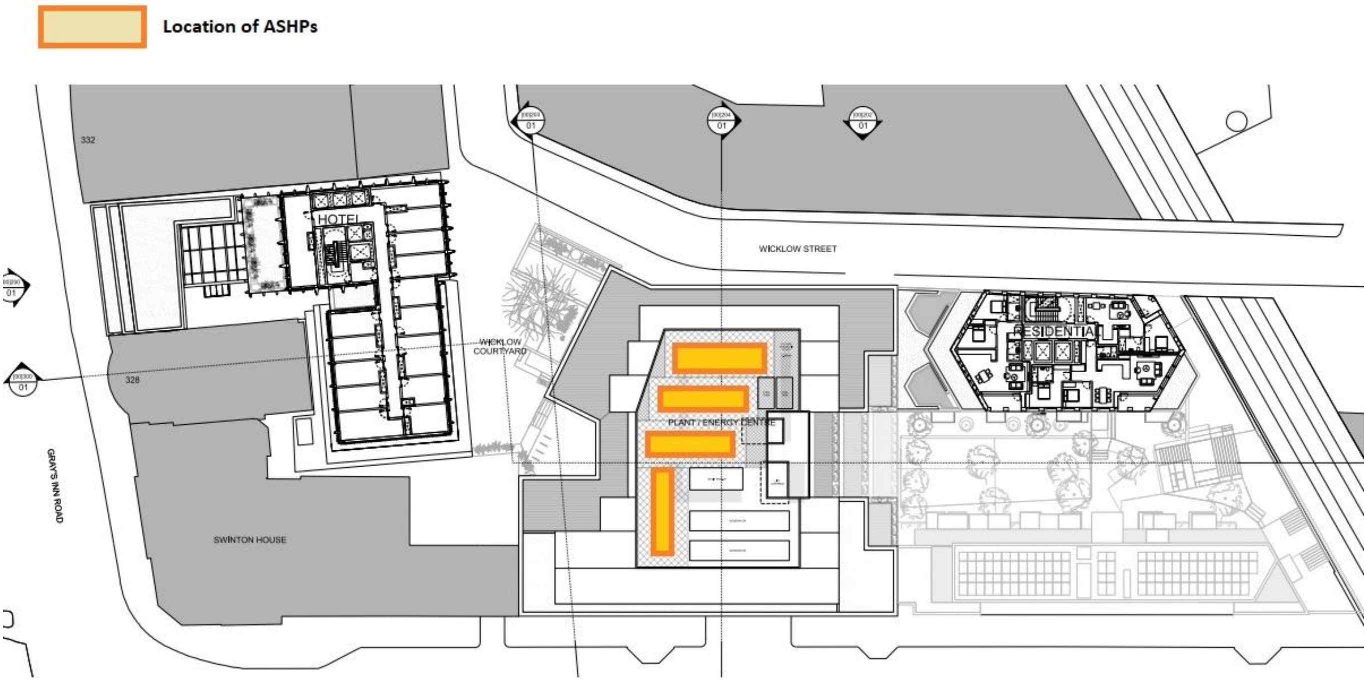


Figure 11. Proposed ASHP layout for the proposed scheme.

BE GREEN CO_2 EMISSIONS

Following the measures adopted at Lean stage, further savings can be obtained through the incorporation of the proposed PV panels and ASHP.

In accordance with Camden Planning Guidance on Energy Efficiency and Adaption, the proposed development needs to exceed the target of 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.

Due to the improve performance that the non-domestic buildings need to present to meet the new Part L 2021 Regulations, the development achieves 9% reduction in carbon dioxide emissions from on-site renewable energy technologies. However, a comparison of the updated proposed design under the previous Part L 2013 Regulations (SAP 10 carbon factors) shows that in reality, the development would normally demonstrate 14.7% in carbon dioxide emissions from on-site renewable energy technologies.

Additionally, as per table 14 below, the actual energy consumption of the building shows, at "be Green" stage that the Part L 2021 scenario is showing a 7.1% reduction in Regulated Energy. Therefore, the development, although is not meeting the 20% target of reduction in carbon dioxide emissions from on-site renewable energy technologies, in reality is performing better and consumes less energy.

Table 14. Regulated Energy Comparison.

Non- Domestic Regulated Energy (kWh/yr)					
	Consented Scheme (Part L 2013)	SAP 10 (Part L 2013)	SAP 10.2 (Part L 2021)	Improvement between Part L 2013 -2021 (%)	Improvement between Consented Scheme - Part L 2021 (%)
"Be Green" - After renewable energy	1,838,940	1,490,890	1,385,710.0	7.1%	24.6%

BE SEEN – ENERGY MONITORING

The proposed development different expected building uses and energy centre will allow for separate metering and submetering in order to be able to report on energy consumption, plant efficiency as well as renewable energy generation.

The new London Plan has introduced a fourth step into the Energy Hierarchy named "Be Seen" in Policy SI 2 (Minimising greenhouse gas emissions). This is a requirement for all major development to 'be seen' i.e. to monitor and report its energy performance post-construction to ensure that the actual carbon performance of the development is aligned with the Mayor's net zero carbon target and reduce the performance gap.

A published 'Be seen' energy monitoring guidance has been released in September 2021 and details the GLA approach to be met by new developments.

Reporting to the GLA is expected to be required at each process stage through a reporting spreadsheet not yet made available and sent to the GLA. An online portal is expected to be made available in due course.

The proposed development will integrate a metering strategy to allow for the measure of energy consumption during the operation of the building.

The proposed development at 330 Gray's Inn Road comprises a mixed used development with a centralised energy centre and has designed to meet high operational performance targets beyond the requirements of Building Regulations.

Each building type will have separate metering split into lighting, small power and HVAC, in line with current Part L requirements. The office will have utility meters on each floor for each tenant.

The residential dwellings will be provided with smart meters to monitor the heat and electricity consumption of each dwelling; the display board will demonstrate real-time and historical energy use data and will be installed at an accessible location within the dwellings.

Furthermore, the proposed development incorporates solar PV which will have their own generation meter to help identify how much renewable energy is generated on site.

ESTIMATION OF OPERATIONAL FUEL COSTS

This section provides an early stage estimation of the operation costs of the development from an energy perspective.

OPERATIONAL COSTS

The annual estimated operational fuel cost predictions associated with the development as a whole using SAP and SBEM methodologies are outlined in the table below.

It should be appreciated that the operational fuel costs presented in this report are solely based on Building Regulations Part L compliance calculations carried out at early design stage. These estimations do not necessarily reflect the actual operational costs, and do not take into consideration occupant behaviour and account for costs associated with un-regulated energy use.

It is noted that Renewable Heat Incentive (RHI) is available for both domestic and non-domestic developments with ASHPs installed. This will be explored in more detail post-planning and post-construction so the applicant can seek a financial subsidiary with the more detailed design information required (e.g. EPCs).

Annual administration costs of the communal system will be confirmed by the management company, they are therefore considered to have a more accurate understanding of these associated costs and given the nature of the scheme, closer to completion of the development.

Table 15. Estimated operational fuel cost for the proposed development.

		Unit
Space heating energy demand	**148,990**	kWh/year
Hot water energy demand	783,280	kWh/year
Other electricity consumption	2,241,680	kWh/year
Per unit cost - electricity	0.33	£/kWh
Total annual operational energy fuel cost	**1,047,404**	**£/year**

CONCLUSIONS

Following the implementation of the three-step Energy Hierarchy, the cumulative CO_2 savings on site are estimated at 59.0% for the domestic part and 18.0% for the non-domestic part of the development, against a Part L 2021compliant scheme. The regulated CO_2 savings for the site as a whole are 27.0% with SAP10.2 emission factors.

ON SITE CO_2 SAVINGS

By implementing the three step Energy Hierarchy as detailed in the previous sections, the Regulated CO_2 emissions for the development have been reduced against a Part L 2021 compliant scheme through onsite measures alone by:

Cumulative Regulated CO2 Savings				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Domestic	45.3	20.5	59.0	40.8
Non-domestic	44.3	171.5	18	43.1
Site wide	44.4	204.6	27	83.9

The regulated CO_2 savings for the refurbishment are:

Refurbishment Regulated CO2 Savings				
	SAP 10 (Part L 2013)		SAP 10.2 (Part L 2021)	
	%	t/yr	%	t/yr
Be Lean	60.67	51.76	53.77	40.29
Be Clean	0.00	0	0	0
Be Green	4.00	3.41	5.63	4.22
Total	64.67	55.17	59.40	44.51

OFF SITE CO_2 SAVINGS: CARBON OFFSET PAYMENT

According to the London Plan and Camden Local Plan CO_2 the savings target of 35% overall, needs to be met. In accordance with Camden Planning Guidance on Energy Efficiency and Adaption, the proposed development also needs to meet the target of 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.

Taking into consideration the improved performance that the buildings need to demonstrate just to meet the new Part L 2021 Regulations, the development performs exceptionally. It achieves a 27% of total CO_2 savings, of which 9% reduction is generated from on-site renewable technologies, against Part L 2021.

With the SAP 10.2 carbon factors, to achieve 'zero carbon' for the residential portion of the scheme, 27.8 tonnes per annum of regulated CO_2, equivalent to 834 tonnes over 30 years, from the new-build domestic portion should be offset offsite. The shortfall to a zero carbon reduction from baseline for the new build non-domestic portion of the scheme would be 195.3 tonnes per annum of regulated CO_2, equivalent to 5,858 tonnes over 30 years, to be offset offsite.

Any carbon offset contributions will be subject to viability discussions and detailed design stage calculations when the SAP10.2 methodology and emission factors are finalised.

The tables in the following pages summarise the implementation of the Energy Hierarchy for the proposed scheme and detail the CO_2 emissions and savings against the baseline scheme for each step of the hierarchy; as well as the savings achieved through carbon offset.

Separate tables are presented for the domestic and non-domestic parts of the development, as well as for the site as a whole.

Overall, the proposed development has been designed to demonstrate the client and the design team's commitment to enhancing the sustainability of the scheme.

BE SEEN

The proposed development integrates a metering strategy to allow for the measure of energy consumption during the operation of the building. Metering will be split into lighting, small power and HVAC, in line with current Part L requirements. The office will have utility meters on each floor for each tenant.

Furthermore, residential dwellings will be provided with smart meters to monitor the heat and electricity consumption of each dwelling; the display board will demonstrate real-time and historical energy use data and will be installed at an accessible location within the dwellings.

DOMESTIC CUMULATIVE SAVINGS

Table 16: CO_2 emissions after each step of the Energy Hierarchy for the domestic part of the development

	Carbon dioxide emissions for domestic buildings (tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline	68.6	43.2
After energy demand reduction	46.5	43.2
After heat network/CHP	46.5	43.2
After renewable energy	27.8	43.2

Table 17: Regulated CO_2 savings from each stage of the Energy Hierarchy for the domestic part of the development

	Regulated domestic carbon dioxide savings	
	Tonnes CO_2 per annum	% over baseline
Savings from energy demand reduction	22.1	32.0%
Savings from heat network/CHP	0.0	0.0%
Savings from renewable energy	18.7	27.0%
Cumulative on site savings	40.8	59.0%
Cumulative for offset payments	834 tonnes over 30 years	

NON-DOMESTIC CUMULATIVE SAVINGS

Table 18: CO_2 emissions after each step of the Energy Hierarchy for the non-domestic part of the development

	Carbon dioxide emissions for non-domestic buildings (tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline	238.4	107.0
After energy demand reduction	205.7	107.0
After heat network/CHP	205.7	107.0
After renewable energy	195.3	107.0

Table 19: Regulated CO_2 savings from each stage of the Energy Hierarchy for the non-domestic part of the development

	Regulated non-domestic carbon dioxide savings	
	Tonnes CO2 per annum	% over baseline
Savings from energy demand reduction	32.7	14.0%
Savings from heat network/CHP	0.0	0.0%
Savings from renewable energy	10.4	4.0%
Cumulative on site savings	43.1	18.0%
Shortfall from zero carbon	5,858 tonnes over 30 years	

SITE-WIDE CUMULATIVE SAVINGS

Table 20: Site wide regulated CO_2 emissions and savings

	Total regulated emissions (tonnes CO_2/year)	Regulated CO_2 savings (tonnes CO_2/year)	Percentage saving (%)
Baseline	307.0		
Be Lean	252.2	54.8	18%
Be Clean	252.2	0.0	0%
Be Green	223.0	29.1	9%
Total		83.9	27%
Offset to zero carbon for domestic		834 tonnes over 30 years	
Offset for non-domestic to zero carbon		5,858 tonnes over 30 years	

REFURBISHMENT ONLY SAVINGS

Table 21: Site wide regulated CO_2 emissions and savings

	Total regulated emissions (tonnes CO_2/year)	Regulated CO_2 savings (tonnes CO_2/year)	Percentage saving (%)
Baseline	74.93		
Be Lean	34.64	40.29	53.8%
Be Clean	34.64	0.0	0.0%
Be Green	30.42	4.22	5.63%
Total		44.51	59.40%

APPENDIX A – OVERHEATING RISK ASSESSMENT

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OVERHEATING RISK ASSESSMENT (TM59/PART O)

9.370 – 330 GRAY'S INN ROAD

21/02/2023 *by* OB, *reviewed by SG*

All habitable rooms assessed for the proposed residential part of the development at 330 Gray's Inn Road, in the London Borough of Camden, were found to meet the requirements outlined in TM59 and Approved Document O, provided that adequate design considerations are taken into account and mitigation measures are implemented. These include passive ventilation through openable windows and solar control strategies, such as balconies, recessed windows and low g-value. Due to acoustic constraints on site, window opening will be restricted and the MVHR units will provide continuous background ventilation as well as incorporate an air tempering system for overheating risk mitigation, as included in the previously consented scheme.

EXECUTIVE SUMMARY

An overheating analysis has been conducted for the proposed residential part of the development at 330 Gray's Inn Road, located in the London Borough of Camden. The purpose of this analysis is to test the design of the proposed scheme and ensure the mitigation of any overheating risk within the occupied zones across the development. This will ensure the comfort of the occupants as well as future-proof the scheme by accounting for projected increased ambient air temperatures from climate change.

In order to assess the thermal performance of the development, models were constructed within thermal simulation software. The internal temperature, lighting and ventilation conditions were estimated for all habitable internal spaces.

With the aim of giving the most robust consideration, the performance of the various occupied rooms was compared with CIBSE Technical Memorandum 59[1] performance recommendations. These are rigorous targets that determine the acceptability of overheating based on the temperature differential between the internal and the external environment (ΔT), considering the frequency of high temperature difference beyond which the level of overheating is considered unacceptable. Specifically, for bedrooms, the methodology aims to evaluate comfort during the sleeping hours by setting a maximum number of hours for which the operative temperature can exceed 26°C.

The restrictions outlined in Approved Document O[2] were also applied within this assessment. Approved Document Part O (AD O) was first published on 15th December 2021 and came into effect in England on 15th June 2022, with transitional arrangements in place. This document was developed to provide guidance on compliance with Requirement O1 (2) (a) of Schedule 1 to the Building Regulations 2010 which notes that:

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[1] CIBSE TM59:2017 – Design Methodology for the assessment of overheating risk in homes
[2] Approved Document O – Requirement O1: Overheating Mitigation, Regulations: 40B

"...

(1) Reasonable provision must be made in respect of a dwelling, institution or any other building containing one or more rooms for residential purposes, other than a room in a hotel ("residences") to –
   a. limit unwanted solar gains in summer;
   b. provide an adequate means to remove heat from the indoor environment.

(2) In meeting the obligations in paragraph (1) –
   a. account must be taken of the safety of any occupant, and their reasonable enjoyment of the residence; and
   b. mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it.

..."

Part O is part of the Building Regulations 2021 and is currently the most appropriate assessment methodology for assessing overheating risk in residential properties in the UK.

Compliance with AD O has been demonstrated through dynamic thermal modelling. The thermal simulations indicate the following:

- The proposed dwellings are predicted to satisfy the overheating risk criteria for the probabilistic Design Summer Year (DSY1) weather data for London Weather Centre through the incorporation of MVHR with air tempering and solar control strategies including balconies, recess windows and solar control glazing.
- Enhanced solar glazing specification (g-value of 0.4) is recommended to all facades to reduce solar radiation without significantly impact energy performance and internal daylight.
- Due to window opening restrictions for acoustic and air quality reasons, it is recommended that an air tempering system is added to the MVHR to mitigate overheating risk during the hottest months of the year. Openable windows are available for the occupants to use, but guidance from the acoustic consultant states that these should not be relied upon. The Air Quality Consultant also recommends the same based on historic Air Quality data – with the expansion of the ULEZ which has come into effect since the consented scheme was submitted; poor air quality due to vehicular traffic is expected to significantly improve. The assessment suggests that small amounts of natural ventilation via opening windows during daytime only may be required to mitigate overheating during the hottest periods of the year.
- As included in the previously consented scheme, the air tempering system added to the MVHR should be able to deliver up to 110 l/s per dwelling balanced per habitable room. It is recommended that specialist detailed design is undertaken at the next design stage.
- For fully enclosed communal corridors, it is recommended that an environmental fan with a flow rate of 40 l/s is incorporated to reduce overheating risk. The details and specification of this fan is however dependent on the final heat distribution method, pipework specification and insulation levels, which will be confirmed at the next design stage, and should be considered alongside the fire and ventilation strategy.

Based on the method of assessment adopted, XCO2 recommend the design team to consider incorporating the features that allow compliance with CIBSE TM59 and Approved Document O under the London Weather Centre DSY1 (2020s, high emissions, 50% percentile scenario) weather data.

It should be noted that the findings of this assessment are related to planning stage design only and are based on a sample of units. Any changes to the ventilation strategy, façade opening areas, window operation and shading elements would impact the performance of the building and may void the results of the current assessment.

METHODOLOGY

Compliance with AD O Requirement O1 (2) can be demonstrated using one of two methods:

a. The simplified method.
b. The dynamic thermal modelling method.

The dynamic thermal modelling method was used to conduct the assessment presented in this note.

AD O outlines additional requirements to be applied to CIBSE's TM59 methodology in order to restrict the choices made by the modeller. To demonstrate compliance using the dynamic thermal modelling method the following guidance was followed:

- CIBSE's TM59 methodology for predicting overheating risk.
- The limits on the use of CIBSE's TM59 methodology, as outlined in AD O.
- The acceptable strategies for reducing overheating risk set out in AD O.

3D thermal models of the proposed scheme have been developed based on the planning architectural drawings. To give a fair representation of the residential development, 28 units including 9 KLDs and 19 bedrooms were analysed to provide a representative sample of the space and dwelling typologies within the development.

Shared communal rooms and common spaces of buildings containing more than one residential unit fall within the scope of AD O. Two communal corridors were therefore analysed as part of this assessment.

The surrounding context was included within the model to account for the shading effects that adjacent buildings are likely to provide.

An axonometric view of the model from the South of the development is presented in Figure 1 below.

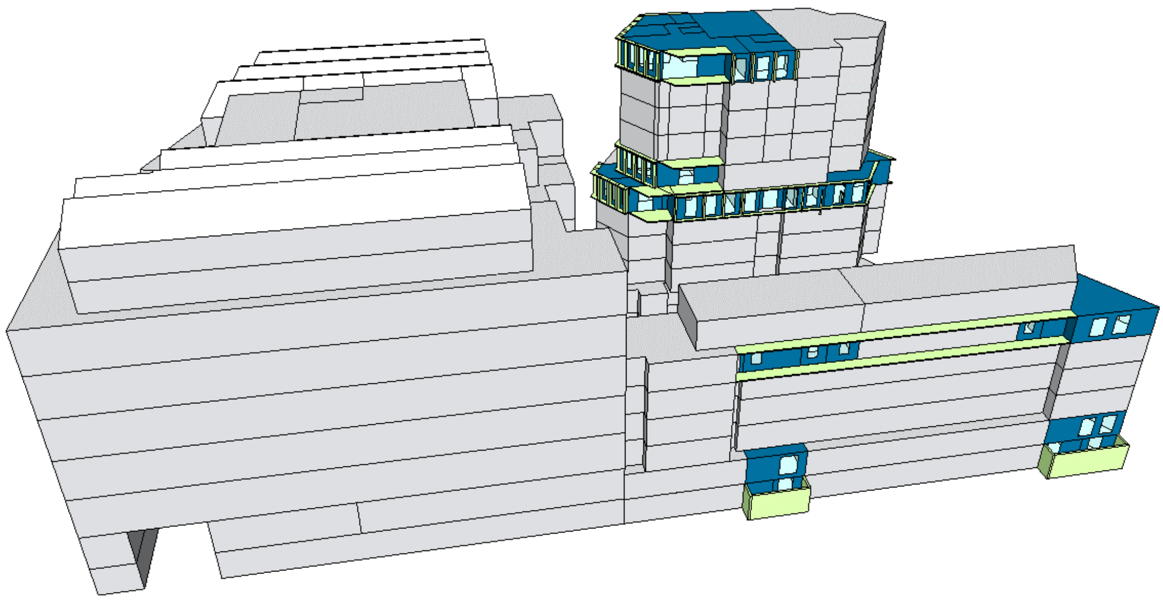

Figure 1: An axonometric view of the development

The overheating risks of the spaces were assessed using the CIBSE Design Summer Year 1 (DSY1) weather file which represents a moderately warm summer. The 2020s, high emissions, 50% percentile scenario was selected in line with methodology requirements. The 2020 period is of particular interest as this relates to the period 2011-2040, which is the period we have now entered.

Further testing with DSY2 and DSY3 (2020s, high emissions, 50% percentile scenario) was also undertaken to test the development robustness against more severe weather patterns, although compliance with these weather files is not a requirement.

The buildings have been modelled using dynamic thermal simulation software. The software can compute operative temperatures using weather data sets, building fabric specification, window areas and opening, all aspects of solar and internal gains as well as natural ventilation flows within buildings. Compliance of the design with the criteria outlined in TM59 (with restrictions outlined in AD O) has been sought and recommendations formulated.

ASSESSMENT CRITERIA

The following two criteria were used:

1) **For living rooms, kitchens, communal rooms and bedrooms:**
   The number of hours during which ΔT (the difference between operative and threshold comfort temperatures) is greater than or equal to one degree (K), during the period of May to September inclusive, shall not be more than 3 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).
2) **For bedrooms only:**
   To evaluate comfort during sleeping hours, the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26°C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26°C will be recorded as a fail).

The first criterion is evaluated in terms of the ΔT, which is the difference between the operative temperature T_{op} and the limiting maximum temperature T_{max}, $\Delta T = T_{op}$[3] $- T_{max}$[4]. In order to estimate T_{op}, dynamic thermal modelling is carried out to compute the predicted temperature distribution in the different thermal zones of the building. The maximum acceptable temperature is a function of the outdoor temperature and the design limits, which are shown below. The table details the suggested acceptability in terms of the temperature range of naturally ventilated buildings. For the purpose of the assessment, we have used Category II limits, as recommended within CIBSE TM52.

Table 1: CIBSE TM52 – Suggested applicability of the category and the associated acceptable temperature range for a free running building

Category	Explanation	Acceptable Range (°C)
II	Normal expectation (for new buildings and renovations)	±3

CIBSE TM59 also recommends assessment criteria for overheating risk in corridors based on exceeding an operative temperature of 28°C. Whilst there is no mandatory target, corridors should aim to comply with the following criteria:

1) **For corridors:**
   If an operative temperature of 28°C is exceeded for more than 3% of total annual hours, this should be flagged as a significant risk within the report.

[3] Operative temperature models the combined effect of convective and radiant heat transfer. It accounts for the combined of the temperature of the air, the temperature of the surfaces and air speed.
[4] T_{max} is the maximum acceptable temperature and is dependent on the outdoor running mean temperature and the building category with each associated acceptability range.

MODELLING ASSUMPTIONS

FABRIC PERFORMANCE

The specification of the fabric is aligned with the proposals at planning stage as these are outlined in the Energy Statement for the scheme and summarised in Table 2.

Table 2: Building fabric assumptions.

Element	Specification	
	U-value [W/m².K]	
External Walls	0.15	
Ground Floor	0.10	
Roof	0.10	
	U-value [W/m².K]	**g-value**
Window	1.20	0.40
	Air permeability (@50Pa)	
	3.0 m³/m².h	

OCCUPANCY

The TM59 methodology specifies the hours during which spaces are anticipated to be occupied and these have been used within the overheating assessment calculations. The same occupancy assumptions apply in the dynamic thermal analysis method of Part O. Table 3 sets out the predicted occupancy patterns for the assessed rooms within the dwellings in line with the TM59 requirements; these are programmed into the dynamic software model to calculate the relative occupancy gains for the designated spaces.

Table 3: Occupancy assumptions for the room types assessed

Area	Predicted occupation pattern
Single Bedroom	00:00 – 24:00, 7 days/week
Double Bedroom	00:00 – 24:00, 7 days/week
1/2/3–Bed Kitchen Living Diner	09:00 – 22:00, 7 days/week

INTERNAL GAINS

For all residential units modelled, the predicted occupancy hours, the internal gains (lighting, equipment, people) for occupied areas are incorporated within the model in line with the guidance set out in TM59.

Table 4 sets out the various internal gains for the assessed rooms within the dwellings. Non-occupied spaces such as circulation, bathrooms and storage were modelled based on the typical internal gains specified within the TM59 methodology.

Table 4: Internal Gains modelled for each room type assessed.

Area	Predicted Internal Gains		
	Lighting [W/m²]	**People [peak W]**	**Equipment [peak W]**
Double Bedroom	2.0 W/m²	150 W sensible, 110 W latent	80 W
Single Bedroom	2.0 W/m²	75 W sensible, 55 W latent	80 W
1Bed Living/kitchen/dining area	2.0 W/m²	75 W sensible, 55 W latent	450 W

2Bed Living/kitchen/dining area	2.0 W/m^2	150 W sensible, 110 W latent	450 W
3Bed Living/kitchen/dining area	2.0 W/m^2	225 W sensible, 165 W latent	450 W

Under Part O, the inclusion of common spaces such as corridors in overheating analysis is required. As outlined in the Energy Statement, space heating and hot water to the domestic parts of the development will be provided by a communal system. Pipework connecting the communal system to the individual flats will run through communal corridors situated on each floor.

Two fully enclosed sample corridors were tested at the 6th and 11th levels as a typical case scenario. To estimate the internal gains associated with the communal pipework, the estimated outside diameter of the flow and return pipes respectively was converted to a maximum heat loss per metre run of pipe (W/m) using a conversion table contained within the CIBSE TM59 guidance document. These figures were converted to a corridor pipework heat gain in watts using the estimated length of the flow and return pipes within each corridor. The internal gains for the internal corridors modelled are displayed in **Error! Reference source not found.**.

Table 5: Internal Gains modelled for corridor areas.

Area	Predicted Internal Gains		
	Lighting [W/m^2]	People [peak W]	Pipework [peak W]
Corridor	2.0 W/m^2	-	390 W

VENTILATION

The proposed ventilation strategy for the development entails the use of Mechanical Ventilation with Heat Recovery (MVHR) for the whole year. Therefore, the estimated ventilation flow rates have been included in the model in line with Part F requirements for ventilation to provide a conservative baseline for assessment. All habitable rooms will have openable windows to provide passive natural ventilation for overheating mitigation.

The methodology outlined in Appendix D of AD O was used to calculate the equivalent area of each of the window types included within the architectural drawings received from Allford Hall Monaghan Morris on the 14th of February 2023. The level of exposure and associated coefficients of discharge are set up in accordance with the relative position of each window in relation to building massing.

A number of different window types were modelled in the assessment using the following conditions:

- All windows and doors are side hung opening types and are capable of opening to 90˚.
- Restrictors will be included that will be able to limit window opening to 10deg.
- All KLD windows to have a secure opening setting for night-time ventilation so that they can be opened at night, if required.
- All ground floor windows to have secure opening setting for daytime ventilation so that they can be opened when the room is unoccupied, if required.

In line with the limits on CIBSE's TM59 methodology outlined in AD O, the assumed opening profiles differ for openings to rooms at ground floor level compared to those above ground floor level that are not deemed to be easily accessible.

<u>Openings to rooms above ground floor level</u>

- Start to open when the internal temperature exceeds 22 ˚C.
- Be fully open when the internal temperature exceeds 26 ˚C.
- Start to close when the internal temperature falls below 26 ˚C.
- Be fully closed when the internal temperature falls below 22 ˚C.
- Be modelled as fully open if the internal temperature exceeds 23 ˚C at 11 pm.

<u>Openings to rooms at ground floor level, unoccupied at night</u>

- Start to open when the internal temperature exceeds 22 ˚C.
- Be fully open when the internal temperature exceeds 26 ˚C.

- Start to close when the internal temperature falls below 26 ˚C.
- Be fully closed when the internal temperature falls below 22 ˚C.
- Be closed at night if the room is unoccupied and be modelled as fully open if the internal temperature exceeds 23 ˚C at 11 pm if the room is occupied.

In order to ensure the overheating mitigation strategy is usable, AD O details further restrictions related to noise, pollution and protection from entrapment. A summary of the requirements and, where applicable, how compliance can be demonstrated for the proposed development at this stage, has been provided below.

- **Noise:** AD O set night-time-only noise level thresholds that may impact window opening on dwellings. The acoustic assessment developed by Hann Tucker Associates and submitted in support of this planning application, indicates that there may be a risk of excessive noise on all facades of the development. As a result, all dwellings will not be able to rely on openable windows as a means of mitigating overheating risk. The MVHR system of all dwellings will include cooling coils for air tempering to reduce overheating risk. Restricted window opening will be required during daytime on the hottest periods as a last resort measure to mitigate overheating.
- **Pollution:** Buildings located near to significant local pollution sources should be designed to minimise the intake of external air pollutants. An Air Quality Assessment has been undertaken for the proposed development at planning stage which indicates that future residents and users of the proposed development will experience acceptable air quality
- **Security:** AD O outlines requirements related to security. During sleeping hours, AD O notes that only the proportion of windows that can be opened securely should be considered to provide useful ventilation. As outlined above, for rooms unoccupied during sleeping hours (e.g. KLDs) that are at ground floor or are easily accessible, windows and patio doors should be modelled as closed at night. For rooms occupied during sleeping hours (e.g. bedrooms), ground floor windows and easily accessible windows should only be used for ventilation during sleeping hours where they have been made secure, specifically via the use of fixed or lockable louvred shutters or fixed or lockable window grilles or railings. Due to noise constraints as noted above, all windows have been assumed closed at night and only restricted window opening during the day, if required.
- **Protection from Falling:** AD O outlines specific requirements to minimise the risk of falling associated with the use of a natural ventilation strategy. Requirements are based on the degree of opening possible and guarding heights.
- **Protection from Entrapment:** Where louvred shutters, window rails and ventilation grilles are specified in line with security requirements, these must comply with criteria to protect from entrapment related to the size of openings and the presence of child safety devices. These requirements will be considered by the planning team at the next design stage, to ensure any security measures required as part of the overheating mitigation strategy comply with these requirements.

RESULTS

This section presents the results summary for each of the tests carried out for the proposed development. In total 28 habitable spaces were included in the assessment (17 double bedrooms, 2 single bedrooms and 9 KLDs). Non-habitable spaces such as bathrooms, storage rooms and circulation areas have also been included in the assessment; and their internal gains have been accounted for in the model.

RESIDENTIAL UNITS

Table 6 shows the modelling iterations undertaken under London Weather Centre DSY1 weather data, the sequential improvement measures that are proposed to be incorporated for each iteration and the number of rooms that were not found to meet the CIBSE TM59 criteria for each of the modelling iterations. The purpose of the improvement measures proposed is to minimise the number of rooms that fail the TM59 criteria to the greatest extent possible, taking into consideration viability, feasibility, and other design constraints.

Table 6: Overheating assessment results for London Weather Centre DSY1 (2020s High 50)

ID	Design change	Bedrooms	KLDs	g-value	Internal Doors	Cooling coil (flow rate)	Bedrooms TM59 night-time 26°C criterion	Bedrooms TM52 Criterion 1	KLDs TM52 Criterion 1
		Window opening degree and profile					No. of rooms not meeting criteria		
1	Natural ventilation	90° (Part O Profile)	90° (Part O Profile)	0.7	Open (day)	No	2/19	0/19	0/9
2	Windows closed 24/7 MVHR only	0°	0°	0.7	Open (day)	No	19/19	19/19	9/9
3	G-value reduction	0°	0°	0.4	Open (day)	No	19/19	19/19	9/9
4	Restricted daytime natural ventilation	10° (Part O daytime only)	10° (Part O daytime only)	0.4	Open (day)	No	19/19	19/19	9/9
5	Air tempering added to MVHR	10° (Part O daytime only)	10° (Part O daytime only)	0.4	Open (day)	Yes (100 – 110 l/s)	0/19	0/19	0/9

The following observations can be made from the results:

- The development is largely compliant with a passive natural ventilation strategy (iteration 1). When using a 90degree opening, only two bedroom spaces fail to meet the TM59 criteria. This is due to the inclusion of non-openable rooflights in these spaces rather than opening windows. All other spaces meet the TM59 criteria, using a relatively high g-value of 0.7.
- As outlined above, ground floor windows and easily accessible windows should only be used for ventilation during sleeping hours where they have been made secure.
- Given the acoustic restrictions on site, additional modelling has been conducted to assess the overheating risk with opening restriction applied to all windows.
- Relying solely on background ventilation through the MVHR without window opening is not sufficient to mitigate risk of overheating (iteration 2).
- Further passive measures were explored such as improvements to the window g-value reducing to 0.4 that significantly reduce the overheating risk in the dwellings but are not sufficient to demonstrate compliance with TM59 overheating risk criteria (iteration 3). Further reducing the g-value is not recommended as it could impact the internal daylight of the dwellings.
- Additional solar shading measures are already incorporated onto the facades in the form of window recesses and solar shading from balconies, further passive design improvements are not deemed feasible at this stage. Testing internal blinds is not permitted as per AD O methodology (although it is expected residents will install them) and external blinds/shutters were ruled out due to the safety risks with high level exposure to wind.

- Additional ventilation strategies were therefore explored. Restricted ventilation during daytime only (to avoid noise exposure during resting hours) was tested with positive impact, although the rooms still fall short from meeting the criteria (iteration 4).
- Finally, iteration 5 explored the installation of cooling coils, as included in the previously consented scheme, as a solution for overheating mitigation. The type of technology has limited cooling capacity (reducing energy consumption) but is able to temper outside air by a few degrees before being supplied to habitable rooms.
- The results show that a combination of a small amount of natural ventilation during the daytime hours only plus the air tempering system, all spaces meet the TM59 overheating risk criteria. Despite the limitations due to acoustic restrictions, window operation will only be required during the very hottest periods of the year during the day. Passive measures have been maximised to reduce the reliability on opening windows as much as possible.
- The assessment suggests all dwellings to pass the TM59 criteria with an air tempering system with a flow rate of between 100 and 110 l/s per dwelling. If the installation of cooling coils within the MVHR system is adopted as the preferred strategy for cooling, this flow rate would be balanced across all habitable zones in the residential portion of the development. It is recommended that specialist detailed design is undertaken at the next design stage.

Finally, both the fully passive solution (iteration 1) and the last iteration (iteration 5) was applied with DSY2 and DSY3 weather types, which are more severe weather types. The results for these years are shown in the table below.

Table 7: Overheating assessment results for the London Weather Centre DSY2 and DSY3 Weather File (2020s High 50)

ID	Design change	Bedrooms	KLDs	g-value	Internal Doors	Cooling Coil Flow Rate	Bedrooms TM59 night-time 26°C criterion	Bedrooms TM52 Criterion 1	KLDs TM52 Criterion 1
		Window opening degree and profile					No. of rooms not meeting criteria		
6	DSY2	90° (Part O Profile)	90° (Part O Profile)	0.7	Open (day)	No	19/19	7/19	9/9
7	DSY3	90° (Part O Profile)	90° (Part O Profile)	0.7	Open (day)	No	18/19	13/19	9/9
8	DSY2	10° (Part O daytime only)	10° (Part O daytime only)	0.4	Open (day)	Yes (100 – 110 l/s)	17/19	0/19	0/9
9	DSY3	10° (Part O daytime only)	10° (Part O daytime only)	0.4	Open (day)	Yes (100 – 110 l/s)	17/19	0/19	2/9

The following observations can be made from the results:

- On a passive ventilation only strategy (iterations 6 and 7), it can be observed that a number of bedrooms are compliant with the hours of exceedance criteria but not the night-time criteria under DSY2 and DSY3 weather files. All KLD's are not compliant with the hours of exceedance criteria under the DSY2 and DSY3 weather files.
- The performance is improved when combining restricted ventilation and air tempering in the MVHR system (iterations 8 and 9). The majority of bedroom and KLD spaces would meet the hours of exceedance. However most bedrooms would not meet the night-time criteria against the future weather files

Please note these results are for information purposes only as compliance with DSY2 and DSY3 is not a strict requirement for Part O. It is important to consider measures that may be applied in the future to mitigate overheating during more extreme weather conditions; potential measures are further explored within the mechanical ventilation assessment section of this report.

It should be noted that the findings of this assessment are related to planning stage design only, and any changes to the ventilation strategy, façade opening areas and window operation and shading elements would impact the performance of the building and may void the results of the current assessment.

COMMUNAL CORRIDORS

Two fully enclosed sample corridors were tested at the 6th and 11th levels as a typical case scenario to assess the overheating risk. TM59 methodology states that "*if an operative temperature of 28°C is exceeded for more than 3% of the total annual hours, then this should be identified as a significant risk within the report*".

Table 8: Communal corridor overheating assessment results for London Weather Centre DSY1, DSY2 and DSY3 (2020s High 50)

ID	Design change	Internal Gains from Communal Corridor	Weather File	Annual Hours T_{op} > 28 ˚C	Criteria Met
10	Communal Corridor (No Environmental Fan)	Y	DSY1	25.9	Y
11	Environmental Fan 10l/s	Y	DSY1	12.2	Y
12	Environmental Fan 20l/s	Y	DSY1	6.7	Y
13	Environmental Fan 30l/s	Y	DSY1	4	Y
14	Environmental Fan 40l/s	Y	DSY1	2.7	Y
15	DSY2 Weather File	Y	DSY2	4	N
16	DSY3 Weather File	Y	DSY3	5.2	N

The following observations can be made from the results:

- The simulations conducted indicated that the operative temperature is likely to exceed 28 ˚C for more than 3% of annual hours under the DSY1 weather file. An environmental fan with a flow rate of 40 l/s was tested and found to be sufficient to reduce overheating risk to below this criterion.
- When modelling against DSY2 and DSY3 weather files, the fans were not capable of mitigating overheating but the percentage of hours above 28°C is only slightly above the recommended threshold.

It should be noted that the overheating risk within communal corridors will depend on the final heat distribution method as well as the pipework specification and insulation levels, which will be confirmed at the next design stage. It is therefore recommended that a full assessment is conducted once the relevant specifications are confirmed. The details and specification of these fans should be considered alongside the fire and ventilation strategy[5].

[5] Fire and ventilation guidance should be sought from the relevant specialist.

CONCLUSIONS AND RECOMMENDATIONS

The results show that all assessed dwellings achieve compliance with CIBSE TM59 and Part O for London Weather Centre DSY1 weather data, provided that adequate design considerations are taken into account and mitigation measures are implemented.

The results detailed in this design note demonstrate that all sampled spaces can comply with CIBSE TM59 and Part O criteria through passive ventilation and solar control strategies, such as balconies and windows recesses. However, due to acoustic constraints on site, window opening on site is restricted and additional measures are recommended for all residential dwellings. These include improvement to solar glazing value to 0.4 and the addition of an air tempering system to the MVHR units in each dwelling to mitigate the risk of overheating. The system should be able to deliver up to 110 l/s per dwelling balanced per habitable room. It is recommended that specialist detailed design is undertaken at the next design stage.

Two fully enclosed communal corridors were assessed and found to comply with TM59 suggested criteria when incorporating an environmental fan with a flow rate of 40 l/s. The details and specification of this fan is however dependent on the final heat distribution method, pipework specification and insulation levels, which will be confirmed at the next design stage, and should be considered alongside the fire and ventilation strategy.

It should be noted that the findings of this assessment are related to planning stage design only and are based on a sample of flats. Any changes to the ventilation strategy, façade opening areas, window operation and shading elements would impact the performance of the building and would void the results of the current assessment.

A Home User Guide will be prepared for residents and will include guidance on the how to minimise the dwelling overheating risk in line with the cooling hierarchy.

Table 9 summarises the design recommendations that contribute to reducing overheating risk.

Table 9: Summary of recommendations for the proposed development.

Measure	Implementation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (LED)	All residential spaces
LTHW pipework design and installations (location, configuration and insulation) to minimise heat losses.	LTHW pipework running in corridors and circulation areas to be highly insulated across the whole length; including jackets for valves and junctions.
Reduce the amount of heat entering the building	
External shade from balconies and overhangs	Slight recesses included within windows across site and balconies where present.
Internal shading via opaque blinds	Whilst not included in compliance calculation in line with Part O guidance, internal shading via opaque blinds is recommended for lounges and bedrooms
Solar control glazing	Solar control glazing on all windows to achieve a g-value of 0.4
Ventilation	
Natural ventilation opening	Inward opening side hung windows, with panes openable to at least 90˚ for natural ventilation. Restricted ventilation to 10° opening recommended for daytime ventilation if required. Easily accessible ground floor windows to incorporate security measures in line with AD O.
Mechanical Ventilation	MVHR to be fitted with cooling coils in all spaces impacted by high noise levels, as included in the previously consented scheme. Precise flow rate calculations for units will be explored at the next design stage.

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OVERHEATING ASSESSMENT (TM52)

9.370 – 330 GRAY'S INN ROAD

20/02/2023 *by CP, reviewed by SG*

All habitable rooms assessed for the proposed non-residential part of the development at 330 Gray's Inn Road, in the London Borough of Camden, were found to meet the CIBSE TM52 overheating risk criteria when including a combination of mechanical ventilation, comfort cooling and solar control techniques within the design. Due to noise constraints on site, windows won't be openable and the non-domestic units were found to require some form of cooling. However, the inclusion of certain measures such as efficient lighting and solar control glazing is recommended to reduce cooling loads.

EXECUTIVE SUMMARY

An overheating analysis has been conducted for the proposed non-residential part of the development at 330 Gray's Inn Road, located in the London Borough of Camden. The purpose of this analysis is to test the proposed building design and recommend design measures to mitigate any potential overheating risks within the occupied zones across the development as well as to future-proof the scheme by taking into account projected increased ambient air temperatures from climate change.

In order to assess the thermal performance of the development, a thermal model was constructed within specialist simulation software. The internal temperature, lighting and ventilation conditions were estimated for all the internal spaces in line with CIBSE guidelines.

With the aim of giving the most robust consideration, performance of the development's summertime performance was compared with CIBSE Technical Memorandum 52 performance recommendations. These are rigorous targets that determine the acceptability of overheating based on the temperature differential between the internal and the external environment (ΔT), considering the frequency of high temperature difference, the severity, and an absolute peak difference beyond which the level of overheating is considered unacceptable. All the non-domestic areas of the development were assessed against CIBSE TM52 criteria which is the most relevant industry standard for evaluating non-domestic spaces.

The spaces were modelled as free running following CIBSE TM52 recommendations. The thermal simulations indicate that the hotel bedroom units are predicted to satisfy the overheating risk criteria through the use of natural ventilation with opening Free Areas of 20%, enhanced g-values for glazing as well as mechanical ventilation. For the Office building the relevant areas are predicted to satisfy the overheating risk criteria through the use of mechanical ventilation, enhanced g-values for glazing as well as comfort cooling.

Due to noise issues on site, the implementation of natural ventilation strategy to the hotel and office building via openable windows was deemed unfeasible. Additional scenarios with closed windows were tested in order to mitigate any risk of overheating. The analysis indicated that for both buildings the TM52 criteria are satisfied through the use of mechanical ventilation, enhanced g-values for glazing as well as comfort cooling.

METHODOLOGY

3D thermal models of the proposed scheme at 330 Gray's Inn Road development have been developed based on the architectural drawings. To better assess the development, two separate models were created. The hotel building and the office were modelled and assessed individually to identify the most appropriate strategy to eliminate overheating based on the CIBSE TM52 criteria.

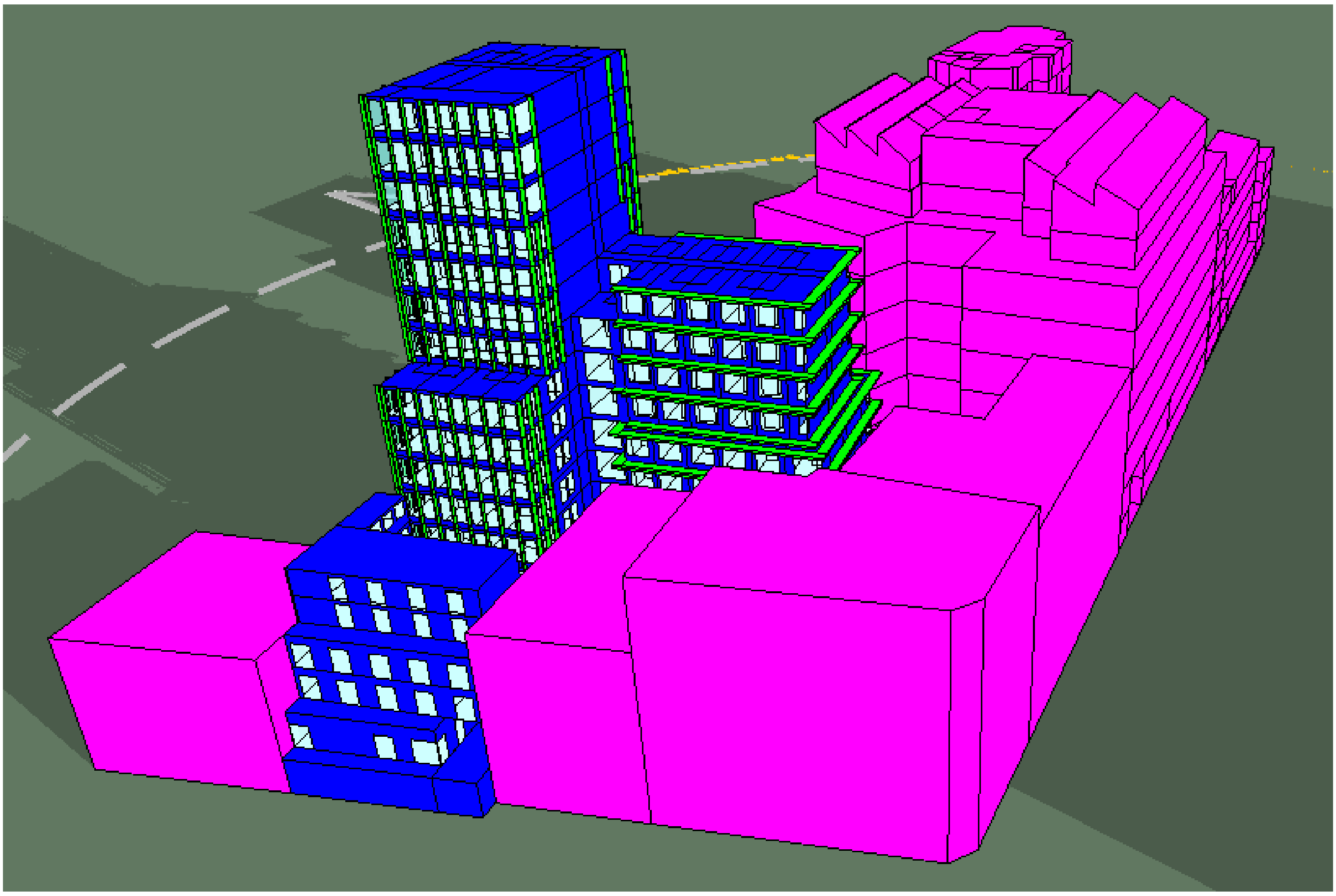


Figure 1: Axonometric view of the dynamic thermal model – Hotel

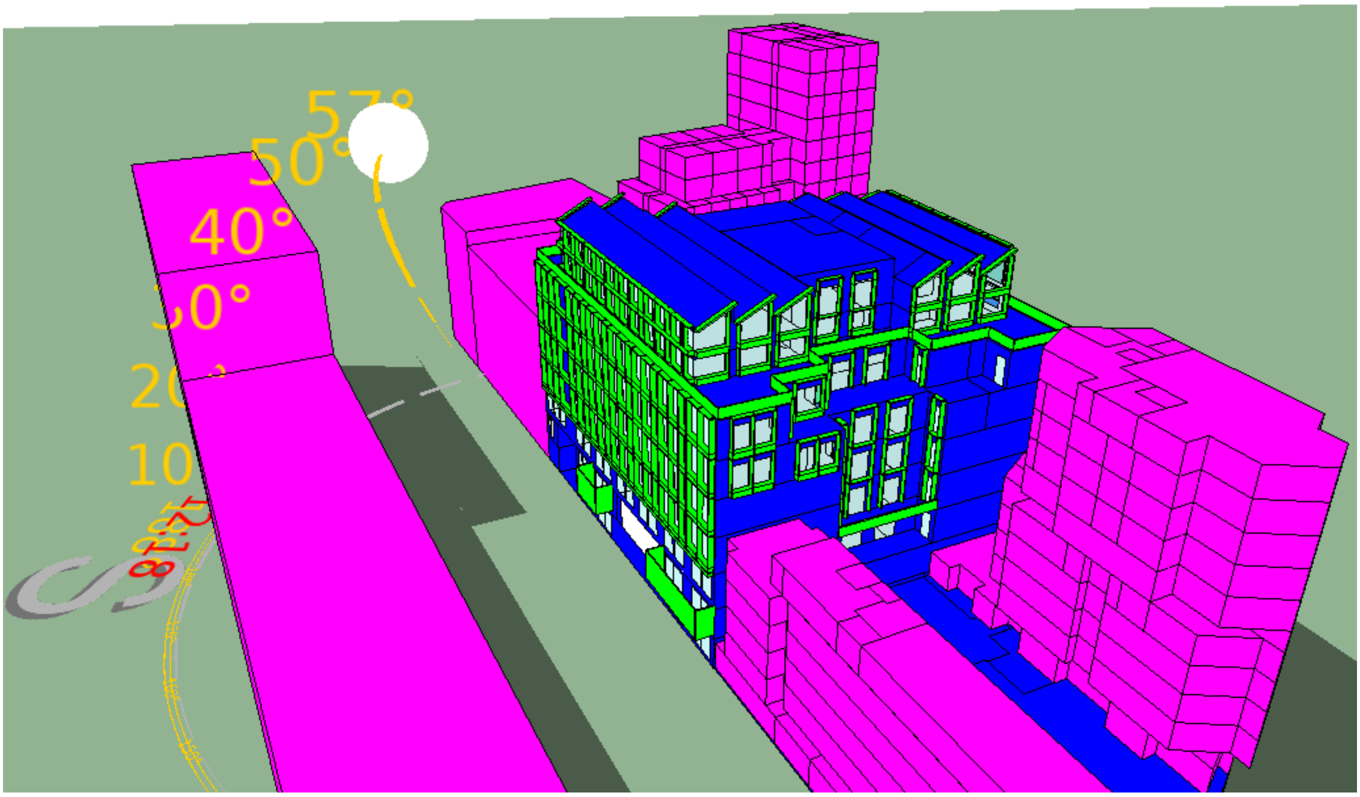


Figure 2: Axonometric view of the dynamic thermal model – Office

The overheating risks of the spaces were assessed for current and future climate scenarios. Following the methodology set out in CIBSE TM49 Design Summer Years for London, the following three years were selected to form the set of probabilistic design summer years for the future weather scenarios:

- 2020 (DSY1-High Emissions 50 Percentile)
- 2020 (DSY2-High Emissions 50 Percentile)
- 2020 (DSY3-High Emissions 50 Percentile)

The first of these years, 2020 (DSY1-High Emissions 50 Percentile) represents a moderately warm summer, as is interpreted in current CIBSE guidance. The years 2020 (DSY2-High Emissions 50 Percentile) and 2020 (DSY3-High Emissions 50 Percentile) were chosen as more extreme years with different types of summer: the former has a more intense single warm spell, whereas the latter represents a year with a long period of persistent warmth.

The development has been modelled using dynamic thermal simulation software, which is fully compliant with CIBSE Applications Manual AM11. The software can compute operative temperatures using CIBSE weather data sets, building fabric specification, window areas and openings, all aspects of solar and internal gains as well as natural ventilation flows within the building. Compliance of the design with the CIBSE TM52 assessment criteria has been sought and recommendations are formulated to future-proof the design for further interventions in the future.

ASSESSMENT CRITERIA

The performance standards set out within CIBSE TM52 have been used to assess the overheating risk within the proposed non-residential parts of the development.

Two of the following three criteria must be met for all habitable areas:

- **Hours of exceedance (H_e):**
  The number of hours (H_e) during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

- **Daily weighted exceedance (W_e):**
  It is the time (hours and part hours) during which the operative temperature exceeds the specified range during the occupied hours, weighted by a factor that is a function depending on by how many degrees the range has been exceeded should not be higher than 6 on any given day.

- **Upper Limit Temperature (T_{upp}):**
  To set an absolute maximum value for the indoor operative temperature, the value of ΔT shall not exceed 4°C.

MODELLING ASSUMPTIONS

FABRIC PERFORMANCE

The fabric specification is summarised in the table below:

Table 1: Building fabric assumptions for first iteration.

Element	Specification	
Non-domestic	**U-value [W/m².K]**	
External Walls	0.15	
Ground Floor	0.10	
Roof	0.10	
Non-domestic	**U-value [W/m².K]**	**g-value**
Window	1.2	0.30
All buildings	**Air permeability (@50Pa)**	
	3.0 m³/m².h	

OCCUPANCY

In line with the TM52 requirements; the occupancy patterns for the non-domestic space has been based on the national calculation methodology. These are then programmed into the dynamic software model to calculate the relative occupancy gains for the designated spaces.

Table 2: Occupancy assumptions for each room type assessed.

Area	Predicted occupation pattern
Bedrooms (Hotel)	24 hours a day as per National Calculation Methodology
Kitchen	06:00 – 24:00 as per National Calculation Methodology
Restaurant	07:00 – 23:00 as per National Calculation Methodology
Offices	07:00-19:00 as per National Calculation Methodology
Classrooms	07:00-19:00 as per National Calculation Methodology
Laboratory	07:00-19:00 as per National Calculation Methodology

Area	Predicted occupation pattern
Gym	09:00-21:00 as per National Calculation Methodology

INTERNAL GAINS

Similar to the predicted occupancy hours, the prediction of internal gains (lighting, equipment, and people) for occupied areas is incorporated in line with the guidance set out in national calculation methodology.

Table 3 sets out the input internal gains for the assessed rooms within the buildings; these are then programmed into the dynamic software model to calculate the relative internal gains for the designated space.

Non-occupied spaces such as circulation, bathrooms and storage, were modelled based on typical internal gains incorporating TM52's guidance for factoring in heat gains where appropriate.

Table 3: Internal Gains modelled for each room type assessed.

Area	Predicted Internal Gains		
	Lighting gains	Occupancy gains	Equipment gains
Bedroom	5.20 W/m^2	61 W sensible, 39 W latent	4.05 W/m^2
Kitchen	26.0 W/m^2	63 W sensible, 117 W latent	28.72 W/m^2
Restaurant	10.40 W/m^2	61.7 W sensible, 42.90 W latent	14.72 W/m^2
Office	11.25 W/m^2	73 W sensible, 50 W latent	11.68 W/m^2
Gym	15.60 W/m^2	102 W sensible, 198 W latent	15.00 W/m^2
Classroom	11.25 W/m^2	70 W sensible, 70 W latent	4.74 W/m^2
Laboratory	18.75 W/m^2	97.60 W sensible, 62.40 W latent	8.47 W/m^2

VENTILATION

The proposed ventilation strategy for the development entails the use of Mechanical Ventilation with Heat Recovery (MVHR) for the whole year. Therefore, the estimated auxiliary ventilation flow rates have been included in the model in line with Part F requirements for background ventilation. The ventilation rates used are set out below:

- 13 litres/second for office spaces;
- 13 litres/second for restaurant and kitchen areas;
- 8 litres/second for hotel bedrooms;
- 8 litres/second per person for all other non-domestic spaces.

According to CIBSE TM52 methodology where openable windows are present, habitable spaces can be modelled against the natural ventilation criteria detailed in the previous section of this report.

Both the hotel and the office were modelled as free-running buildings, in order to evaluate overheating risks with passive design measures. Window openings were modelled with different free areas to evaluate the appropriate minimum free area that should be achieved by the design. It is assumed that occupants will open windows when internal dry bulb temperature exceeds 22 °C for occupied hours. The level of exposure and associated coefficients of discharge are set up in accordance to the relative position of each window in relation to the site context and building massing. More details of the different iterations tested can be found in the subsequent section of the report.

RESULTS

This section presents the results summary for each of the tests carried out for the spaces assessed. In terms of hotel areas, 198 habitable spaces were included in the assessment comprising 186 bedrooms and restaurant, kitchen and reception areas. Non-habitable spaces such as bathrooms, storage rooms and circulation areas have been excluded from the assessment; however, their internal gains have been included in the model. Further to the above, the office building spaces were also modelled and the results are presented separately in this section of the report.

Once a baseline simulation is undertaken, a series of potential mitigating strategies are modelled. The purpose of the proposed improvement measures is to minimise the number of rooms that fail the TM52 criteria to the extent feasible, taking into consideration viability, feasibility and other design or design intent constraints.

HOTEL BUILDING

The non-domestic areas of the hotel building were included in the assessment and the results are presented in this subsection in line with CIBSE TM52 methodology, using DSY1, DSY2 and DSY3 weather files (2020s, high emissions, 50% percentile scenario).

The table below shows the number of the modelling iterations undertaken and the sequential improvement measures that are proposed to be incorporated for each iteration.

Table 4: Overheating assessment results for the hotel building.

Design Summer Year DSY1 (2020 High 50s)						
Iteration	**Window F.A.**	**Lighting Bedrooms**	**Auxiliary ventilation**	**Solar control**	**Active cooling**	**No of rooms not meeting TM52 criteria**
1	0%	5.20 W/m^2	13l/s/person	g-value 0.3	No	198 / 198
2	20%	5.20 W/m^2	13l/s/person	g-value 0.3	No	12/ 198
3	0%	5.20 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 198

The following observations can be made from the results:

- The inclusion of some form of natural ventilation combined with solar control glazing enabled most of the spaces to reduce the overheating risk (iteration 2).
- Implementation of comfort cooling to the habitable areas, even with the windows permanently closed, enabled the mitigation of any overheating risk. This iteration is applicable to the hotel building due to the noise-related restrictions that do not allow the building occupants to open any windows.
- Non-domestic spaces have stricter environmental control requirements, so some form of cooling would be recommended to achieve the desirable temperatures, as per iteration 3. Energy efficient lighting and solar control glazing with a maximum g-value of 0.3 would be recommended to reduce overall cooling loads for non-domestic area of the scheme.

The analysis was also undertaken for different design summer year weather files, in line with CIBSE TM52 methodology. As for DSY1, the same observations were made from the results for Design Summer Year 2 and 3, as shown in the following table.

Table 5: Overheating assessment results for the Design Summer Year DSY2 and DSY3.

Design Summer Year DSY2 and DSY3						
Iteration	**Window F.A.**	**Lighting Retail**	**Auxiliary ventilation**	**Solar control**	**Active cooling**	**No of rooms meeting TM52 criteria**
1	0%	5.20 W/m^2	13l/s/person	g-value 0.3	No	198 / 198
2	20%	5.20 W/m^2	13l/s/person	g-value 0.3	No	12/ 198
3	0%	5.20 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 198

Please note these results are for informative purpose only and do not require more measures to be implemented, as compliance with DSY2-High Emissions 50 Percentile and DSY3-High Emissions 50 Percentile is not a strict requirement It should be noted that notable measures have been adopted as far as feasible to reduce risk of overheating for the development under all 3 climate scenarios, taking into account architectural, energy efficiency, daylight and acoustic considerations.

OFFICE BUILDING

The non-domestic areas of the office building were included in the assessment and the results are presented in this subsection in line with CIBSE TM52 methodology, using DSY1, DSY2 and DSY3 weather files.

The table below shows the number of the modelling iterations undertaken and the sequential improvement measures that are proposed to be incorporated for each iteration.

Table 6: Overheating assessment results for the office building.

Design Summer Year DSY1						
Iteration	**Window F.A.**	**Lighting Offices**	**Auxiliary ventilation**	**Solar control**	**Comfort cooling**	**No of rooms not meeting TM52 criteria**
1	0%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
2	20%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m^2	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m^2	13l/s/person	g-value 0.3	Yes	0/ 28

The following observations can be made from the results:

- The inclusion of some form of natural ventilation combined with solar control glazing did not enable the areas to reduce the overheating risk (iteration 2).
- Implementing an increase to the mechanical ventilation supply together with a decrease in the lighting gains (from use of energy efficient lighting) was also not found to enable compliance with the criteria (iteration 3 and 4).
- Implementation of comfort cooling to the habitable areas, even with the windows permanently closed enabled the mitigation of any overheating risk. This iteration is also applicable to the office building due to the noise issues that do not allow the building to open any windows.
- Non-domestic spaces have stricter environmental control requirements, so some form of cooling would be recommended to achieve the desirable temperatures, as per iteration 5. Energy efficient lighting and solar control glazing with a maximum g-value of 0.3 would be recommended to reduce overall cooling loads for non-domestic area of the scheme.

The analysis was also undertaken for different design summer year weather files, in line with CIBSE TM52 methodology. As for DSY1, the same observations were made from the results for Design Summer Year 2 and 3, as shown in the following table.

Table 7: Overheating assessment results for the Design Summer Year DSY2 and DSY3.

Design Summer Year DSY2 and DSY3						
Iteration	**Window F.A.**	**Lighting Retail**	**Auxiliary ventilation**	**Solar control**	**Comfort cooling**	**No of rooms meeting TM52 criteria**
2	20%	11.25 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m^2	13l/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m^2	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m^2	13l/s/person	g-value 0.3	Yes	2/ 28

Please note these results are for informative purpose only and do not require more measures to be implemented, as compliance with DSY2-High Emissions 50 Percentile and DSY3-High Emissions 50 Percentile is not a strict requirement It should be noted that notable measures have been adopted as far as feasible to reduce risk of overheating for the development under all 3 climate scenarios, taking into account architectural, energy efficiency, daylight and acoustic considerations.

CONCLUSIONS AND RECOMMENDATIONS

High external temperature combined with solar gain and internal occupant/equipment gains in the spaces are the main contributors to the rise of internal air temperatures. The internal gains for all the habitable spaces analysed are based on CIBSE TM52 and NCM.

The results show that all spaces are likely to achieve compliance with overheating benchmarks, provided that adequate design measures are taken into account. The analysis indicated that some form of cooling would be required to achieve the desirable internal environment due to stricter conditioning requirements for the non-domestic buildings. The use of solar control glazing and energy efficient lighting is recommended to reduce cooling loads.

The following table summarises the recommendations made in line with the GLA guidance.

Table 8: Summary of recommendations.

Measure	Implementation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (LED)	Energy efficient lighting installation recommended for the non-domestic spaces.
LTHW pipework design and installations (location, configuration and insulation) to minimise heat losses.	LTHW pipework running areas are proposed to be highly insulated across the development including jackets for valves and junctions.
Reduce the amount of heat entering the building	
Solar control glazing	Solar control glazing with a maximum g-value of 0.3 for non-domestic spaces.
Use of thermal mass to manage heat within the building	
Concrete slab providing thermal mass	Not offering a significant impact.
Passive ventilation	
Natural ventilation opening	Not applicable due to noise restrictions on site.
Mechanical ventilation	
MVHR with summer boost mode	Mechanical engineer to investigate post-planning the optimum balance between fan energy (by increasing mechanical ventilation) and chiller energy (for providing cooling) to the spaces.
Comfort Cooling	
Air-Condition to main habitable areas	Some form of comfort cooling is recommended for all habitable areas. Mechanical engineer to investigate applicable AC system.

APPENDIX B –DETAILED RENEWABLES APPRAISAL

BIOMASS HEATING – NOT ADOPTED

A biomass system designed for this development would be fuelled by wood pellets due to their high energy content. Wood pellets also require less volume of storage than other biomass fuels, require less maintenance and produce considerably less ash residue.

A biomass system, however, would not be an appropriate low-carbon technology for the site for the following reasons:

- the burning of wood pellets releases substantially more NOx emissions than gas boiler equivalents. This would impact the air quality of the site which is located in an urban environment; and,
- storage and delivery of wood pellets would be difficult due to the site constraints and the lack of local biomass suppliers. Pellets would have to be transported from elsewhere in the UK

For the reasons listed above, biomass is not considered feasible for this development.

Summary of technical/operational data and estimated CO_2 savings for biomass heating

Biomass		
% of heating load supplied by biomass	50	%
Biomass system efficiency	80	%
Backup system efficiency	90	%
Heating demand met	1,002,039	kWh/yr.
Total CO_2 savings	209.2	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	28.9	%
% Total CO_2 reduction*	19.8	%

* % reduction from site baseline

SOLAR THERMAL – NOT ADOPTED

Solar thermal arrays are available as evacuated tubes and flat plate collectors. Evacuated tubes are more efficient, produce higher temperatures and are more suited to the UK climate in general when compared to flat plate collectors.

Solar thermal arrays have similar requirements as PV arrays, in terms of their orientation and inclination. The most efficient use of solar thermal arrays would be to orientate them to the south, at an inclination of about 35°.

For this development solar thermal would be used for domestic hot water only. The use of solar thermal for space heating would not be practical as it is not required when solar thermal is at its most effective during the summer months.

If solar thermal were to be considered for this development, based on a solar fraction of 20%, 100m^2 solar thermal arrays would produce a regulated CO_2 saving of 1.4%.

Solar thermal panels are not considered a suitable technology for the following reasons:

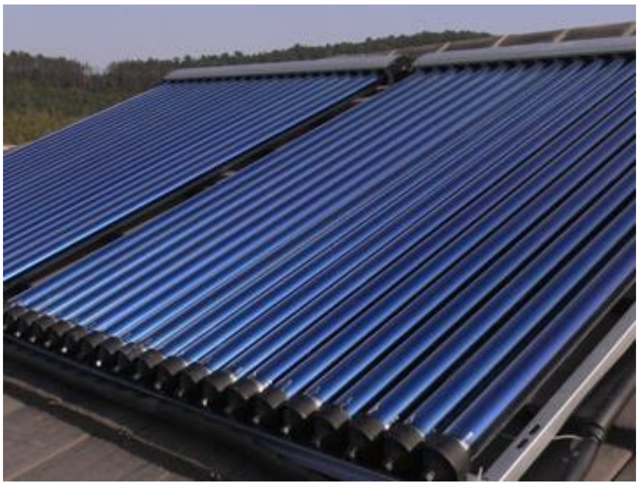
- Solar thermal arrays would require additional plumbing which is likely to incur additional financial costs;
- The CO_2 savings achieved through PV are considerably more compared to solar thermal arrays, therefore the roof space would be better suited to a PV installation;

For these reasons, solar thermal technology would not be the most feasible option for the proposed development.

Summary of technical/operational data and estimated CO_2 savings for solar thermal

Solar thermal		
Collector type	Evacuated tube	
System efficiency	40	%
Orientation	South	
Predicted site solar energy	1079.5	kWh/m^2.yr
Solar fraction	1.0	%
Total collector area	100	m^2
Primary gas energy offset by solar thermal system	47,976	kWh/yr.
Total CO_2 savings	10.1	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	1.4	%
% Total CO_2 reduction*	1.0	%

* % reduction from site baseline



GROUND SOURCE HEAT PUMPS – NOT ADOPTED

The footprint of the development occupies a significant portion of the site. For this reason, a ground source loop would need to be incorporated within the foundations piles of the building.

A suitable ground source heat pump system for the site would include a closed ground loop, where liquid passes through the system, absorbing heat from the ground and relaying this heat via an electrically run heat pump into the building.

Studies have shown that ground source loops located within close proximity of structural foundations may result in a reduction of the life span of the loops. Thermal testing would need to be carried out on the foundations to determine the implications to the ground loops over time.

Ground source heat pumps would deliver space heating through a low temperature efficient distribution network such as underfloor heating. The annual space heating and cooling demand would be supplied by a system sized to meet approximately 50% of the peak load.

The number of ground loops required would require a significant amount of space on site and result in additional time at the beginning of the construction process. In addition, the capital cost of installing these ground loops would be very high. This cost is not considered financially feasible given the limited reduction of regulated carbon emissions. For these reasons, ground source heat pumps were not considered to be an appropriate renewable technology for the site.

Summary of technical/operational data and estimated CO_2 savings for GSHP

GSHP		
COP heating	3.5	
COP cooling	6.0	
Carbon intensity of electricity	0.233	$kgCO_2$/kWh
Proportion of space heating and hot water met by GSHP	100	%
Proportion of space cooling met by GSHP	100	%
Energy met by GSHP	2,677,958	kWh/yr.
Energy used by GSHP	684,907	kWh/yr.
Total CO_2 savings	369.8	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	51.1	%
% Total CO_2 reduction*	34.9	%

* % reduction from site baseline

WIND TURBINES – NOT ADOPTED

Building-integrated turbines would be most suited to this site due to the limited amount of roof space, as opposed to stand alone turbines.

CO_2 savings from wind turbine technologies take into account their mounting height, the turbine wind curve and wind data. This information was obtained from the BERR website and used in the Carbon Trust Wind Yield Estimation Tool. The average annual wind speed at a mounting height of 10m above the building canopy is estimated to be 3.5m/s.

Due to the spacing required between wind turbines, approximately one turbine of 2.5kW or one turbine of 6kW could be sited on the roof. The two tables below outline CO_2 savings for a 2.5kW and 6kW roof-mounted wind turbine.

The results show that the CO_2 savings are minimal for each option, offering no savings for the 2.5kW turbine and only 0.1% savings for the 6kW turbine.

This technology is not considered appropriate for this development due to the low CO_2 savings achieved, and the significant visual impact the turbines have on the building.

Summary of technical/operational data and estimated CO_2 savings for wind turbines

Wind power – 2.5 KW		
Average wind speed at site	3.5	m/s
No. of turbines	1	
Electricity offset by turbine	1,584	kWh/yr.
Carbon intensity of offset electricity	0.233	$kgCO_2/kWh$
Total CO_2 savings	0.37	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	0.0	%
% Total CO_2 reduction*	0.0	%
Wind power – 6 KW		
Average wind speed at site	3.5	m/s
No. of turbines	1	
Electricity offset by turbine	3,987	kWh/yr.
Carbon intensity of offset electricity	0.233	$kgCO_2/kWh$
Total CO_2 savings	0.93	t/yr.
Regulated baseline CO_2 emissions	723.1	t/yr.
Total baseline CO_2 emissions	1,059.2	t/yr.
% Regulated CO_2 reduction*	0.1	%
% Total CO_2 reduction*	0.1	%

* % reduction from site baseline

APPENDIX C – DHN COMMUNICATION

Nuno Correia

From: Alex Neal ·
Sent: 04 February 2020 12:04
To: Sara Godinho; Nuno Correia; Ray Choi; Stefano Vegezzi; Merrick Odam; Matthew Hart
Cc: Sophie Hardy
Subject: FW: 330 Grays Inn Road - potential connection to district heat network

Nuno

Please see below...

Alex Neal
Senior Associate

Gerald Eve LLP
72 Welbeck Street, London, W1G 0AY
www.geraldeve.com

GERALDEVE

From: McClue, Jonathan
Sent: 04 February 2020 11:55
To: Alex Neal
Cc: Farrant, Ben Sophie Hardy Katie Fong
Subject: 330 Grays Inn Road - potential connection to district heat network

Alex

Some responses below in red from our Energy Officer.

Kind regards

Jonathan McClue
Principal Planner

Telephone:

From: Alex Neal
Sent: 16 January 2020 17:09
To: McClue, Jonathan
Cc: Farrant, Ben Sophie Hardy Katie Fong

<KFong@geraldeve.com>
Subject: 330 Grays Inn Road - potential connection to district heat network

Jonathan

Please could you forward our queries on the District Heating Networking availability to the Camden Energy Officer?

- The existing Kings Cross DHN is located about 400m from our site. As a first query we would only really need to understand if there are any plans to expand the network on the Gray's Inn Road direction?

The network is managed by Argent. The network only reaches to Pancras Square, so it's much further than 400m to the 330 Gray's inn site.

- If there is scope for connection for our development and if Camden requires it?

We don't think they have plans to extend it beyond the boundary of their site.

- If so, what is the current timescale for availability of heat
- Contact details for the project leads for the above network.

Many thanks
Alex

Alex Neal

Gerald Eve LLP
72 Welbeck Street, London, W1G 0AY
www.geraldeve.com

GERALDEVE

APPENDIX D – ENERGY CENTRE

01 GENERAL ARRANGEMENT: SUB-BASEMENT LEVEL

KEY

SITE BOUNDARY

REV	DATE
A	

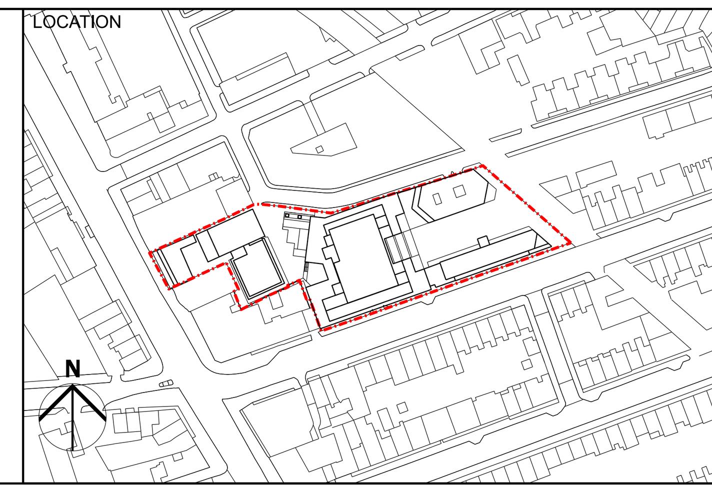
CONSULTANTS	NAME
CLIENT:	GROVEWORLD
STRUCTURAL ENGINEER:	WSP
MECHANICAL ENGINEER:	XC02
COST CONSULTANT:	TURNER TOWNSEND
ACOUSTIC CONSULTANT:	HANN TUCKER
TRANSPORT CONSULTANT:	STEER
DAYLIGHT / SUNLIGHT :	POINT2

NOTE

When this drawing is issued in uncontrolled CAD format it will be accompanied by a PDF version and is issued to enable the recipient to prepare their own documents / models / drawings for which they are solely responsible.
The recipient should report all drawing errors, omissions and discrepancies to the architect. All dimensions should be checked on site by the contractor and such dimensions shall be the contractor's responsibility.

Allford Hall Monaghan Morris Limited accepts no responsibility or liability for:-
- any use of this drawing by parties other than the party for whom it was prepared or for purposes other than those for which it was prepared
- any alterations or additions to or discrepancies arising out of changes to the background information on which the drawings are based that was current at the time of issue, and which occur to that information after it has been issued by AHMM
- any loss or degradation of the information held in this drawing resulting from the translation from the original file format to any other file format or from the recipients reading of it in any other programme or any version of the programme other than that which was used to prepare it
- the accuracy of survey information provided by others or for any costs, claims, proceedings and expenses arising out of reliance on such information
- any scaling from this drawing other than by the local planning authority solely for the purposes of the planning application to which it relates

LOCATION



ALLFORD HALL MONAGHAN MORRIS
ARCHITECTS Ltd
MORELANDS, 5-23 OLD STREET LONDON EC1V 9HL
TEL 020 7251 5261 FAX 020 7251 5123 WEB WWW.AHMM.CO.UK

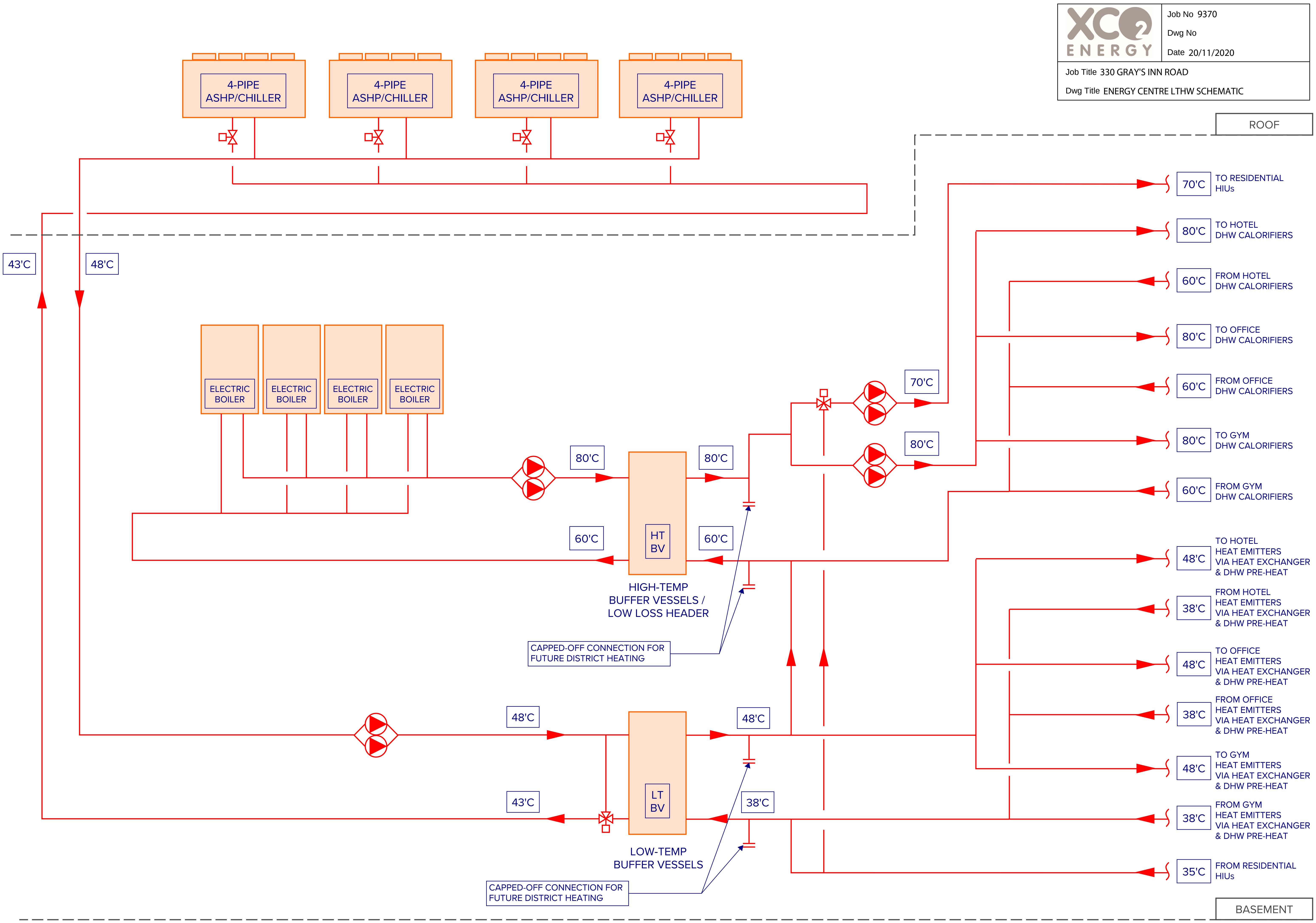
job title
330 GRAYS INN ROAD

drawing title / location
PROPOSED MASTERPLAN
BASEMENT-3 LEVEL

drawn by	checked	scale	status
GS	MH	1:250@A1; 1:500@A3	INFORMATION

project	zone	source	classification drawing no.	revision
18116	00	A	(00)_097	A

Basement 3



XCO2 ENERGY
Job No 9370
Dwg No
Date 20/11/2020
Job Title 330 GRAY'S INN ROAD
Dwg Title ENERGY CENTRE LTHW SCHEMATIC
ROOF
4-PIPE ASHP/CHILLER
4-PIPE ASHP/CHILLER
4-PIPE ASHP/CHILLER
4-PIPE ASHP/CHILLER
43'C
48'C
ELECTRIC BOILER
ELECTRIC BOILER
ELECTRIC BOILER
ELECTRIC BOILER
80'C
80'C
60'C
60'C
HT BV
HIGH-TEMP BUFFER VESSELS / LOW LOSS HEADER
CAPPED-OFF CONNECTION FOR FUTURE DISTRICT HEATING
70'C
80'C
48'C
48'C
43'C
38'C
LT BV
LOW-TEMP BUFFER VESSELS
CAPPED-OFF CONNECTION FOR FUTURE DISTRICT HEATING
70'C TO RESIDENTIAL HIUs
80'C TO HOTEL DHW CALORIFIERS
60'C FROM HOTEL DHW CALORIFIERS
80'C TO OFFICE DHW CALORIFIERS
60'C FROM OFFICE DHW CALORIFIERS
80'C TO GYM DHW CALORIFIERS
60'C FROM GYM DHW CALORIFIERS
48'C TO HOTEL HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
38'C FROM HOTEL HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
48'C TO OFFICE HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
38'C FROM OFFICE HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
48'C TO GYM HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
38'C FROM GYM HEAT EMITTERS VIA HEAT EXCHANGER & DHW PRE-HEAT
35'C FROM RESIDENTIAL HIUs
BASEMENT

APPENDIX E – GLA ENERGY SUMMARY TABLES

Part L 2021 Performance

Residential

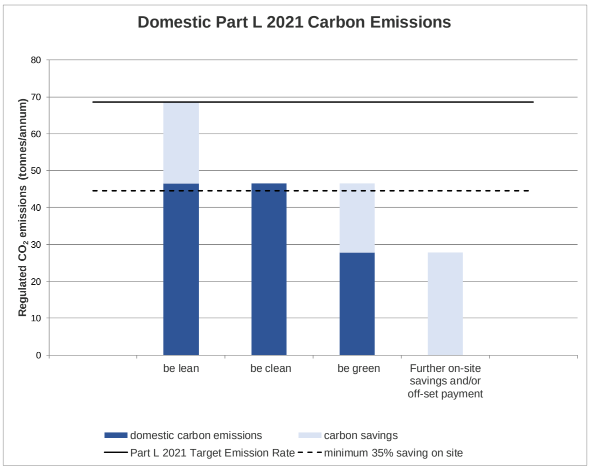
Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for residential buildings

	Carbon Dioxide Emissions for residential buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2021 of the Building Regulations Compliant Development	68.6	
After energy demand reduction (be lean)	46.5	
After heat network connection (be clean)	46.5	
After renewable energy (be green)	27.8	

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

	Regulated residential carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	22.1	32%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	18.7	27%
Cumulative on site savings	**40.8**	**59%**
Annual savings from off-set payment	27.8	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**834**	-
Cash in-lieu contribution (£)	**79,210**	

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



Non-residential

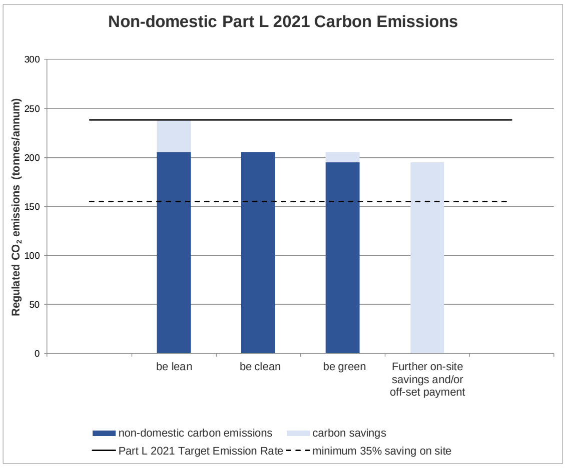
Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-residential buildings

	Carbon Dioxide Emissions for non-residential buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2021 of the Building Regulations Compliant Development	238.4	
After energy demand reduction (be lean)	205.7	
After heat network connection (be clean)	205.7	
After renewable energy (be green)	195.3	

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-residential buildings

	Regulated non-residential carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	32.7	14%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	10.4	4%
Total Cumulative Savings	**43.1**	**18%**
Annual savings from off-set payment	195.3	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**5,858**	-
Cash in-lieu contribution (£)	**556,480**	

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



SITE-WIDE

	Total regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Part L 2021 baseline	307.0		
Be lean	252.2	54.8	18%
Be clean	252.2	0.0	0%
Be green	223.0	29.1	9%
Total Savings	-	83.9	27%
	-	CO_2 savings off-set (Tonnes CO_2)	-
Off-set	-	**6,691.5**	-

	Target Fabric Energy Efficiency (kWh/m²)	Dwelling Fabric Energy Efficiency (kWh/m²)	Improvement (%)
Development total	17.63	15.66	11%

	Area weighted non-residential cooling demand (MJ/m²)	Total non-residential cooling demand (MJ/year)
Actual	54.45	1679472.92
Notional	116.55	3467614.78

EUI & space heating demand (predicted energy use)

Residential

Building type	EUI (kWh/m²/year) (excluding renewable energy)	Space heating demand (kWh/m²/year) (excluding renewable energy)	EUI value from Table 4 of the guidance (kWh/m²/year) (excluding renewable energy)	Space heating demand from Table 4 of the guidance(kWh/m²/year) (excluding renewable energy)	Methodology used (e.g. 'be seen' methodology or an alternative predictive energy modelling methodology)	Explanatory notes (if expected performance differs from the Table 4 values in the guidance)
Residential	40.54350859	6.367354423	35	15	Part L1 - SAP 10.2 & Other (provide details in column T) dwellings / Part L1 - SAP 10.2 & Other (provide details in column T) Landlord Circulation	

Non-residential

Building type	EUI (kWh/m²/year) (excluding renewable energy)	Space heating demand (kWh/m²/year) (excluding renewable energy)	EUI value from Table 4 of the guidance (kWh/m²/year) (excluding renewable energy)	Space heating demand from Table 4 of the guidance(kWh/m²/year) (excluding renewable energy)	Methodology used (e.g. 'be seen' methodology or an alternative predictive energy modelling methodology)	Explanatory notes (if expected performance differs from the Table 4 values in the guidance)
All other non-residential	96.18665051	7.787743375	55	15	Part L2 - approved DSM & CIBSE TM54	

APPENDIX F – SAP AND SBEM MODELLING INPUTS

9_370 - Gray's Inn Road SAP Calculation Assumptions

XCO2

20/02/2023

The figures listed below are assumptions only, based on a combination of best judgement at design stage and information from the design team where appropriate. Throughout the design stage the systems and size of renewable systems are likely to change whilst the building designs are being finalised. All information detailed in this design note is a basic recommendation at the Planning Stage Part L pre-assessment. It should be noted that this document is not exhaustive and the contractor should allow for flexibility on site where necessary.

Opaque Elements			
U-Values new elements			
Floors			
Ground and exposed floors	0.1	$W/m^2.K$	Based on best judgement on Planning Stage
Floor to commercial	0.2	$W/m^2.K$	Based on best judgement on Planning Stage
Walls			
External walls	0.15	$W/m^2.K$	Based on best judgement on Planning Stage
Walls to unheated corridors, stairs & lifts	0.3	$W/m^2.K$	Based on best judgement on Planning Stage
Wall to commercial	0.2	$W/m^2.K$	Based on best judgement on Planning Stage
Party walls - unit to unit	Zero heat loss - Fully filled cavity		Based on best judgement on Planning Stage
Roofs / Ceilings			
Flat roofs	0.1	$W/m^2.K$	Based on best judgement on Planning Stage
Y-value (Thermal bridging)	0.04		All junctions to meet Accredited Construction Details, otherwise will require thermal bridging modelling at detailed design stage.
Heated Corridors			
Block B is assumed to have heated corridors, stairs and lifts.			
Openings			
Flat doors to external or corridors	1	$W/m^2.K$	Based on best judgement on Planning Stage
Windows	1.2	$W/m^2.K$	Based on best judgement on Planning Stage
Transmittance Factor (g value)	0.4		Based on best judgement on Planning Stage
Frame Factor	0.8		Based on best judgement on Planning Stage
Glazing type	double-glazed low-e with argon filled		Based on best judgement on Planning Stage
Air gap	12mm		Based on best judgement on Planning Stage
Ventilation			
MVHR	yes		Based on best judgement on Planning Stage
Extract fans assumed in kitchens and bathrooms	yes		Based on best judgement on Planning Stage
Balanced with heat recovery	yes		Based on best judgement on Planning Stage
No. of wet rooms (excluding kitchen)	1 or 2 depending on dwelling		Dependant on dwelling layout
Insulated ridged ductwork	yes		Based on best judgement on Planning Stage
Product name modelled	Nuaire MRXBOXAB-ECO4		Based on best judgement on Planning Stage
Air permeability			
Design air permeability rate (max) for new build	3	m^3/hm^3	Based on best judgement on Planning Stage
Heating			
Primary Heating - (50% ASHP, 50% E-boliers)			
Heating efficiency ASHP	310	%	Based on best judgement on Planning Stage
Heating fraction from ASHP	0.5		Based on best judgement on Planning Stage
Heating efficiency E-boilers	100	%	Based on best judgement on Planning Stage
Heating fraction from E-boilers	0.5		Based on best judgement on Planning Stage
Heating emitter type	Radiators/underfloor		Based on best judgement on Planning Stage
Charging system linked to use of community heating	Yes		Based on best judgement on Planning Stage
TRVs	Yes		Based on best judgement on Planning Stage
Programmer	Yes		Based on best judgement on Planning Stage
Heating fuel	Electricity		Based on best judgement on Planning Stage
Water Heating			
From main heating system	Yes		Based on best judgement on Planning Stage
Storage Type	HIU		Based on best judgement on Planning Stage
Cooling			
Cooling within MVHR system			
System type	Packaged System		Based on best judgement on Planning Stage
EER	2.6		Based on best judgement on Planning Stage
Compressor control	Systems with variable speed compressors		Based on best judgement on Planning Stage
Cooled area	100	%	Based on best judgement on Planning Stage
Renewable Technologies			
Total PV output	16.15	kWp	Based on best judgement on Planning Stage
PV efficiency	19	%	Based on best judgement on Planning Stage
PV area	85	m^2	Based on best judgement on Planning Stage
Tilt of Collector	30 deg		Based on best judgement on Planning Stage
Overshading	none/little		Based on best judgement on Planning Stage
Orientation	Southwest		Based on best judgement on Planning Stage
Lighting			
Low energy lights	100	%	Based on best judgement on Planning Stage
Domestic water consumption			
Water consumption in dwellings to be less than 110 litres/person/day	Yes		Part G compliance requirement

330 Gray's Inn Road SBEM Calculation Assumptions
Draft for information only NOT FOR SUBMISSION TO COUNCIL
31/01/2023

XCO2

The figures listed below are assumptions only, based on a combination of best judgement at design stage and information from the design team where appropriate. Throughout the design stage the systems and size of renewable systems are likely to change whilst the building designs are being finalised. All information detailed in this design note is a basic recommendation at the BREEAM and Planning Stage Part L pre-assessment. It should be noted that this document is not exhaustive and the contractor should allow for flexibility on site where necessary.

Opaque Elements			
U-Values			
Ground floor	0.1	$W/m^2.K$	Based on best judgement on Planning Stage
External walls	0.15	$W/m^2.K$	Based on best judgement on Planning Stage
Roofs	0.1	$W/m^2.K$	Based on best judgement on Planning Stage
Openings			
Doors			
U-Value	1.6	$W/m^2.K$	Based on best judgement on Planning Stage
Windows			
U-Value	1.2	$W/m^2.K$	Based on best judgement on Planning Stage
Transmittance Factor (g value)	30	%	Based on best judgement on Planning Stage
Frame Factor			Based on best judgement on Planning Stage
Ventilation			
Supply and extract			
MVHR assumed	Yes		Based on best judgement on Planning Stage
Specific Fan Power	1.6	W/l/s	To be improved as low as 1.3
Extract only (WC, kitchens, etc)			
MVHR assumed	No		
Specific Fan Power	0.3	W/l/s	Based on best judgement on Planning Stage
Heat Recovery			
Heat Recovery assumed	Yes		Based on best judgement on Planning Stage
Type	Plate heat exchanger		Based on best judgement on Planning Stage
Efficiency	0.9		Based on best judgement on Planning Stage
Air permeability			
Design air permeability rate	3	m^3/hm^2	Example with as low as 2.
Heating/ DHW			
Electric ASHP			
HVAC system type	Split or multi-split system		
Seasonal efficiency			non dom Service Compliance Guide 2013 figures
Seasonal EER in cooling mode	5.9		6.2
Seasonal COP in heating mode	4.6		GLA 2.64 - Be Lean
System Controls (proposed)			
Central time control	yes		Based on best judgement on Planning Stage
Optimum start/stop control	no		Based on best judgement on Planning Stage
Local time control (i.e. room by room)	yes		Based on best judgement on Planning Stage
Local temperature control (i.e. room by room)	yes		Based on best judgement on Planning Stage
Weather compensation control	no		Based on best judgement on Planning Stage
Hot Water			
Electric ASHP 50%			
DHW Generator type	ASHP		Based on best judgement on Planning Stage
Generator efficiency	4.6		Based on best judgement on Planning Stage
Fuel type	Electricity		Based on best judgement on Planning Stage
Storage losses (if storage present)	0.001	kWh/(l.day)	Based on best judgement on Planning Stage
Electric Boiler			
DHW Generator type	Dedicated hot water boiler		Based on best judgement on Planning Stage
Generator efficiency	1.00		Based on best judgement on Planning Stage
Fuel type	Electricity		Based on best judgement on Planning Stage
Storage losses (if storage present)	0.001	kWh/(l.day)	Based on best judgement on Planning Stage
Distribution losses			Based on best judgement on Planning Stage
PV			
Total PV output	6.75	kWp	To meet planning targets
PV efficiency	15	%	To meet planning targets
No. of panels	27		To meet planning targets
Tilt of Collector/ orientation	30°		Based on best judgement on Planning Stage
Overshading	None or Little (<20%)		Based on best judgement on Planning Stage
Orientation	South		Based on best judgement on Planning Stage
Ductwork and metering (proposed)			
Ductwork and AHU leakage			
Ductwork leakage tested?	Yes		Based on best judgement on Planning Stage
CEN classification	Class D		Based on best judgement on Planning Stage

AHU meets CEN leakage standards?	Yes	Based on best judgement on Planning Stage
CEN classification	Class L1	Based on best judgement on Planning Stage
Metering provision		
The system has provision for metering	Yes	Based on best judgement on Planning Stage
The metering warns "out of range" values	Yes	Based on best judgement on Planning Stage
Lighting and lighting controls		
Proposed		
Lamp efficacy	125 lm/cW	Based on best judgement on Planning Stage
Light Output Ratio LED Lighting	1.00	Based on best judgement on Planning Stage
Light Output Ratio Other Lighting	1.00	Based on best judgement on Planning Stage
Display Lighting Efficiency	125 lm/W	Based on best judgement on Planning Stage
Photoelectric lighting control	Yes, where feasible	Based on best judgement on Planning Stage
Occupancy Sensing	Yes, where feasible	Based on best judgement on Planning Stage

APPENDIX G – SAP RESULTS

The table below lists a sample of the typical flats that were modelled using SAP methodology, the TER and DER outputs and the % CO_2 reduction achieved after the Be Lean, Be Clean and Be Green measures have been applied.

The results from these 19 flats were extrapolated over the entire development, in order to predict the energy consumption and carbon dioxide emissions for the domestic spaces of the Development.

The following pages show the DER/TER FSAP2012 worksheets for a sample flat at the Be Lean and Be Green stages. The SAP outputs for all sample flats are available on request.

SAP Ref No.	TER ($kgCO_2/m^2/yr$)	Be Lean		Be Clean		Be Green	
		DER ($kgCO_2/m^2/yr$)	% CO_2 reduction	DER ($kgCO_2/m^2/yr$)	% CO_2 reduction	DER ($kgCO_2/m^2/yr$)	% CO_2 reduction
1	10.63	8.04	24.37%	8.04	24.37%	4.45	58.14%
2	10.12	7.65	24.41%	7.65	24.41%	1.76	82.61%
3	12.16	9.49	21.96%	9.49	21.96%	5.11	57.98%
4	10.91	7.58	30.52%	7.58	30.52%	4.23	61.23%
5	12.43	8.56	31.13%	8.56	31.13%	4.82	61.22%
6	12.31	8.93	27.46%	8.93	27.46%	4.94	59.87%
7	14.89	11.88	20.21%	11.88	20.21%	5.97	59.91%
8	11.31	8.16	27.85%	8.16	27.85%	4.67	58.71%
9	15.04	11.13	26.00%	11.13	26.00%	6.15	59.11%
10	13.94	10.34	25.82%	10.34	25.82%	5.54	60.26%
11	10.16	6.88	32.28%	6.88	32.28%	4.03	60.33%
12	13.42	9.94	25.93%	9.94	25.93%	5.62	58.12%
13	11.82	8.34	29.44%	8.34	29.44%	4.67	60.49%
14	11.8	8.12	31.19%	8.12	31.19%	4.62	60.85%
15	13.55	10.91	19.48%	10.91	19.48%	6.02	55.57%
16	17.92	13.54	24.44%	13.54	24.44%	7.31	59.21%
17	12.44	9.12	26.69%	9.12	26.69%	5.09	59.08%
18	16.73	13.59	18.77%	13.59	18.77%	7.2	56.96%
19	12.91	10.41	19.36%	10.41	19.36%	5.5	57.40%

Full SAP Calculation Printout

elmhurst energy

Property Reference	A-GF-02_Copy_Copy	Issued on Date	20/02/2023
Assessment Reference	A-GF-02 BeGreen	Prop Type Ref	01
Property			

SAP Rating	83 B	DER	4.45	TER	10.63
Environmental	96 A	% DER < TER			58.14
CO_2 Emissions (t/year)	0.44	DFEE	31.00	TFEE	34.81
Compliance Check	See BREL	% DFEE < TFEE			10.92
% DPER < TPER	15.88	DPER	47.29	TPER	56.21

Assessor Details	Mr. Andrew Jones	Assessor ID	N955-0001
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         Storey height             Volume
                                                                      (m2)                (m)                  (m3)
Ground floor                                                      61.0000 (1b)    x     2.9000 (2b)    =    176.9000 (1b) -
First floor                                                       51.0000 (1c)    x     3.2000 (2c)    =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)            112.0000                                           (4)
Dwelling volume                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (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                                                                                        3.0000 (17)
Infiltration rate                                                                                           0.1500 (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)  =      0.1500 (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
                0.1912    0.1875    0.1837    0.1650    0.1612    0.1425    0.1425    0.1388    0.1500    0.1612    0.1687    0.1762 (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) =               84.6000 (23c)

Effective ac    0.2682    0.2645    0.2607    0.2420    0.2382    0.2195    0.2195    0.2157    0.2270    0.2382    0.2457    0.2532 (25)

-----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                Gross      Openings      NetArea      U-value        A x U      K-value        A x K
                                          m2            m2           m2        W/m2K          W/K       kJ/m2K         kJ/K
Front Door                                                       2.0000       1.0000       2.0000                           (26)
Window (Uw = 1.20)                                              23.8500       1.1450      27.3092                           (27)
```

Opening			2.1300	1.1450	2.4389	(27a)
Floor to unheated			61.0000	0.1000	6.1000	(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285	(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540	(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040	(30)
Total net area of external elements Aum(A, m2)			136.5700			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		44.7346	(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000	(35)
Thermal bridges (User defined value 0.040 * total exposed area)		5.4628	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	50.1974	(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	30.1065	29.6856	29.2648	27.1604	26.7395	24.6351	24.6351	24.2143	25.4769	26.7395	27.5813	28.4230	(38)
Heat transfer coeff	80.3039	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204	(39)
Average = Sum(39)m / 12 =												77.2526	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7170	0.7132	0.7095	0.6907	0.6869	0.6681	0.6681	0.6644	0.6757	0.6869	0.6945	0.7020	(40)
HLP (average)												0.6898	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.8263	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)											Total = Sum(45)m =	657.9858	
Distribution loss (46)m = 0.15 x (45)m	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
Water storage loss:													
Store volume												110.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0152	(51)
Volume factor from Table 2a												1.0294	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.0327	(55)
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(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	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
									Total per year (kWh/year) = Sum(64)m =			1308.8255	(64)
12Total per year (kWh/year)												1309	(64)
Electric shower(s)	73.6804	65.6499	71.6871	68.4101	69.6938	66.4812	68.6972	69.6938	68.4101	71.6871	70.3391	73.6804	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							838.1104	(64a)
Heat gains from water heating, kWh/month	85.5877	76.2355	82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(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	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	138.4026	153.2315	138.4026	143.0161	138.4026	143.0161	138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	274.3987	277.2461	270.0707	254.7953	235.5127	217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	(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)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)	115.0372	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total internal gains	593.2333	609.3180	585.1475	570.9390	544.5683	528.5663	510.8707	509.6939	523.3188	536.7130	564.0663	580.7756	(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	8.5700	10.6334	0.4000	0.8000	0.7700	20.2086	(74)
South	15.2800	46.7521	0.4000	0.8000	0.7700	158.4190	(78)
North	2.1300	26.0000	0.4000	0.7000	1.0000	13.9558	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	192.5834	327.0542	447.6459	559.4518	634.2937	633.9533	609.3668	552.3024	485.8676	361.2385	230.4236	165.0075	(83)
Total gains	785.8166	936.3723	1032.7934	1130.3908	1178.8620	1162.5196	1120.2376	1061.9962	1009.1864	897.9515	794.4898	745.7831	(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	96.8543	97.3646	97.8803	100.5429	101.0929	103.9358	103.9358	104.5236	102.7797	101.0929	99.9989	98.9282	
alpha	7.4570	7.4910	7.5254	7.7029	7.7395	7.9291	7.9291	7.9682	7.8520	7.7395	7.6666	7.5952	
util living area	0.9922	0.9729	0.9250	0.7868	0.6019	0.4118	0.2939	0.3223	0.5160	0.8285	0.9732	0.9943	(86)
MIT	20.4167	20.6100	20.7951	20.9513	20.9938	20.9997	21.0000	21.0000	20.9985	20.9412	20.6786	20.3963	(87)
Th 2	20.3258	20.3292	20.3325	20.3491	20.3524	20.3691	20.3691	20.3724	20.3624	20.3524	20.3457	20.3391	(88)
util rest of house	0.9900	0.9660	0.9083	0.7541	0.5617	0.3713	0.2518	0.2783	0.4689	0.7924	0.9651	0.9926	(89)
MIT 2	19.6472	19.8916	20.1173	20.3045	20.3477	20.3689	20.3690	20.3724	20.3615	20.3004	19.9929	19.6323	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	19.7778	20.0134	20.2323	20.4142	20.4573	20.4759	20.4761	20.4788	20.4696	20.4091	20.1092	19.7619	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7778	20.0134	20.2323	20.4142	20.4573	20.4759	20.4761	20.4788	20.4696	20.4091	20.1092	19.7619	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9877	0.9622	0.9055	0.7575	0.5683	0.3781	0.2589	0.2858	0.4769	0.7957	0.9616	0.9908	(94)
Useful gains	776.1533	900.9675	935.1846	856.2545	669.9278	439.5878	290.0523	303.5039	481.2493	714.5278	764.0142	738.9041	(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	1242.9244	1207.3067	1091.2003	890.7134	673.7589	439.7106	290.0571	303.5140	482.0112	754.6798	1011.8388	1223.4799	(97)
Space heating kWh	347.2777	205.8599	116.0757	24.8104	2.8503	0.0000	0.0000	0.0000	0.0000	29.8731	178.4337	360.5244	(98a)
Space heating requirement - total per year (kWh/year)												1265.7052	
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	347.2777	205.8599	116.0757	24.8104	2.8503	0.0000	0.0000	0.0000	0.0000	29.8731	178.4337	360.5244	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1265.7052	
Space heating per m2											(98c) / (4) =	11.3009	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	703.4258	553.7608	565.5286	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9959	0.9990	0.9984	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	700.5422	553.2038	564.5982	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1271.9489	1226.0126	1163.0526	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	411.4128	500.5697	445.2500	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9821	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	101.0165	122.9077	109.3248	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												333.2491	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (301)

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Fraction of space heat from community system                                                                                  1.0000 (302)
Fraction of heat from community Boilers-Space and Water                                                                       0.5000 (303a)
Fraction of heat from community Heat pump-Space and Water                                                                     0.5000 (303b)
Factor for control and charging method (Table 4c(3)) for space heating                                                        1.0000 (305)
Factor for charging method (Table 4c(3)) for water heating                                                                    1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system                                                             1.1500 (306)
Efficiency of secondary/supplementary heating system, %                                                                       0.0000 (208)
Space heating:
Space heating requirement
               347.2777   205.8599   116.0757    24.8104     2.8503     0.0000     0.0000     0.0000     0.0000    29.8731   178.4337   360.5244 (98)
Space heat from Boilers = (98) x 0.50 x 1.00 x 1.15
307a           199.6847   118.3695    66.7435    14.2660     1.6389     0.0000     0.0000     0.0000     0.0000    17.1770   102.5994   207.3015
Space heat from Heat pump = (98) x 0.50 x 1.00 x 1.15
307b           199.6847   118.3695    66.7435    14.2660     1.6389     0.0000     0.0000     0.0000     0.0000    17.1770   102.5994   207.3015
Space heating requirement
               399.3693   236.7389   133.4870    28.5320     3.2779     0.0000     0.0000     0.0000     0.0000    34.3540   205.1988   414.6031 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)                                        0.0000 (308)
Space heating fuel for secondary/supplementary system
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (309)

Water heating
Annual water heating requirement
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
Water heat from Boilers = (64) x 0.50 x 1.00 x 1.15
310a            71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heat from Heat pump = (64) x 0.50 x 1.00 x 1.15
310b            71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heating fuel
               142.9310   126.1783   134.9849   122.6329   121.2145   111.9313   113.1536   116.5904   116.5680   126.6223   130.3131   142.0291 (310)
Cooling System Energy Efficiency Ratio                                                                                        2.6000 (314)
Space coolin     0.0000     0.0000     0.0000     0.0000     0.0000    38.8525    47.2722    42.0480     0.0000     0.0000     0.0000     0.0000 (315)
Pumps and Fa    24.0336    21.7078    24.0336    23.2584    24.0336    23.2584    24.0336    24.0336    23.2584    24.0336    23.2584    24.0336 (331)
Lighting        26.7589    21.4670    19.3286    14.1610    10.9383     8.9367     9.9783    12.9702    16.8470    22.1042    24.9666    27.5026 (332)
Electricity generated by PVs (Appendix M) (negative quantity)
(333a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                     1455.5610 (307)
Space heating fuel - secondary                                                                                                0.0000 (309)
Water heating fuel - community heating                                                                                     1505.1494 (310)
Efficiency of water heater                                                                                                    0.0000 (311)
Electricity used for heat distribution                                                                                       14.5556 (313)
Space cooling fuel                                                                                                          128.1727 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)
   mechanical ventilation fans (SFP =       0.6820)                                                                         282.9768 (330a)
Total electricity for the above, kWh/year                                                                                   282.9768 (331)
Electricity for lighting (calculated in Appendix L)                                                                         215.9594 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                 0.0000 (333)
Wind generation                                                                                                               0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                        0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                                0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                    -0.0000 (336)
Energy used                                                                                                                   0.0000 (337)
Total delivered energy for all uses                                                                                        4425.9296 (338)


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12b. Carbon dioxide emissions - Community heating scheme
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                                                                                Energy      Emission factor         Emissions
                                                                              kWh/year          kg CO2/kWh        kg CO2/year
Efficiency of heat source Boilers                                                                                   100.0000 (367)
Space and Water heating from Boilers                                         1480.3552              0.1588          115.5746 (367)
Efficiency of heat source Heat pump                                                                                 310.0000 (367)
Space and Water heating from Heat pump                                        477.5339              0.1588           37.2821 (368)
Electrical energy for heat distribution (space & water)                        14.5556              0.0000            4.4214 (372)
Overall CO2 factor for heat network                                                                                   0.1002 (386)
Total CO2 associated with community systems                                                                         296.8075 (373)
Energy for instantaneous electric shower(s)                                   838.1104              0.1391          116.5997 (264a)
Space and water heating                                                                                             296.8075 (376)
Space cooling                                                                 128.1727              0.1141           14.6189 (377)
Pumps, fans and electric keep-hot                                             282.9768              0.1387           39.2524 (378)
Energy for lighting                                                           215.9594              0.1443           31.1696 (379)
Total CO2, kg/year                                                                                                  498.4481 (383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)                                                                       4.4500 (384)


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13b. Primary energy - Community heating scheme
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	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Boilers			100.0000	(467a)
Space and Water heating from Boilers	1480.3552	1.5878	1155.5710	(467)
Efficiency of heat source Heat pump			310.0000	(467b)
Space and Water heating from Heat pump	477.5339	1.5878	372.7648	(468)
Electrical energy for heat distribution (space & water)	14.5556	0.0000	45.9642	(472)
Overall CO2 factor for heat network			1.0422	(486)
Total CO2 associated with community systems			3085.5332	(473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792	(278a)
Space and water heating			3085.5332	(476)
Space cooling	128.1727	1.4204	182.0541	(477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873	(478)
Energy for lighting	215.9594	1.5338	331.2457	(479)
Total Primary energy kWh/year			5296.0995	(483)
Dwelling Primary energy Rate (DPER)			47.2900	(484)

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	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	112.0000				(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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) =	0.1176	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.3676	(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) =	0.3676	(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	0.4687	0.4595	0.4503	0.4044	0.3952	0.3492	0.3492	0.3400	0.3676	0.3952	0.4136	0.4319	(22b)
Effective ac	0.6098	0.6056	0.6014	0.5818	0.5781	0.5610	0.5610	0.5578	0.5676	0.5781	0.5855	0.5933	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			2.0000	1.0000	2.0000			(26)
TER Opening Type (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	2.0221	4.3070			(27a)
Floor to unheated			61.0000	0.1300	7.9300			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1800	2.9142			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1800	4.7448			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1100	0.5544			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 49.7595 (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)	22.4000	0.1600	3.5840
E1 Steel lintel with perforated steel base plate	11.7600	0.0500	0.5880
E3 Sill	10.7600	0.0500	0.5380
E4 Jamb	36.9600	0.0500	1.8480
E5 Ground floor (normal)	10.9000	0.1600	1.7440
E6 Intermediate floor within a dwelling	11.5000	0.0000	0.0000
E18 Party wall between dwellings	24.4000	0.0600	1.4640
R11 Upstands or kerbs of rooflights	7.8600	0.0800	0.6288

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 10.3948 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 60.1543 (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	68.4445	67.9658	67.4965	65.2926	64.8802	62.9606	62.9606	62.6052	63.7000	64.8802	65.7144	66.5865	(38)
Heat transfer coeff	128.5988	128.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408	(39)
Average = Sum(39)m / 12 =												125.4449	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1482	1.1439	1.1397	1.1201	1.1164	1.0992	1.0992	1.0961	1.1058	1.1164	1.1238	1.1316	(40)
HLP (average)												1.1200	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	92.0047	90.6220	88.6072	84.7523	81.9074	78.7349	76.9316	78.9311	81.1230	84.5294	88.4671	91.6522	(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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												124.4382	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.5789	132.6118	129.0125	123.5730	119.1436	114.3866	112.5833	116.1673	119.9437	124.9346	130.4569	135.2264	(44)
Energy conte	214.7239	188.8374	198.2874	169.1653	160.3902	140.6516	136.1597	143.8394	147.9026	169.5351	185.8597	211.7319	(45)
Energy content (annual)											Total = Sum(45)m =	2067.0843	
Distribution loss (46)m = 0.15 x (45)m	32.2086	28.3256	29.7431	25.3748	24.0585	21.0977	20.4240	21.5759	22.1854	25.4303	27.8790	31.7598	(46)

Water storage loss:
Store volume 150.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.3938 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 0.7527 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	261.3188	230.9231	244.8823	214.2571	206.9851	185.7435	182.7546	190.4334	192.9945	216.1300	230.9516	258.3268	(62)
WWHRS	-42.0607	-37.1988	-38.9525	-32.2542	-30.0597	-25.7223	-24.1106	-25.6392	-26.6133	-31.3742	-35.5431	-41.2818	(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	219.2581	193.7243	205.9298	182.0029	176.9254	160.0211	158.6440	164.7951	166.3811	184.7558	195.4085	217.0450	(64)

Total per year (kWh/year) = Sum(64)m = 2224.8913 (64)
12Total per year (kWh/year) 2225 (64)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	108.6716	96.4570	103.2065	92.3209	90.6057	82.8401	82.5490	85.1025	85.2511	93.6463	97.8718	107.6768	(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	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	138.4026	153.2315	138.4026	143.0161	138.4026	143.0161	138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	274.3987	277.2461	270.0707	254.7953	235.5127	217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	(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)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)

Water heating gains (Table 5)													
	146.0640	143.5372	138.7184	128.2235	121.7818	115.0557	110.9530	114.3851	118.4043	125.8687	135.9331	144.7269	(72)
Total internal gains													
	627.2600	642.4095	615.5864	594.4295	564.0919	540.8563	520.0330	520.6177	536.4256	557.5521	591.5125	613.8157	(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	8.5700	10.6334	0.6300	0.7000	0.7700	27.8500	(74)
South	15.2800	46.7521	0.6300	0.7000	0.7700	218.3212	(78)
North	2.1300	26.0000	0.6300	0.7000	1.0000	21.9803	(82)

Solar gains	268.1515	456.4280	627.0567	786.8457	894.4255	894.8018	859.7562	777.7326	681.7389	504.8063	321.0397	229.6201	(83)
Total gains	895.4115	1098.8376	1242.6432	1381.2752	1458.5174	1435.6581	1379.7891	1298.3503	1218.1645	1062.3584	912.5522	843.4358	(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	60.4809	60.7069	60.9301	62.0006	62.2050	63.1749	63.1749	63.3578	62.7978	62.2050	61.7928	61.3676	
alpha	5.0321	5.0471	5.0620	5.1334	5.1470	5.2117	5.2117	5.2239	5.1865	5.1470	5.1195	5.0912	
util living area													
	0.9928	0.9801	0.9520	0.8737	0.7303	0.5377	0.3908	0.4317	0.6641	0.9091	0.9826	0.9946	(86)
MIT	19.7950	20.0555	20.3595	20.7007	20.9059	20.9846	20.9976	20.9960	20.9559	20.6778	20.1798	19.7608	(87)
Th 2	19.9617	19.9651	19.9685	19.9845	19.9875	20.0015	20.0015	20.0040	19.9961	19.9875	19.9814	19.9751	(88)
util rest of house													
	0.9905	0.9741	0.9377	0.8397	0.6701	0.4587	0.3031	0.3400	0.5818	0.8760	0.9762	0.9928	(89)
MIT 2	18.5769	18.9080	19.2868	19.6997	19.9148	19.9934	20.0007	20.0027	19.9695	19.6871	19.0800	18.5432	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	18.7835	19.1026	19.4688	19.8695	20.0829	20.1615	20.1698	20.1712	20.1368	19.8552	19.2665	18.7498	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.7835	19.1026	19.4688	19.8695	20.0829	20.1615	20.1698	20.1712	20.1368	19.8552	19.2665	18.7498	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9868	0.9674	0.9292	0.8354	0.6761	0.4716	0.3180	0.3555	0.5940	0.8709	0.9702	0.9898	(94)
Useful gains	883.6075	1063.0075	1154.6362	1153.8896	986.1738	677.0737	438.7286	461.5899	723.5409	925.2185	885.3618	834.8320	(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													
	1862.5657	1819.6422	1655.4743	1376.0913	1048.1525	684.7061	439.5001	462.9552	747.6851	1157.2139	1531.3861	1844.0509	(97)
Space heating kWh													
	728.3449	508.4585	372.6235	159.9852	46.1121	0.0000	0.0000	0.0000	0.0000	172.6046	465.1375	750.8588	(98a)
Space heating requirement - total per year (kWh/year)												3204.1252	
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													
	728.3449	508.4585	372.6235	159.9852	46.1121	0.0000	0.0000	0.0000	0.0000	172.6046	465.1375	750.8588	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3204.1252	
Space heating per m2										(98c) / (4) =		28.6083	(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													
	728.3449	508.4585	372.6235	159.9852	46.1121	0.0000	0.0000	0.0000	0.0000	172.6046	465.1375	750.8588	(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)													
	789.1061	550.8760	403.7091	173.3318	49.9590	0.0000	0.0000	0.0000	0.0000	187.0039	503.9410	813.4982	(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

	219.2581	193.7243	205.9298	182.0029	176.9254	160.0211	158.6440	164.7951	166.3811	184.7558	195.4085	217.0450	(64)

Efficiency of water heater 79.8000 (216)

(217)m	86.5416	86.1203	85.3728	83.7719	81.5079	79.8000	79.8000	79.8000	79.8000	83.9075	85.9329	86.6096	(217)
Fuel for water heating, kWh/month													
	253.3556	224.9460	241.2123	217.2601	217.0653	200.5277	198.8020	206.5102	208.4977	220.1899	227.3965	250.6016	(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	28.7573	23.0702	20.7722	15.2186	11.7553	9.6042	10.7235	13.9389	18.1052	23.7550	26.8312	29.5566	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-24.2411	-36.0429	-54.5965	-64.7809	-72.8175	-69.0204	-68.1451	-62.8406	-54.0402	-42.6574	-27.2943	-20.7435	(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	-8.5569	-18.4125	-37.3867	-57.3445	-77.0239	-77.8638	-76.9820	-64.6553	-46.6833	-26.7529	-11.5553	-6.7386	(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	3471.4250	(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	2666.3651	(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)	232.0882	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1107.1761	(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	5348.7021	(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	3471.4250	0.2100	728.9992	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2666.3651	0.2100	559.9367	(264)
Space and water heating			1288.9359	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	232.0882	0.1443	33.4975	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-597.2204	0.1335	-79.7287	
PV Unit electricity exported	-509.9557	0.1253	-63.8843	
Total			-143.6129	(269)
Total CO2, kg/year			1190.7498	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.6300	(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	3471.4250	1.1300	3922.7102	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2666.3651	1.1300	3012.9925	(278)
Space and water heating			6935.7027	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	232.0882	1.5338	355.9846	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-597.2204	1.4933	-891.8472	
PV Unit electricity exported	-509.9557	0.4598	-234.4834	
Total			-1126.3305	(283)
Total Primary energy kWh/year			6295.4576	(286)
Target Primary Energy Rate (TPER)			56.2100	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)   112.0000   (4)
Dwelling volume   (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =   340.1000 (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) =   0.1176 (8)
Pressure test   Yes
Pressure Test Method   Blower Door
Measured/design AP50   3.0000 (17)
Infiltration rate   0.2676 (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) =   0.2676 (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	0.3412	0.3345	0.3278	0.2944	0.2877	0.2542	0.2542	0.2475	0.2676	0.2877	0.3011	0.3144	(22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)   0.0000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =   0.0000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.5582	0.5560	0.5537	0.5433	0.5414	0.5323	0.5323	0.5306	0.5358	0.5414	0.5453	0.5494	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K   250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)   5.4628 (36)
Point Thermal bridges   (36a) =   0.0000
Total fabric heat loss   (33) + (36) + (36a) =   50.1974 (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	62.6497	62.3960	62.1473	60.9793	60.7608	59.7435	59.7435	59.5551	60.1354	60.7608	61.2029	61.6650	(38)
Heat transfer coeff	112.8471	112.5934	112.3447	111.1767	110.9582	109.9409	109.9409	109.7525	110.3328	110.9582	111.4003	111.8624	(39)
Average = Sum(39)m / 12 =												111.1757	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0076	1.0053	1.0031	0.9926	0.9907	0.9816	0.9816	0.9799	0.9851	0.9907	0.9946	0.9988	(40)
HLP (average)												0.9926	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)
-------------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                                    2.8263 (42)
Hot water usage for mixer showers
                 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (42a)
Hot water usage for baths
                30.9169   30.4578   29.8112   28.6190   27.7263   26.7364   26.2017   26.8438   27.5429   28.6021   29.8188   30.8124 (42b)
Hot water usage for other uses
                43.5743   41.9897   40.4052   38.8207   37.2362   35.6517   35.6517   37.2362   38.8207   40.4052   41.9897   43.5743 (42c)
Average daily hot water use (litres/day)                                                                                                      68.2778 (43)

                  Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Daily hot water use
                74.4912   72.4475   70.2164   67.4397   64.9624   62.3881   61.8534   64.0800   66.3636   69.0073   71.8086   74.3867 (44)
Energy conte   117.9758  103.1643  107.9200   92.3215   87.4519   76.7134   74.8063   79.3444   81.8329   93.6423  102.3045  116.4715 (45)
Energy content (annual)                                                                                   Total = Sum(45)m =    1133.9488
Distribution loss  (46)m = 0.15 x (45)m
                 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (46)
Water storage loss:
Total storage loss
                 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (56)
If cylinder contains dedicated solar storage
                 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (57)
Primary loss     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (59)
Combi loss       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (61)
Total heat required for water heating calculated for each month
               100.2794   87.6896   91.7320   78.4733   74.3341   65.2064   63.5854   67.4427   69.5580   79.5959   86.9588   99.0008 (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
               100.2794   87.6896   91.7320   78.4733   74.3341   65.2064   63.5854   67.4427   69.5580   79.5959   86.9588   99.0008 (64)
                                                                                Total per year (kWh/year) = Sum(64)m =     963.8565 (64)
12Total per year (kWh/year)                                                                                                       964 (64)
Electric shower(s)
                57.3459   51.0957   55.7945   53.2440   54.2431   51.7427   53.4674   54.2431   53.2440   55.7945   54.7454   57.3459 (64a)
                                          Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =     652.3063 (64a)
Heat gains from water heating, kWh/month
                39.4063   34.6963   36.8816   32.9293   32.1443   29.2373   29.2632   30.4215   30.7005   33.8476   35.4260   39.0867 (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          141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156  141.3156 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
               138.4026  153.2315  138.4026  143.0161  138.4026  143.0161  138.4026  138.4026  143.0161  138.4026  143.0161  138.4026 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               274.3987  277.2461  270.0707  254.7953  235.5127  217.3898  205.2826  202.4352  209.6106  224.8861  244.1686  262.2915 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316   37.1316 (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)
              -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 (71)
Water heating gains (Table 5)
                52.9655   51.6314   49.5721   45.7352   43.2047   40.6073   39.3323   40.8891   42.6396   45.4941   49.2028   52.5359 (72)
Total internal gains
               531.1615  547.5037  523.4402  508.9412  482.5148  466.4079  448.4122  447.1216  460.6609  474.1775  501.7822  518.6247 (73)


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6. Solar gains
-------------------------------------------------------------------------------------------------------
[Jan]                                        Area        Solar flux             g               FF            Access              Gains
                                               m2          Table 6a     Specific data     Specific data        factor                  W
                                                              W/m2       or Table 6b       or Table 6c      Table 6d
-------------------------------------------------------------------------------------------------------
North                                      8.5700           10.6334          0.4000           0.8000          0.7700            20.2086 (74)
South                                     15.2800           46.7521          0.4000           0.8000          0.7700           158.4190 (78)
North                                      2.1300           26.0000          0.4000           0.7000          1.0000            13.9558 (82)
-------------------------------------------------------------------------------------------------------

Solar gains    192.5834  327.0542  447.6459  559.4518  634.2937  633.9533  609.3668  552.3024  485.8676  361.2385  230.4236  165.0075 (83)
Total gains    723.7449  874.5580  971.0860 1068.3930 1116.8085 1100.3612 1057.7790  999.4240  946.5285  835.4160  732.2058  683.6321 (84)


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7. Mean internal temperature (heating season)
-------------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                          21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                  Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
tau             68.9232   69.0785   69.2314   69.9587   70.0965   70.7451   70.7451   70.8665   70.4938   70.0965   69.8183   69.5298
alpha            5.5949    5.6052    5.6154    5.6639    5.6731    5.7163    5.7163    5.7244    5.6996    5.6731    5.6546    5.6353
util living area
                 0.9971    0.9912    0.9771    0.9289    0.8146    0.6206    0.4545    0.5001    0.7450    0.9500    0.9923    0.9979 (86)
```

```
MIT             19.8573    20.0702    20.3312    20.6523    20.8796    20.9795    20.9970    20.9950    20.9446    20.6449    20.1905    19.8218 (87)
Th 2            20.0770    20.0789    20.0808    20.0895    20.0911    20.0987    20.0987    20.1001    20.0958    20.0911    20.0878    20.0844 (88)
util rest of house
                 0.9961     0.9884     0.9697     0.9064     0.7634     0.5412     0.3629     0.4049     0.6689     0.9294     0.9894     0.9972 (89)
MIT 2           19.0360    19.2487    19.5064    19.8179    20.0137    20.0898    20.0979    20.0987    20.0677    19.8183    19.3762    19.0065 (90)
Living area fraction                                                                                  fLA = Living area / (4) =      0.1696 (91)
MIT             19.1753    19.3880    19.6463    19.9595    20.1606    20.2407    20.2505    20.2508    20.2165    19.9586    19.5144    19.1448 (92)
Temperature adjustment                                                                                                                0.0000
adjusted MIT    19.1753    19.3880    19.6463    19.9595    20.1606    20.2407    20.2505    20.2508    20.2165    19.9586    19.5144    19.1448 (93)


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

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9948     0.9857     0.9653     0.9027     0.7677     0.5541     0.3785     0.4211     0.6798     0.9257     0.9869     0.9962 (94)
Useful gains   720.0118   862.0324   937.4087   964.4461   857.3372   609.7182   400.3554   420.8573   643.4252   773.3293   722.6132   681.0071 (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
              1678.6386  1631.2556  1476.9188  1229.5569   938.7736   620.1440   401.3350   422.6308   674.8469  1038.4084  1382.9630  1671.7589 (97)
Space heating kWh
               713.2183   516.9180   401.3956   190.8797    60.5887     0.0000     0.0000     0.0000     0.0000   197.2188   475.4519   737.1193 (98a)
Space heating requirement - total per year (kWh/year)                                                                              3292.7903
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
               713.2183   516.9180   401.3956   190.8797    60.5887     0.0000     0.0000     0.0000     0.0000   197.2188   475.4519   737.1193 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                     3292.7903
Space heating per m2                                                                                            (98c) / (4) =     29.3999 (99)


----------------------------------------------------------------------------------------------------
8c. Space cooling requirement
----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.       4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000
Heat loss rate W
                 0.0000     0.0000     0.0000     0.0000     0.0000  1033.4446   813.5628   834.1192     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation      0.0000     0.0000     0.0000     0.0000     0.0000     0.9097     0.9575     0.9418     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss      0.0000     0.0000     0.0000     0.0000     0.0000   940.1094   778.9705   785.5839     0.0000     0.0000     0.0000     0.0000 (102)
Total gains      0.0000     0.0000     0.0000     0.0000     0.0000  1211.3498  1165.2390  1102.6705     0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000   195.2931   287.3838   235.9125     0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                        fC = cooled area / (4) =      1.0000 (105)
Intermittency factor (Table 10b)
                 0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500 (106)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000    48.8233    71.8460    58.9781     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                           179.6473 (107)
Energy for space heating                                                                                                             29.3999 (99)
Energy for space cooling                                                                                                              1.6040 (108)
Total                                                                                                                                31.0039 (109)
Fabric Energy Efficiency (DFEE)                                                                                                        31.0 (109)


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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY
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----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
----------------------------------------------------------------------------------------------------
                                                                                       Area         Storey height               Volume
                                                                                       (m2)              (m)                     (m3)
Ground floor                                                                        61.0000 (1b)    x      2.9000 (2b)    =    176.9000 (1b) -
First floor                                                                         51.0000 (1c)    x      3.2000 (2c)    =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)              112.0000                                                             (4)
Dwelling volume                                                                             (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (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) =	0.1176 (8)
Pressure test			Yes
Pressure Test Method			Blower Door
Measured/design AP50			5.0000 (17)
Infiltration rate			0.3676 (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) =	0.3676 (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	0.4687	0.4595	0.4503	0.4044	0.3952	0.3492	0.3492	0.3400	0.3676	0.3952	0.4136	0.4319	(22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.6098	0.6056	0.6014	0.5818	0.5781	0.5610	0.5610	0.5578	0.5676	0.5781	0.5855	0.5933	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			2.0000	1.0000	2.0000			(26)
TER Opening Type (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	2.0221	4.3070			(27a)
Floor to unheated			61.0000	0.1300	7.9300			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1800	2.9142			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1800	4.7448			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1100	0.5544			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		49.7595			(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)	22.4000	0.1600	3.5840
E1 Steel lintel with perforated steel base plate	11.7600	0.0500	0.5880
E3 Sill	10.7600	0.0500	0.5380
E4 Jamb	36.9600	0.0500	1.8480
E5 Ground floor (normal)	10.9000	0.1600	1.7440
E6 Intermediate floor within a dwelling	11.5000	0.0000	0.0000
E18 Party wall between dwellings	24.4000	0.0600	1.4640
R11 Upstands or kerbs of rooflights	7.8600	0.0800	0.6288

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		10.3948 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	60.1543 (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	68.4445	67.9658	67.4965	65.2926	64.8802	62.9606	62.9606	62.6052	63.7000	64.8802	65.7144	66.5865	(38)
Heat transfer coeff	128.5988	128.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408	(39)

Average = Sum(39)m / 12 = 125.4449

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1482	1.1439	1.1397	1.1201	1.1164	1.0992	1.0992	1.0961	1.1058	1.1164	1.1238	1.1316	(40)
HLP (average)												1.1200	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	30.9169	30.4578	29.8112	28.6190	27.7263	26.7364	26.2017	26.8438	27.5429	28.6021	29.8188	30.8124	(42b)
Hot water usage for other uses	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)

Average daily hot water use (litres/day) 68.2778 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	74.4912	72.4475	70.2164	67.4397	64.9624	62.3881	61.8534	64.0800	66.3636	69.0073	71.8086	74.3867	(44)
Energy conte	117.9758	103.1643	107.9200	92.3215	87.4519	76.7134	74.8063	79.3444	81.8329	93.6423	102.3045	116.4715	(45)

Energy content (annual) Total = Sum(45)m = 1133.9488

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)

Water storage loss:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	100.2794	87.6896	91.7320	78.4733	74.3341	65.2064	63.5854	67.4427	69.5580	79.5959	86.9588	99.0008	(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	100.2794	87.6896	91.7320	78.4733	74.3341	65.2064	63.5854	67.4427	69.5580	79.5959	86.9588	99.0008	(64)

Total per year (kWh/year) = Sum(64)m = 963.8565 (64)

12Total per year (kWh/year) 964 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Electric shower(s)	57.3459	51.0957	55.7945	53.2440	54.2431	51.7427	53.4674	54.2431	53.2440	55.7945	54.7454	57.3459	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 652.3063 (64a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	39.4063	34.6963	36.8816	32.9293	32.1443	29.2373	29.2632	30.4215	30.7005	33.8476	35.4260	39.0867	(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	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	138.4026	153.2315	138.4026	143.0161	138.4026	143.0161	138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	274.3987	277.2461	270.0707	254.7953	235.5127	217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	(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)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)	52.9655	51.6314	49.5721	45.7352	43.2047	40.6073	39.3323	40.8891	42.6396	45.4941	49.2028	52.5359	(72)
Total internal gains	531.1615	547.5037	523.4402	508.9412	482.5148	466.4079	448.4122	447.1216	460.6609	474.1775	501.7822	518.6247	(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	8.5700	10.6334	0.6300	0.7000	0.7700	27.8500	(74)
South	15.2800	46.7521	0.6300	0.7000	0.7700	218.3212	(78)
North	2.1300	26.0000	0.6300	0.7000	1.0000	21.9803	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	268.1515	456.4280	627.0567	786.8457	894.4255	894.8018	859.7562	777.7326	681.7389	504.8063	321.0397	229.6201	(83)
Total gains	799.3130	1003.9318	1150.4969	1295.7869	1376.9403	1361.2097	1308.1684	1224.8542	1142.3998	978.9838	822.8219	748.2448	(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	60.4809	60.7069	60.9301	62.0006	62.2050	63.1749	63.1749	63.3578	62.7978	62.2050	61.7928	61.3676	
alpha	5.0321	5.0471	5.0620	5.1334	5.1470	5.2117	5.2117	5.2239	5.1865	5.1470	5.1195	5.0912	
util living area	0.9956	0.9863	0.9639	0.8954	0.7593	0.5642	0.4116	0.4566	0.6979	0.9305	0.9888	0.9968	(86)
MIT	19.7058	19.9723	20.2885	20.6558	20.8871	20.9808	20.9969	20.9948	20.9447	20.6250	20.0998	19.6715	(87)
Th 2	19.9617	19.9651	19.9685	19.9845	19.9875	20.0015	20.0015	20.0040	19.9961	19.9875	19.9814	19.9751	(88)
util rest of house	0.9942	0.9819	0.9525	0.8650	0.7004	0.4825	0.3195	0.3601	0.6151	0.9030	0.9845	0.9958	(89)
MIT 2	18.7942	19.0603	19.3708	19.7250	19.9183	19.9935	20.0007	20.0027	19.9694	19.7084	19.2012	18.7706	(90)

Living area fraction fLA = Living area / (4) = 0.1696 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	18.9488	19.2150	19.5264	19.8829	20.0826	20.1610	20.1697	20.1710	20.1349	19.8639	19.3536	18.9234	(92)

Temperature adjustment 0.0000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
adjusted MIT	18.9488	19.2150	19.5264	19.8829	20.0826	20.1610	20.1697	20.1710	20.1349	19.8639	19.3536	18.9234	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9923	0.9778	0.9465	0.8615	0.7063	0.4959	0.3352	0.3765	0.6273	0.8989	0.9809	0.9943	(94)
Useful gains	793.1211	981.6432	1088.9633	1116.3297	972.5461	675.0365	438.4932	461.1370	716.5845	880.0251	807.0979	743.9538	(95)

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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
              1883.8223   1834.0374   1662.8371   1377.7678   1048.1163    684.6413    439.4858    462.9272    747.4470   1158.3118   1542.3479   1866.0598 (97)
Space heating kWh
               811.4817    572.8089    426.9621    188.2354     56.2242      0.0000      0.0000      0.0000      0.0000    207.0454    529.3799    834.8469 (98a)
Space heating requirement - total per year (kWh/year)                                                                                            3626.9847
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
               811.4817    572.8089    426.9621    188.2354     56.2242      0.0000      0.0000      0.0000      0.0000    207.0454    529.3799    834.8469 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                                   3626.9847
Space heating per m2                                                                                                    (98c) / (4) =     32.3838 (99)


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8c. Space cooling requirement
-----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                 Jan         Feb         Mar         Apr         May         Jun         Jul         Aug         Sep         Oct         Nov         Dec
Ext. temp.       4.3000      4.9000      6.5000      8.9000     11.7000     14.6000     16.6000     16.4000     14.1000     10.6000      7.1000      4.2000
Heat loss rate W
                 0.0000      0.0000      0.0000      0.0000      0.0000   1157.2808    911.0508    932.9722      0.0000      0.0000      0.0000      0.0000 (100)
Utilisation      0.0000      0.0000      0.0000      0.0000      0.0000      0.9271      0.9649      0.9512      0.0000      0.0000      0.0000      0.0000 (101)
Useful loss      0.0000      0.0000      0.0000      0.0000      0.0000   1072.9094    879.0573    887.4822      0.0000      0.0000      0.0000      0.0000 (102)
Total gains      0.0000      0.0000      0.0000      0.0000      0.0000   1505.8162   1448.0536   1357.9795      0.0000      0.0000      0.0000      0.0000 (103)
Space cooling kWh
                 0.0000      0.0000      0.0000      0.0000      0.0000    311.6929    423.3332    350.0500      0.0000      0.0000      0.0000      0.0000 (104)
Cooled fraction                                                                                     fC = cooled area / (4) =      1.0000 (105)
Intermittency factor (Table 10b)
                 0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500      0.2500 (106)
Space cooling kWh
                 0.0000      0.0000      0.0000      0.0000      0.0000     77.9232    105.8333     87.5125      0.0000      0.0000      0.0000      0.0000 (107)
Space cooling requirement                                                                                                                  271.2690 (107)
Energy for space heating                                                                                                                    32.3838 (99)
Energy for space cooling                                                                                                                     2.4220 (108)
Total                                                                                                                                       34.8058 (109)
Fabric Energy Efficiency (TFEE)                                                                                                                34.8 (109)


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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF ENERGY RATING
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1. Overall dwelling characteristics
-----------------------------------------------------------------------------------------------------
                                                                                                    Area         Storey height              Volume
                                                                                                    (m2)              (m)                    (m3)
Ground floor                                                                                     61.0000 (1b)    x     2.9000 (2b)    =    176.9000 (1b) -
First floor                                                                                      51.0000 (1c)    x     3.2000 (2c)    =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)              112.0000                                                                        (4)
Dwelling volume                                                                                        (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (5)



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

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

                                                                                                                  Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =          0.0000 / (5) =      0.0000 (8)
Pressure test                                                                                                                      Yes
Pressure Test Method                                                                                                       Blower Door
Measured/design AP50                                                                                                            3.0000 (17)
Infiltration rate                                                                                                               0.1500 (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)  =      0.1500 (21)

                 Jan         Feb         Mar         Apr         May         Jun         Jul         Aug         Sep         Oct         Nov         Dec
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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
                 0.1912     0.1875     0.1837     0.1650     0.1612     0.1425     0.1425     0.1388     0.1500     0.1612     0.1687     0.1762 (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) =                                            84.6000 (23c)

Effective ac     0.2682     0.2645     0.2607     0.2420     0.2382     0.2195     0.2195     0.2157     0.2270     0.2382     0.2457     0.2532 (25)



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3. Heat losses and heat loss parameter
----------------------------------------------------------------------------------------------------
Element                                          Gross       Openings        NetArea        U-value          A x U        K-value          A x K
                                                    m2             m2             m2          W/m2K            W/K         kJ/m2K           kJ/K
Front Door                                                                    2.0000         1.0000         2.0000                                 (26)
Window (Uw = 1.20)                                                           23.8500         1.1450        27.3092                                 (27)
Opening                                                                       2.1300         1.1450         2.4389                                 (27a)
Floor to unheated                                                            61.0000         0.1000         6.1000                                 (28a)
External Wall LGF                              31.6000        15.4100        16.1900         0.1500         2.4285                                 (29a)
External Wall UGF                              36.8000        10.4400        26.3600         0.1500         3.9540                                 (29a)
LGF Roof                                        7.1700         2.1300         5.0400         0.1000         0.5040                                 (30)
Total net area of external elements Aum(A, m2)                              136.5700                                                               (31)
Fabric heat loss, W/K = Sum (A x U)                                                 (26)...(30) + (32) =     44.7346                                 (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                      250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)                                                                          5.4628 (36)
Point Thermal bridges                                                                                                      (36a) =       0.0000
Total fabric heat loss                                                                                         (33) + (36) + (36a) =    50.1974 (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           30.1065    29.6856    29.2648    27.1604    26.7395    24.6351    24.6351    24.2143    25.4769    26.7395    27.5813    28.4230 (38)
Heat transfer coeff
                80.3039    79.8830    79.4621    77.3578    76.9369    74.8325    74.8325    74.4117    75.6743    76.9369    77.7787    78.6204 (39)
Average = Sum(39)m / 12 =                                                                                                               77.2526

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP              0.7170     0.7132     0.7095     0.6907     0.6869     0.6681     0.6681     0.6644     0.6757     0.6869     0.6945     0.7020 (40)
HLP (average)                                                                                                                            0.6898
Days in mont         31         28         31         30         31         30         31         31         30         31         30         31



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4. Water heating energy requirements (kWh/year)
----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                        2.8263 (42)
Hot water usage for mixer showers
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
                 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
                43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (42c)
Average daily hot water use (litres/day)                                                                                                39.6130 (43)

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
                43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (44)
Energy conte    69.0110    59.7928    62.1013    53.1436    50.1271    43.8379    43.1176    46.1062    47.8698    54.8295    59.8221    68.2268 (45)
Energy content (annual)                                                                                          Total = Sum(45)m =    657.9858
Distribution loss  (46)m = 0.15 x (45)m
                10.3516     8.9689     9.3152     7.9715     7.5191     6.5757     6.4676     6.9159     7.1805     8.2244     8.9733    10.2340 (46)
Water storage loss:
Store volume                                                                                                                           110.0000 (47)
   b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                             0.0152 (51)
  Volume factor from Table 2a                                                                                                            1.0294 (52)
  Temperature factor from Table 2b                                                                                                       0.6000 (53)
Enter (49) or (54) in (55)                                                                                                               1.0327 (55)
Total storage loss
                32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (56)
If cylinder contains dedicated solar storage
                32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (57)
Primary loss    23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (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
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
                                                                                          Total per year (kWh/year) = Sum(64)m =   1308.8255 (64)
Electric shower(s)
                73.6804    65.6499    71.6871    68.4101    69.6938    66.4812    68.6972    69.6938    68.4101    71.6871    70.3391    73.6804 (64a)
                                                      Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    838.1104 (64a)
Heat gains from water heating, kWh/month
                85.5877    76.2355    82.7919    77.5677    78.3122    73.9913    75.7323    76.9752    75.8142    80.3740    80.2706    85.3269 (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         169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
               30.5713    27.1531    22.0824    16.7178    12.4968    10.5503    11.4000    14.8181    19.8888    25.2534    29.4745    31.4210 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              409.5503   413.8002   403.0907   380.2914   351.5115   324.4624   306.3920   302.1421   312.8516   335.6509   364.4308   391.4799 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842 (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)
             -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
              115.0372   113.4457   111.2795   107.7330   105.2583   102.7657   101.7908   103.4613   105.2975   108.0296   111.4869   114.6868 (72)
Total internal gains
              666.4693   665.7095   647.7630   616.0527   580.5770   549.0889   530.8932   531.7320   549.3484   580.2443   616.7026   648.8980 (73)


-----------------------------------------------------------------------------------------------------
6. Solar gains
-----------------------------------------------------------------------------------------------------

[Jan]                                    Area        Solar flux                g              FF           Access              Gains
                                           m2          Table 6a   Specific data   Specific data           factor                  W
                                                           W/m2     or Table 6b     or Table 6c         Table 6d
-----------------------------------------------------------------------------------------------------
North                                  8.5700           10.6334          0.4000          0.8000           0.7700            20.2086 (74)
South                                 15.2800           46.7521          0.4000          0.8000           0.7700           158.4190 (78)
North                                  2.1300           26.0000          0.4000          0.7000           1.0000            13.9558 (82)
-----------------------------------------------------------------------------------------------------

Solar gains    192.5834   327.0542   447.6459   559.4518   634.2937   633.9533   609.3668   552.3024   485.8676   361.2385   230.4236   165.0075 (83)
Total gains    859.0526   992.7637  1095.4089  1175.5045  1214.8707  1183.0422  1140.2600  1084.0343  1035.2160   941.4828   847.1262   813.9055 (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            96.8543    97.3646    97.8803   100.5429   101.0929   103.9358   103.9358   104.5236   102.7797   101.0929    99.9989    98.9282
alpha           7.4570     7.4910     7.5254     7.7029     7.7395     7.9291     7.9291     7.9682     7.8520     7.7395     7.6666     7.5952
util living area
                0.9867     0.9631     0.9038     0.7637     0.5849     0.4046     0.2888     0.3157     0.5032     0.8021     0.9621     0.9901 (86)

MIT            20.4873    20.6569    20.8312    20.9601    20.9948    20.9998    21.0000    21.0000    20.9987    20.9530    20.7222    20.4633 (87)
Th 2           20.3258    20.3292    20.3325    20.3491    20.3524    20.3691    20.3691    20.3724    20.3624    20.3524    20.3457    20.3391 (88)
util rest of house
                0.9831     0.9542     0.8842     0.7305     0.5456     0.3648     0.2474     0.2727     0.4572     0.7646     0.9514     0.9874 (89)
MIT 2          19.7360    19.9486    20.1581    20.3129    20.3485    20.3689    20.3690    20.3724    20.3616    20.3115    20.0454    19.7170 (90)
Living area fraction                                                                          fLA = Living area / (4) =      0.1696 (91)
MIT            19.8635    20.0688    20.2723    20.4227    20.4582    20.4759    20.4761    20.4789    20.4697    20.4203    20.1602    19.8436 (92)
Temperature adjustment                                                                                                        0.0000
adjusted MIT   19.8635    20.0688    20.2723    20.4227    20.4582    20.4759    20.4761    20.4789    20.4697    20.4203    20.1602    19.8436 (93)


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

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation     0.9801     0.9502     0.8823     0.7344     0.5521     0.3716     0.2544     0.2800     0.4650     0.7687     0.9479     0.9849 (94)
Useful gains  841.9312   943.3598   966.4632   863.2718   670.6746   439.6041   290.0530   303.5055   481.3854   723.7079   803.0237   801.5840 (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
             1249.8062  1211.7262  1094.3744   891.3708   673.8266   439.7120   290.0572   303.5141   482.0234   755.5443  1015.8073  1229.9070 (97)
Space heating kWh
              303.4591   180.3422    95.1659    20.2313     2.3451     0.0000     0.0000     0.0000     0.0000    23.6863   153.2042   318.6723 (98a)
Space heating requirement - total per year (kWh/year)                                                                      1097.1065
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
              303.4591   180.3422    95.1659    20.2313     2.3451     0.0000     0.0000     0.0000     0.0000    23.6863   153.2042   318.6723 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                             1097.1065
Space heating per m2                                                                                 (98c) / (4) =      9.7956 (99)


-----------------------------------------------------------------------------------------------------
8c. Space cooling requirement
-----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.      4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000
```

```
Heat loss rate W
                0.0000     0.0000     0.0000     0.0000     0.0000   703.4258   553.7608   565.5286     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation     0.0000     0.0000     0.0000     0.0000     0.0000     0.9959     0.9990     0.9984     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss     0.0000     0.0000     0.0000     0.0000     0.0000   700.5422   553.2038   564.5982     0.0000     0.0000     0.0000     0.0000 (102)
Total gains     0.0000     0.0000     0.0000     0.0000     0.0000  1271.9489  1226.0126  1163.0526     0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000   411.4128   500.5697   445.2500     0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                        fC = cooled area / (4) =      0.9821 (105)
Intermittency factor (Table 10b)
                0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500 (106)
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000   101.0165   122.9077   109.3248     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                          333.2491 (107)



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9b. Energy requirements
-----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                                0.0000 (301)
Fraction of space heat from community system                                                                                         1.0000 (302)
Fraction of heat from community Boilers-Space and Water                                                                              0.5000 (303a)
Fraction of heat from community Heat pump-Space and Water                                                                            0.5000 (303b)
Factor for control and charging method (Table 4c(3)) for space heating                                                               1.0000 (305)
Factor for charging method (Table 4c(3)) for water heating                                                                           1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system                                                                    1.1500 (306)
Efficiency of secondary/supplementary heating system, %                                                                              0.0000 (208)
Space heating:
Space heating requirement
              303.4591   180.3422    95.1659    20.2313     2.3451     0.0000     0.0000     0.0000     0.0000    23.6863   153.2042   318.6723 (98)
Space heat from Boilers = (98) x 0.50 x 1.00 x 1.15
307a          174.4890   103.6968    54.7204    11.6330     1.3485     0.0000     0.0000     0.0000     0.0000    13.6196    88.0924   183.2366
Space heat from Heat pump = (98) x 0.50 x 1.00 x 1.15
307b          174.4890   103.6968    54.7204    11.6330     1.3485     0.0000     0.0000     0.0000     0.0000    13.6196    88.0924   183.2366
Space heating requirement
              348.9779   207.3936   109.4408    23.2660     2.6969     0.0000     0.0000     0.0000     0.0000    27.2393   176.1848   366.4732 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)                                              0.0000 (308)
Space heating fuel for secondary/supplementary system
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (309)

Water heating
Annual water heating requirement
              124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
Water heat from Boilers = (64) x 0.50 x 1.00 x 1.15
310a           71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heat from Heat pump = (64) x 0.50 x 1.00 x 1.15
310b           71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heating fuel
              142.9310   126.1783   134.9849   122.6329   121.2145   111.9313   113.1536   116.5904   116.5680   126.6223   130.3131   142.0291 (310)
Cooling System Energy Efficiency Ratio                                                                                               2.6000 (314)
Space coolin    0.0000     0.0000     0.0000     0.0000     0.0000    38.8525    47.2722    42.0480     0.0000     0.0000     0.0000     0.0000 (315)
Pumps and Fa   24.0336    21.7078    24.0336    23.2584    24.0336    23.2584    24.0336    24.0336    23.2584    24.0336    23.2584    24.0336 (331)
Lighting       26.7589    21.4670    19.3286    14.1610    10.9383     8.9367     9.9783    12.9702    16.8470    22.1042    24.9666    27.5026 (332)
Electricity generated by PVs (Appendix M) (negative quantity)
(333a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                            1261.6724 (307)
Space heating fuel - secondary                                                                                                       0.0000 (309)
Water heating fuel - community heating                                                                                            1505.1494 (310)
Efficiency of water heater                                                                                                           0.0000 (311)
Electricity used for heat distribution                                                                                              12.6167 (313)
Space cooling fuel                                                                                                                 128.1727 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)
   mechanical ventilation fans (SFP =       0.6820)                                                                                282.9768 (330a)
Total electricity for the above, kWh/year                                                                                          282.9768 (331)
Electricity for lighting (calculated in Appendix L)                                                                                215.9594 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                        0.0000 (333)
Wind generation                                                                                                                      0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                               0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                                       0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                           -0.0000 (336)
Energy used                                                                                                                          0.0000 (337)
Total delivered energy for all uses                                                                                               4232.0411 (338)



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10b. Fuel costs - using Table 12 prices
-----------------------------------------------------------------------------------------------------
                                                                                                      Fuel           Fuel price           Fuel cost
```

	kWh/year	p/kWh	£/year	
Space heating from Boilers	630.8362	4.4400	28.0091	(340a)
Space heating from Heat pump	630.8362	4.4400	28.0091	(340b)
Space heating total			56.0183	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Boilers	752.5747	4.4400	33.4143	(342a)
Water heating from Heat pump	752.5747	4.4400	33.4143	(342b)
Water heating total			66.8286	(342)
Energy for instantaneous electric shower(s)	838.1104	16.4900	138.2044	(347a)
Space cooling	128.1727	16.4900	21.1357	(348)
Pumps, fans and electric keep-hot	282.9768	16.4900	46.6629	(349)
Energy for lighting	215.9594	16.4900	35.6117	(350)
Additional standing charges			92.0000	(351)
Total energy cost			456.4615	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600	(356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.0467	(357)
SAP value		83.0336	
SAP rating (Section 12)		83	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			100.0000	(367)
Space and Water heating from Boilers	1383.4109	0.1589	100.2687	(367)
Efficiency of heat source Heat pump			310.0000	(367)
Space and Water heating from Heat pump	446.2616	0.1589	32.3447	(368)
Electrical energy for heat distribution (space & water)	12.6167	0.0000	4.1153	(372)
Overall CO2 factor for heat network			0.0998	(386)
Total CO2 associated with community systems			276.2582	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			276.2582	(376)
Space cooling	128.1727	0.1141	14.6189	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			477.8987	(383)
CO2 emissions per m2			4.2700	(384)
EI value			95.9211	(384a)
EI rating			96	(385)
EI band			A	

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (5)

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2. Ventilation rate

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

			Air changes per hour
Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test			Yes
Pressure Test Method			Blower Door
Measured/design AP50			3.0000 (17)
Infiltration rate			0.1500 (18)
Number of sides sheltered			0 (19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	1.0000 (20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.1500 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.2000	4.0000	4.0000	3.7000	3.7000	3.3000	3.4000	3.2000	3.3000	3.5000	3.5000	3.8000	(22)
Wind factor	1.0500	1.0000	1.0000	0.9250	0.9250	0.8250	0.8500	0.8000	0.8250	0.8750	0.8750	0.9500	(22a)
Adj infilt rate	0.1575	0.1500	0.1500	0.1388	0.1388	0.1237	0.1275	0.1200	0.1237	0.1313	0.1313	0.1425	(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) =	84.6000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2345	0.2270	0.2270	0.2157	0.2157	0.2007	0.2045	0.1970	0.2007	0.2082	0.2082	0.2195	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)		5.4628 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	50.1974 (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	26.3186	25.4769	25.4769	24.2143	24.2143	22.5308	22.9516	22.1099	22.5308	23.3725	23.3725	24.6351	(38)
Heat transfer coeff	76.5160	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325	(39)
Average = Sum(39)m / 12 =												74.1311	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6832	0.6757	0.6757	0.6644	0.6644	0.6494	0.6531	0.6456	0.6494	0.6569	0.6569	0.6681	(40)
HLP (average)												0.6619	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)										Total = Sum(45)m =		657.9858	
Distribution loss (46)m = 0.15 x (45)m	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)

Water storage loss:

Store volume	110.0000 (47)
b) If manufacturer declared loss factor is not known :	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.0152 (51)
Volume factor from Table 2a	1.0294 (52)
Temperature factor from Table 2b	0.6000 (53)
Enter (49) or (54) in (55)	1.0327 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Total heat required for water heating calculated for each month

```
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (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
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
                                                                                                   Total per year (kWh/year) = Sum(64)m =   1308.8255 (64)
Electric shower(s)
                73.6804    65.6499    71.6871    68.4101    69.6938    66.4812    68.6972    69.6938    68.4101    71.6871    70.3391    73.6804 (64a)
                                                           Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    838.1104 (64a)
Heat gains from water heating, kWh/month
                85.5877    76.2355    82.7919    77.5677    78.3122    73.9913    75.7323    76.9752    75.8142    80.3740    80.2706    85.3269 (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          169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                30.5713    27.1531    22.0824    16.7178    12.4968    10.5503    11.4000    14.8181    19.8888    25.2534    29.4745    31.4210 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               409.5503   413.8002   403.0907   380.2914   351.5115   324.4624   306.3920   302.1421   312.8516   335.6509   364.4308   391.4799 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842 (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)
              -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
               115.0372   113.4457   111.2795   107.7330   105.2583   102.7657   101.7908   103.4613   105.2975   108.0296   111.4869   114.6868 (72)
Total internal gains
               666.4693   665.7095   647.7630   616.0527   580.5770   549.0889   530.8932   531.7320   549.3484   580.2443   616.7026   648.8980 (73)



-----------------------------------------------------------------------------------------------------
6. Solar gains
-----------------------------------------------------------------------------------------------------
[Jan]                                        Area        Solar flux                g               FF             Access            Gains
                                               m2          Table 6a    Specific data    Specific data             factor                W
                                                               W/m2      or Table 6b      or Table 6c           Table 6d
-----------------------------------------------------------------------------------------------------
North                                      8.5700           11.9814           0.4000           0.8000             0.7700          22.7705 (74)
South                                     15.2800           50.9848           0.4000           0.8000             0.7700         172.7617 (78)
North                                      2.1300           30.0000           0.4000           0.7000             1.0000          16.1028 (82)
-----------------------------------------------------------------------------------------------------

Solar gains    211.6350   323.4846   438.5844   568.4742   631.7399   677.5182   643.4626   593.4386   517.1329   381.7370   259.4024   179.6047 (83)
Total gains    878.1043   989.1941  1086.3474  1184.5269  1212.3169  1226.6071  1174.3557  1125.1706  1066.4813   961.9814   876.1050   828.5027 (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            101.6490   102.7797   102.7797   104.5236   104.5236   106.9431   106.3278   107.5656   106.9431   105.7195   105.7195   103.9358
alpha            7.7766     7.8520     7.8520     7.9682     7.9682     8.1295     8.0885     8.1710     8.1295     8.0480     8.0480     7.9291
util living area
                 0.9766     0.9455     0.8616     0.6849     0.4902     0.2965     0.1931     0.2056     0.3954     0.7039     0.9243     0.9821 (86)

MIT             20.6244    20.7589    20.9024    20.9845    20.9989    21.0000    21.0000    21.0000    20.9999    20.9849    20.8458    20.6053 (87)
Th 2            20.3557    20.3624    20.3624    20.3724    20.3724    20.3858    20.3824    20.3891    20.3858    20.3791    20.3791    20.3691 (88)
util rest of house
                 0.9705     0.9332     0.8369     0.6497     0.4521     0.2600     0.1546     0.1664     0.3536     0.6622     0.9059     0.9772 (89)
MIT 2           19.9328    20.1015    20.2659    20.3593    20.3717    20.3858    20.3824    20.3891    20.3857    20.3672    20.2211    19.9207 (90)
Living area fraction                                                                                   fLA = Living area / (4) =      0.1696 (91)
MIT             20.0501    20.2130    20.3739    20.4654    20.4781    20.4900    20.4872    20.4928    20.4899    20.4720    20.3271    20.0369 (92)
Temperature adjustment                                                                                                                 0.0000
adjusted MIT    20.0501    20.2130    20.3739    20.4654    20.4781    20.4900    20.4872    20.4928    20.4899    20.4720    20.3271    20.0369 (93)



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

                    Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9670     0.9299     0.8373     0.6550     0.4585     0.2662     0.1612     0.1730     0.3607     0.6686     0.9042     0.9741 (94)
Useful gains   849.1664   919.8603   909.6463   775.8392   555.8471   326.5423   189.2509   194.7062   384.6626   643.1713   792.1827   807.0712 (95)
Ext temp.        5.1000     5.6000     7.4000     9.9000    13.0000    16.0000    17.9000    17.8000    15.2000    11.6000     8.0000     5.1000 (96)
Heat loss rate W
              1143.9218  1105.8306   981.7877   786.1877   556.4556   326.5474   189.2509   194.7063   384.7244   652.7086   906.9047  1117.7639 (97)
Space heating kWh
               219.2980   124.9721    53.6732     7.4509     0.4527     0.0000     0.0000     0.0000     0.0000     7.0958    82.5999   231.1554 (98a)
Space heating requirement - total per year (kWh/year)                                                                                726.6980
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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 726.6980

Space heating per m2 (98c) / (4) = 6.4884 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	581.8253	446.2091	448.3052	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9993	0.9999	0.9998	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	581.4113	446.1459	448.2205	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1321.3284	1264.5960	1209.6840	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	532.7403	608.9269	566.5288	0.0000	0.0000	0.0000	0.0000	(104)

Cooled fraction fC = cooled area / (4) = 0.9821 (105)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	130.8068	149.5133	139.1031	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling requirement 419.4231 (107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Boilers-Space and Water	0.5000	(303a)
Fraction of heat from community Heat pump-Space and Water	0.5000	(303b)
Factor for control and charging method (Table 4c(3)) for space heating	1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system	1.1500	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98)
Space heat from Boilers = (98) x 0.50 x 1.00 x 1.15													
307a	126.0964	71.8589	30.8621	4.2843	0.2603	0.0000	0.0000	0.0000	0.0000	4.0801	47.4949	132.9143	
Space heat from Heat pump = (98) x 0.50 x 1.00 x 1.15													
307b	126.0964	71.8589	30.8621	4.2843	0.2603	0.0000	0.0000	0.0000	0.0000	4.0801	47.4949	132.9143	
Space heating requirement	252.1927	143.7179	61.7242	8.5685	0.5207	0.0000	0.0000	0.0000	0.0000	8.1601	94.9899	265.8287	(307)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Annual water heating requirement	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Water heat from Boilers = (64) x 0.50 x 1.00 x 1.15													
310a	71.4655	63.0892	67.4924	61.3164	60.6072	55.9657	56.5768	58.2952	58.2840	63.3111	65.1566	71.0146	
Water heat from Heat pump = (64) x 0.50 x 1.00 x 1.15													
310b	71.4655	63.0892	67.4924	61.3164	60.6072	55.9657	56.5768	58.2952	58.2840	63.3111	65.1566	71.0146	
Water heating fuel	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)

Cooling System Energy Efficiency Ratio 2.6000 (314)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	50.3103	57.5051	53.5012	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	24.0336	21.7078	24.0336	23.2584	24.0336	23.2584	24.0336	24.0336	23.2584	24.0336	23.2584	24.0336	(331)
Lighting	26.7589	21.4670	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)

Annual totals kWh/year

Space heating fuel - community heating	835.7027	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	1505.1494	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	8.3570	(313)
Space cooling fuel	161.3166	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)

mechanical ventilation fans (SFP = 0.6820)	282.9768	(330a)
Total electricity for the above, kWh/year	282.9768	(331)
Electricity for lighting (calculated in Appendix L)	215.9594	(332)

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

PV generation	0.0000	(333)
Wind generation	0.0000	(334)

Hydro-electric generation (Appendix N)			0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)			0.0000 (335)
Appendix Q - special features			
Energy saved or generated			-0.0000 (336)
Energy used			0.0000 (337)
Total delivered energy for all uses			3839.2152 (338)

10b. Fuel costs - using BEDF prices (511)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating from Boilers	417.8514	3.5000	14.6248 (340a)
Space heating from Heat pump	417.8514	3.5000	14.6248 (340b)
Space heating total			29.2496 (340)
Total CO2 associated with community systems			0.0000 (473)
Space heating - secondary	0.0000	0.0000	0.0000 (341)
Water heating from Boilers	752.5747	3.5000	26.3401 (342a)
Water heating from Heat pump	752.5747	3.5000	26.3401 (342b)
Water heating total			52.6802 (342)
Energy for instantaneous electric shower(s)	838.1104	18.3900	154.1285 (347a)
Space cooling	161.3166	18.3900	29.6661 (348)
Pumps, fans and electric keep-hot	282.9768	18.3900	52.0394 (349)
Energy for lighting	215.9594	18.3900	39.7149 (350)
Additional standing charges			94.0000 (351)
Total energy cost			451.4788 (355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Boilers			100.0000 (367)
Space and Water heating from Boilers	1170.4260	0.1599	66.8117 (367)
Efficiency of heat source Heat pump			310.0000 (367)
Space and Water heating from Heat pump	377.5568	0.1599	21.5522 (368)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	3.4462 (372)
Overall CO2 factor for heat network			0.0988 (386)
Total CO2 associated with community systems			231.3395 (373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997 (264a)
Space and water heating			231.3395 (376)
Space cooling	161.3166	0.1141	18.4124 (377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524 (378)
Energy for lighting	215.9594	0.1443	31.1696 (379)
Total CO2, kg/year			436.7736 (383)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Efficiency of heat source Boilers			100.0000 (467a)
Space and Water heating from Boilers	1170.4260	1.5918	665.1396 (467)
Efficiency of heat source Heat pump			310.0000 (467b)
Space and Water heating from Heat pump	377.5568	1.5918	214.5612 (468)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	36.1556 (472)
Overall CO2 factor for heat network			1.0368 (486)
Total CO2 associated with community systems			2427.0895 (473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792 (278a)
Space and water heating			2427.0895 (476)
Space cooling	161.3166	1.4207	229.1765 (477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873 (478)
Energy for lighting	215.9594	1.5338	331.2457 (479)
Total Primary energy kWh/year			4684.7782 (483)

SAP 10 EPC IMPROVEMENTS

A-GF-02 BeGreen

Current energy efficiency rating: B 83
Current environmental impact rating: A 96

N Solar water heating	Not applicable
U Solar photovoltaic panels	Not applicable
V2 Wind turbine	Not applicable

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

Energy Environmental

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

Potential energy efficiency rating:                                   B 83
Potential environmental impact rating:                                        A 96

Fuel prices for cost data on this page from database revision number 511 TEST (31 Jan 2023)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, Thames Valley):
                                Current        Potential      Saving
  Electricity                    £276          £276        £0
  Community scheme               £176          £176        £0

  Space heating                  £175          £175        £0
  Space cooling                  £30           £30         £0
  Water heating                  £207          £207        £0
  Lighting                       £40           £40         £0

  Total cost of fuels           £452           £452          £0
  Total cost of uses            £452           £452          £0
  Delivered energy              34 kWh/m²      34 kWh/m²     0 kWh/m²
  Carbon dioxide emissions      0.4 tonnes     0.4 tonnes    0.0 tonnes
  CO2 emissions per m²          4 kg/m²        4 kg/m²       0 kg/m²
  Primary energy                42 kWh/m²      42 kWh/m²     0 kWh/m²
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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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		3.0000 (17)
Infiltration rate		0.1500 (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) =	0.1500 (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	0.1912	0.1875	0.1837	0.1650	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1687	0.1762	(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) =	84.6000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2682	0.2645	0.2607	0.2420	0.2382	0.2195	0.2195	0.2157	0.2270	0.2382	0.2457	0.2532	(25)

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3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                            Gross        Openings         NetArea        U-value          A x U        K-value           A x K
                                                      m2              m2              m2          W/m2K            W/K         kJ/m2K            kJ/K
Front Door                                                                        2.0000         1.0000         2.0000                              (26)
Window (Uw = 1.20)                                                               23.8500         1.1450        27.3092                              (27)
Opening                                                                           2.1300         1.1450         2.4389                              (27a)
Floor to unheated                                                                61.0000         0.1000         6.1000                              (28a)
External Wall LGF                                31.6000         15.4100         16.1900         0.1500         2.4285                              (29a)
External Wall UGF                                36.8000         10.4400         26.3600         0.1500         3.9540                              (29a)
LGF Roof                                          7.1700          2.1300          5.0400         0.1000         0.5040                              (30)
Total net area of external elements Aum(A, m2)                                  136.5700                                                            (31)
Fabric heat loss, W/K = Sum (A x U)                                   (26)...(30) + (32) =     44.7346                                            (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                          250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)                                                                              5.4628 (36)
Point Thermal bridges                                                                                                          (36a) =       0.0000
Total fabric heat loss                                                                                          (33) + (36) + (36a) =       50.1974 (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        30.1065    29.6856    29.2648    27.1604    26.7395    24.6351    24.6351    24.2143    25.4769    26.7395    27.5813    28.4230 (38)
Heat transfer coeff
             80.3039    79.8830    79.4621    77.3578    76.9369    74.8325    74.8325    74.4117    75.6743    76.9369    77.7787    78.6204 (39)
Average = Sum(39)m / 12 =                                                                                                               77.2526

                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP           0.7170     0.7132     0.7095     0.6907     0.6869     0.6681     0.6681     0.6644     0.6757     0.6869     0.6945     0.7020 (40)
HLP (average)                                                                                                                            0.6898
Days in mont      31         28         31         30         31         30         31         31         30         31         30         31


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4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                        2.8263 (42)
Hot water usage for mixer showers
              0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
              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
             43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (42c)
Average daily hot water use (litres/day)                                                                                                39.6130 (43)

                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
             43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (44)
Energy conte 69.0110    59.7928    62.1013    53.1436    50.1271    43.8379    43.1176    46.1062    47.8698    54.8295    59.8221    68.2268 (45)
Energy content (annual)                                                                                          Total = Sum(45)m =    657.9858
Distribution loss  (46)m = 0.15 x (45)m
             10.3516     8.9689     9.3152     7.9715     7.5191     6.5757     6.4676     6.9159     7.1805     8.2244     8.9733    10.2340 (46)
Water storage loss:
Store volume                                                                                                                           110.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                             0.0152 (51)
  Volume factor from Table 2a                                                                                                            1.0294 (52)
  Temperature factor from Table 2b                                                                                                       0.6000 (53)
Enter (49) or (54) in (55)                                                                                                               1.0327 (55)
Total storage loss
             32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (56)
If cylinder contains dedicated solar storage
             32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (57)
Primary loss 23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
            124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (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
            124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
                                                                                   Total per year (kWh/year) = Sum(64)m =     1308.8255 (64)
Electric shower(s)
             73.6804    65.6499    71.6871    68.4101    69.6938    66.4812    68.6972    69.6938    68.4101    71.6871    70.3391    73.6804 (64a)
                                                   Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    838.1104 (64a)
Heat gains from water heating, kWh/month
             85.5877    76.2355    82.7919    77.5677    78.3122    73.9913    75.7323    76.9752    75.8142    80.3740    80.2706    85.3269 (65)


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5. Internal gains (see Table 5 and 5a)
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Metabolic gains (Table 5), Watts
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m       169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
             30.5713    27.1531    22.0824    16.7178    12.4968    10.5503    11.4000    14.8181    19.8888    25.2534    29.4745    31.4210 (67)
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	409.5503	413.8002	403.0907	380.2914	351.5115	324.4624	306.3920	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	(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)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)	115.0372	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
Total internal gains	666.4693	665.7095	647.7630	616.0527	580.5770	549.0889	530.8932	531.7320	549.3484	580.2443	616.7026	648.8980	(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	8.5700	10.6334	0.4000	0.8000	0.7700	20.2086	(74)
South	15.2800	46.7521	0.4000	0.8000	0.7700	158.4190	(78)
North	2.1300	26.0000	0.4000	0.7000	1.0000	13.9558	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	192.5834	327.0542	447.6459	559.4518	634.2937	633.9533	609.3668	552.3024	485.8676	361.2385	230.4236	165.0075	(83)
Total gains	859.0526	992.7637	1095.4089	1175.5045	1214.8707	1183.0422	1140.2600	1084.0343	1035.2160	941.4828	847.1262	813.9055	(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	96.8543	97.3646	97.8803	100.5429	101.0929	103.9358	103.9358	104.5236	102.7797	101.0929	99.9989	98.9282	
alpha	7.4570	7.4910	7.5254	7.7029	7.7395	7.9291	7.9291	7.9682	7.8520	7.7395	7.6666	7.5952	
util living area	0.9867	0.9631	0.9038	0.7637	0.5849	0.4046	0.2888	0.3157	0.5032	0.8021	0.9621	0.9901	(86)
MIT	20.4873	20.6569	20.8312	20.9601	20.9948	20.9998	21.0000	21.0000	20.9987	20.9530	20.7222	20.4633	(87)
Th 2	20.3258	20.3292	20.3325	20.3491	20.3524	20.3691	20.3691	20.3724	20.3624	20.3524	20.3457	20.3391	(88)
util rest of house	0.9831	0.9542	0.8842	0.7305	0.5456	0.3648	0.2474	0.2727	0.4572	0.7646	0.9514	0.9874	(89)
MIT 2	19.7360	19.9486	20.1581	20.3129	20.3485	20.3689	20.3690	20.3724	20.3616	20.3115	20.0454	19.7170	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	19.8635	20.0688	20.2723	20.4227	20.4582	20.4759	20.4761	20.4789	20.4697	20.4203	20.1602	19.8436	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8635	20.0688	20.2723	20.4227	20.4582	20.4759	20.4761	20.4789	20.4697	20.4203	20.1602	19.8436	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9801	0.9502	0.8823	0.7344	0.5521	0.3716	0.2544	0.2800	0.4650	0.7687	0.9479	0.9849	(94)
Useful gains	841.9312	943.3598	966.4632	863.2718	670.6746	439.6041	290.0530	303.5055	481.3854	723.7079	803.0237	801.5840	(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	1249.8062	1211.7262	1094.3744	891.3708	673.8266	439.7120	290.0572	303.5141	482.0234	755.5443	1015.8073	1229.9070	(97)
Space heating kWh	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98a)
Space heating requirement - total per year (kWh/year)												1097.1065	
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	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1097.1065	
Space heating per m2										(98c) / (4) =		9.7956	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	703.4258	553.7608	565.5286	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9959	0.9990	0.9984	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	700.5422	553.2038	564.5982	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1271.9489	1226.0126	1163.0526	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	411.4128	500.5697	445.2500	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9821	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)

Space cooling kWh

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                0.0000    0.0000    0.0000    0.0000    0.0000  101.0165  122.9077  109.3248    0.0000    0.0000    0.0000    0.0000 (107)
Space cooling requirement                                                                                                  333.2491 (107)


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9b. Energy requirements
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Fraction of space heat from secondary/supplementary system (Table 11)                                                       0.0000 (301)
Fraction of space heat from community system                                                                                1.0000 (302)
Fraction of heat from community Boilers-Space and Water                                                                     0.5000 (303a)
Fraction of heat from community Heat pump-Space and Water                                                                   0.5000 (303b)
Factor for control and charging method (Table 4c(3)) for space heating                                                      1.0000 (305)
Factor for charging method (Table 4c(3)) for water heating                                                                  1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system                                                           1.1500 (306)
Efficiency of secondary/supplementary heating system, %                                                                     0.0000 (208)
Space heating:
Space heating requirement
              303.4591  180.3422   95.1659   20.2313    2.3451    0.0000    0.0000    0.0000    0.0000   23.6863  153.2042  318.6723 (98)
Space heat from Boilers = (98) x 0.50 x 1.00 x 1.15
307a          174.4890  103.6968   54.7204   11.6330    1.3485    0.0000    0.0000    0.0000    0.0000   13.6196   88.0924  183.2366
Space heat from Heat pump = (98) x 0.50 x 1.00 x 1.15
307b          174.4890  103.6968   54.7204   11.6330    1.3485    0.0000    0.0000    0.0000    0.0000   13.6196   88.0924  183.2366
Space heating requirement
              348.9779  207.3936  109.4408   23.2660    2.6969    0.0000    0.0000    0.0000    0.0000   27.2393  176.1848  366.4732 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)                                     0.0000 (308)
Space heating fuel for secondary/supplementary system
                0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (309)

Water heating
Annual water heating requirement
              124.2878  109.7203  117.3781  106.6373  105.4039   97.3316   98.3944  101.3830  101.3635  110.1063  113.3158  123.5036 (64)
Water heat from Boilers = (64) x 0.50 x 1.00 x 1.15
310a           71.4655   63.0892   67.4924   61.3164   60.6072   55.9657   56.5768   58.2952   58.2840   63.3111   65.1566   71.0146
Water heat from Heat pump = (64) x 0.50 x 1.00 x 1.15
310b           71.4655   63.0892   67.4924   61.3164   60.6072   55.9657   56.5768   58.2952   58.2840   63.3111   65.1566   71.0146
Water heating fuel
              142.9310  126.1783  134.9849  122.6329  121.2145  111.9313  113.1536  116.5904  116.5680  126.6223  130.3131  142.0291 (310)
Cooling System Energy Efficiency Ratio                                                                                      2.6000 (314)
Space coolin    0.0000    0.0000    0.0000    0.0000    0.0000   38.8525   47.2722   42.0480    0.0000    0.0000    0.0000    0.0000 (315)
Pumps and Fa   24.0336   21.7078   24.0336   23.2584   24.0336   23.2584   24.0336   24.0336   23.2584   24.0336   23.2584   24.0336 (331)
Lighting       26.7589   21.4670   19.3286   14.1610   10.9383    8.9367    9.9783   12.9702   16.8470   22.1042   24.9666   27.5026 (332)
Electricity generated by PVs (Appendix M) (negative quantity)
(333a)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334a)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)m         0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                   1261.6724 (307)
Space heating fuel - secondary                                                                                              0.0000 (309)
Water heating fuel - community heating                                                                                   1505.1494 (310)
Efficiency of water heater                                                                                                  0.0000 (311)
Electricity used for heat distribution                                                                                     12.6167 (313)
Space cooling fuel                                                                                                        128.1727 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)
   mechanical ventilation fans (SFP =       0.6820)                                                                       282.9768 (330a)
Total electricity for the above, kWh/year                                                                                 282.9768 (331)
Electricity for lighting (calculated in Appendix L)                                                                       215.9594 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                               0.0000 (333)
Wind generation                                                                                                             0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                      0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                              0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                  -0.0000 (336)
Energy used                                                                                                                 0.0000 (337)
Total delivered energy for all uses                                                                                      4232.0411 (338)


---------------------------------------------------------------------------------------------
10b. Fuel costs - using Table 12 prices
---------------------------------------------------------------------------------------------
                                                                                 Fuel         Fuel price         Fuel cost
                                                                             kWh/year              p/kWh            £/year
Space heating from Boilers                                                   630.8362             4.4400           28.0091 (340a)
Space heating from Heat pump                                                 630.8362             4.4400           28.0091 (340b)
Space heating total                                                                                                56.0183 (340)
Total CO2 associated with community systems                                                                         0.0000 (473)
Space heating - secondary                                                      0.0000             0.0000            0.0000 (341)
Water heating from Boilers                                                   752.5747             4.4400           33.4143 (342a)
Water heating from Heat pump                                                 752.5747             4.4400           33.4143 (342b)
Water heating total                                                                                                66.8286 (342)
Energy for instantaneous electric shower(s)                                  838.1104            16.4900          138.2044 (347a)
Space cooling                                                                128.1727            16.4900           21.1357 (348)
```

Pumps, fans and electric keep-hot	282.9768	16.4900	46.6629 (349)
Energy for lighting	215.9594	16.4900	35.6117 (350)
Additional standing charges			92.0000 (351)
Total energy cost			456.4615 (355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600 (356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.0467 (357)
SAP value		83.0336
SAP rating (Section 12)		83 (358)
SAP band		B

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Boilers			100.0000 (367)
Space and Water heating from Boilers	1383.4109	0.1589	100.2687 (367)
Efficiency of heat source Heat pump			310.0000 (367)
Space and Water heating from Heat pump	446.2616	0.1589	32.3447 (368)
Electrical energy for heat distribution (space & water)	12.6167	0.0000	4.1153 (372)
Overall CO2 factor for heat network			0.0998 (386)
Total CO2 associated with community systems			276.2582 (373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997 (264a)
Space and water heating			276.2582 (376)
Space cooling	128.1727	0.1141	14.6189 (377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524 (378)
Energy for lighting	215.9594	0.1443	31.1696 (379)
Total CO2, kg/year			477.8987 (383)
CO2 emissions per m2			4.2700 (384)
EI value			95.9211 (384a)
EI rating			96 (385)
EI band			A

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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		3.0000 (17)
Infiltration rate		0.1500 (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) =	0.1500 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.2000	4.0000	4.0000	3.7000	3.7000	3.3000	3.4000	3.2000	3.3000	3.5000	3.5000	3.8000	(22)
Wind factor	1.0500	1.0000	1.0000	0.9250	0.9250	0.8250	0.8500	0.8000	0.8250	0.8750	0.8750	0.9500	(22a)
Adj infilt rate	0.1575	0.1500	0.1500	0.1388	0.1388	0.1237	0.1275	0.1200	0.1237	0.1313	0.1313	0.1425	(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) = 84.6000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2345	0.2270	0.2270	0.2157	0.2157	0.2007	0.2045	0.1970	0.2007	0.2082	0.2082	0.2195	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		44.7346			(33)

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

Thermal bridges (User defined value 0.040 * total exposed area) 5.4628 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 50.1974 (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	26.3186	25.4769	25.4769	24.2143	24.2143	22.5308	22.9516	22.1099	22.5308	23.3725	23.3725	24.6351	(38)
Heat transfer coeff	76.5160	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325	(39)
Average = Sum(39)m / 12 =												74.1311	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6832	0.6757	0.6757	0.6644	0.6644	0.6494	0.6531	0.6456	0.6494	0.6569	0.6569	0.6681	(40)
HLP (average)												0.6619	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)											Total = Sum(45)m =	657.9858	
Distribution loss (46)m = 0.15 x (45)m	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)

Water storage loss:

Store volume 110.0000 (47)

b) If manufacturer declared loss factor is not known :

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.0152 (51)

Volume factor from Table 2a 1.0294 (52)

Temperature factor from Table 2b 0.6000 (53)

Enter (49) or (54) in (55) 1.0327 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(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	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Total per year (kWh/year) = Sum(64)m =												1308.8255	(64)
Electric shower(s)	73.6804	65.6499	71.6871	68.4101	69.6938	66.4812	68.6972	69.6938	68.4101	71.6871	70.3391	73.6804	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =												838.1104	(64a)

Heat gains from water heating, kWh/month

85.5877	76.2355	82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(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	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	30.5713	27.1531	22.0824	16.7178	12.4968	10.5503	11.4000	14.8181	19.8888	25.2534	29.4745	31.4210	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	409.5503	413.8002	403.0907	380.2914	351.5115	324.4624	306.3920	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	(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)													
	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)													
	115.0372	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
Total internal gains													
	666.4693	665.7095	647.7630	616.0527	580.5770	549.0889	530.8932	531.7320	549.3484	580.2443	616.7026	648.8980	(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	8.5700	11.9814	0.4000	0.8000	0.7700	22.7705	(74)
South	15.2800	50.9848	0.4000	0.8000	0.7700	172.7617	(78)
North	2.1300	30.0000	0.4000	0.7000	1.0000	16.1028	(82)

Solar gains	211.6350	323.4846	438.5844	568.4742	631.7399	677.5182	643.4626	593.4386	517.1329	381.7370	259.4024	179.6047	(83)
Total gains	878.1043	989.1941	1086.3474	1184.5269	1212.3169	1226.6071	1174.3557	1125.1706	1066.4813	961.9814	876.1050	828.5027	(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	101.6490	102.7797	102.7797	104.5236	104.5236	106.9431	106.3278	107.5656	106.9431	105.7195	105.7195	103.9358	
alpha	7.7766	7.8520	7.8520	7.9682	7.9682	8.1295	8.0885	8.1710	8.1295	8.0480	8.0480	7.9291	
util living area													
	0.9766	0.9455	0.8616	0.6849	0.4902	0.2965	0.1931	0.2056	0.3954	0.7039	0.9243	0.9821	(86)
MIT	20.6244	20.7589	20.9024	20.9845	20.9989	21.0000	21.0000	21.0000	20.9999	20.9849	20.8458	20.6053	(87)
Th 2	20.3557	20.3624	20.3624	20.3724	20.3724	20.3858	20.3824	20.3891	20.3858	20.3791	20.3791	20.3691	(88)
util rest of house													
	0.9705	0.9332	0.8369	0.6497	0.4521	0.2600	0.1546	0.1664	0.3536	0.6622	0.9059	0.9772	(89)
MIT 2	19.9328	20.1015	20.2659	20.3593	20.3717	20.3858	20.3824	20.3891	20.3857	20.3672	20.2211	19.9207	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9670	0.9299	0.8373	0.6550	0.4585	0.2662	0.1612	0.1730	0.3607	0.6686	0.9042	0.9741	(94)
Useful gains	849.1664	919.8603	909.6463	775.8392	555.8471	326.5423	189.2509	194.7062	384.6626	643.1713	792.1827	807.0712	(95)
Ext temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	(96)
Heat loss rate W													
	1143.9218	1105.8306	981.7877	786.1877	556.4556	326.5474	189.2509	194.7063	384.7244	652.7086	906.9047	1117.7639	(97)
Space heating kWh													
	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98a)
Space heating requirement - total per year (kWh/year)												726.6980	
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													
	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												726.6980	
Space heating per m2										(98c) / (4) =		6.4884	(99)

8c. Space cooling requirement

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

```
                Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.      5.1000     5.6000     7.4000     9.9000     13.0000    16.0000    17.9000    17.8000    15.2000    11.6000    8.0000     5.1000
Heat loss rate W
                0.0000     0.0000     0.0000     0.0000     0.0000     581.8253   446.2091   448.3052   0.0000     0.0000     0.0000     0.0000 (100)
Utilisation     0.0000     0.0000     0.0000     0.0000     0.0000     0.9993     0.9999     0.9998     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss     0.0000     0.0000     0.0000     0.0000     0.0000     581.4113   446.1459   448.2205   0.0000     0.0000     0.0000     0.0000 (102)
Total gains     0.0000     0.0000     0.0000     0.0000     0.0000    1321.3284  1264.5960  1209.6840   0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000     532.7403   608.9269   566.5288   0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                          fC = cooled area / (4) =        0.9821 (105)
Intermittency factor (Table 10b)
                0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500 (106)
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000     130.8068   149.5133   139.1031   0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                              419.4231 (107)



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9b. Energy requirements
-----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                                    0.0000 (301)
Fraction of space heat from community system                                                                                             1.0000 (302)
Fraction of heat from community Boilers-Space and Water                                                                                  0.5000 (303a)
Fraction of heat from community Heat pump-Space and Water                                                                                0.5000 (303b)
Factor for control and charging method (Table 4c(3)) for space heating                                                                   1.0000 (305)
Factor for charging method (Table 4c(3)) for water heating                                                                               1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system                                                                        1.1500 (306)
Efficiency of secondary/supplementary heating system, %                                                                                  0.0000 (208)
Space heating:
Space heating requirement
              219.2980   124.9721    53.6732     7.4509     0.4527     0.0000     0.0000     0.0000     0.0000     7.0958    82.5999   231.1554 (98)
Space heat from Boilers = (98) x 0.50 x 1.00 x 1.15
307a          126.0964    71.8589    30.8621     4.2843     0.2603     0.0000     0.0000     0.0000     0.0000     4.0801    47.4949   132.9143
Space heat from Heat pump = (98) x 0.50 x 1.00 x 1.15
307b          126.0964    71.8589    30.8621     4.2843     0.2603     0.0000     0.0000     0.0000     0.0000     4.0801    47.4949   132.9143
Space heating requirement
              252.1927   143.7179    61.7242     8.5685     0.5207     0.0000     0.0000     0.0000     0.0000     8.1601    94.9899   265.8287 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)                                                  0.0000 (308)
Space heating fuel for secondary/supplementary system
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (309)

Water heating
Annual water heating requirement
              124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
Water heat from Boilers = (64) x 0.50 x 1.00 x 1.15
310a           71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heat from Heat pump = (64) x 0.50 x 1.00 x 1.15
310b           71.4655    63.0892    67.4924    61.3164    60.6072    55.9657    56.5768    58.2952    58.2840    63.3111    65.1566    71.0146
Water heating fuel
              142.9310   126.1783   134.9849   122.6329   121.2145   111.9313   113.1536   116.5904   116.5680   126.6223   130.3131   142.0291 (310)
Cooling System Energy Efficiency Ratio                                                                                                   2.6000 (314)
Space coolin    0.0000     0.0000     0.0000     0.0000     0.0000    50.3103    57.5051    53.5012     0.0000     0.0000     0.0000     0.0000 (315)
Pumps and Fa   24.0336    21.7078    24.0336    23.2584    24.0336    23.2584    24.0336    24.0336    23.2584    24.0336    23.2584    24.0336 (331)
Lighting       26.7589    21.4670    19.3286    14.1610    10.9383     8.9367     9.9783    12.9702    16.8470    22.1042    24.9666    27.5026 (332)
Electricity generated by PVs (Appendix M) (negative quantity)
(333a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                                 835.7027 (307)
Space heating fuel - secondary                                                                                                           0.0000 (309)
Water heating fuel - community heating                                                                                                1505.1494 (310)
Efficiency of water heater                                                                                                               0.0000 (311)
Electricity used for heat distribution                                                                                                   8.3570 (313)
Space cooling fuel                                                                                                                     161.3166 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)
   mechanical ventilation fans (SFP =        0.6820)                                                                                   282.9768 (330a)
Total electricity for the above, kWh/year                                                                                              282.9768 (331)
Electricity for lighting (calculated in Appendix L)                                                                                    215.9594 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                            0.0000 (333)
Wind generation                                                                                                                          0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                                   0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                                           0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                               -0.0000 (336)
Energy used                                                                                                                              0.0000 (337)
Total delivered energy for all uses                                                                                                   3839.2152 (338)



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10b. Fuel costs - using BEDF prices (511)
```

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Boilers	417.8514	3.5000	14.6248	(340a)
Space heating from Heat pump	417.8514	3.5000	14.6248	(340b)
Space heating total			29.2496	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Boilers	752.5747	3.5000	26.3401	(342a)
Water heating from Heat pump	752.5747	3.5000	26.3401	(342b)
Water heating total			52.6802	(342)
Energy for instantaneous electric shower(s)	838.1104	18.3900	154.1285	(347a)
Space cooling	161.3166	18.3900	29.6661	(348)
Pumps, fans and electric keep-hot	282.9768	18.3900	52.0394	(349)
Energy for lighting	215.9594	18.3900	39.7149	(350)
Additional standing charges			94.0000	(351)
Total energy cost			451.4788	(355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			100.0000	(367)
Space and Water heating from Boilers	1170.4260	0.1599	66.8117	(367)
Efficiency of heat source Heat pump			310.0000	(367)
Space and Water heating from Heat pump	377.5568	0.1599	21.5522	(368)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	3.4462	(372)
Overall CO2 factor for heat network			0.0988	(386)
Total CO2 associated with community systems			231.3395	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			231.3395	(376)
Space cooling	161.3166	0.1141	18.4124	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			436.7736	(383)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Boilers			100.0000	(467a)
Space and Water heating from Boilers	1170.4260	1.5918	665.1396	(467)
Efficiency of heat source Heat pump			310.0000	(467b)
Space and Water heating from Heat pump	377.5568	1.5918	214.5612	(468)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	36.1556	(472)
Overall CO2 factor for heat network			1.0368	(486)
Total CO2 associated with community systems			2427.0895	(473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792	(278a)
Space and water heating			2427.0895	(476)
Space cooling	161.3166	1.4207	229.1765	(477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873	(478)
Energy for lighting	215.9594	1.5338	331.2457	(479)
Total Primary energy kWh/year			4684.7782	(483)

Full SAP Calculation Printout

Property Reference	A-GF-02_Copy	Issued on Date	20/02/2023
Assessment Reference	A-GF-02 BeLean_Copy	Prop Type Ref	01
Property			

SAP Rating	83 B	DER	8.04	TER	10.63
Environmental	93 A	% DER < TER			24.37
CO_2 Emissions (t/year)	0.76	DFEE	31.00	TFEE	34.81
Compliance Check	See BREL	% DFEE < TFEE			10.92
% DPER < TPER	4.78	DPER	53.52	TPER	56.21

Assessor Details	Mr. Andrew Jones	Assessor ID	N955-0001
Client			

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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE
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1. Overall dwelling characteristics
-----------------------------------------------------------------------------------------------------
                                                                       Area         Storey height              Volume
                                                                       (m2)              (m)                    (m3)
Ground floor                                                       61.0000 (1b)    x     2.9000 (2b)    =    176.9000 (1b) -
First floor                                                        51.0000 (1c)    x     3.2000 (2c)    =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             112.0000                                              (4)
Dwelling volume                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (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                                                                                         3.0000 (17)
Infiltration rate                                                                                            0.1500 (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)  =      0.1500 (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
                 0.1912     0.1875     0.1837     0.1650     0.1612     0.1425     0.1425     0.1388     0.1500     0.1612     0.1687     0.1762 (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) =                84.6000 (23c)

Effective ac     0.2682     0.2645     0.2607     0.2420     0.2382     0.2195     0.2195     0.2157     0.2270     0.2382     0.2457     0.2532 (25)

-----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                        Gross       Openings        NetArea       U-value         A x U      K-value         A x K
                                                  m2             m2             m2         W/m2K           W/K       kJ/m2K          kJ/K
Front Door                                                                  2.0000        1.0000        2.0000                            (26)
Window (Uw = 1.20)                                                         23.8500        1.1450       27.3092                            (27)
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Opening                                                             2.1300        1.1450        2.4389                               (27a)
Floor to unheated                                                  61.0000        0.1000        6.1000                               (28a)
External Wall LGF                              31.6000      15.4100      16.1900        0.1500        2.4285                               (29a)
External Wall UGF                              36.8000      10.4400      26.3600        0.1500        3.9540                               (29a)
LGF Roof                                        7.1700       2.1300       5.0400        0.1000        0.5040                               (30)
Total net area of external elements Aum(A, m2)                    136.5700                                                              (31)
Fabric heat loss, W/K = Sum (A x U)                                     (26)...(30) + (32) =    44.7346                               (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                          250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)                                                              5.4628 (36)
Point Thermal bridges                                                                                       (36a) =       0.0000
Total fabric heat loss                                                                          (33) + (36) + (36a) =    50.1974 (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          30.1065    29.6856    29.2648    27.1604    26.7395    24.6351    24.6351    24.2143    25.4769    26.7395    27.5813    28.4230 (38)
Heat transfer coeff
               80.3039    79.8830    79.4621    77.3578    76.9369    74.8325    74.8325    74.4117    75.6743    76.9369    77.7787    78.6204 (39)
Average = Sum(39)m / 12 =                                                                                                   77.2526

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP             0.7170     0.7132     0.7095     0.6907     0.6869     0.6681     0.6681     0.6644     0.6757     0.6869     0.6945     0.7020 (40)
HLP (average)                                                                                                                0.6898
Days in mont        31         28         31         30         31         30         31         31         30         31         30         31



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4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                            2.8263 (42)
Hot water usage for mixer showers
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
                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
               43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (42c)
Average daily hot water use (litres/day)                                                                                    39.6130 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
               43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (44)
Energy conte   69.0110    59.7928    62.1013    53.1436    50.1271    43.8379    43.1176    46.1062    47.8698    54.8295    59.8221    68.2268 (45)
Energy content (annual)                                                                                  Total = Sum(45)m =    657.9858
Distribution loss  (46)m = 0.15 x (45)m
               10.3516     8.9689     9.3152     7.9715     7.5191     6.5757     6.4676     6.9159     7.1805     8.2244     8.9733    10.2340 (46)
Water storage loss:
Store volume                                                                                                               110.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                 0.0152 (51)
  Volume factor from Table 2a                                                                                                1.0294 (52)
  Temperature factor from Table 2b                                                                                           0.6000 (53)
Enter (49) or (54) in (55)                                                                                                   1.0327 (55)
Total storage loss
               32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (56)
If cylinder contains dedicated solar storage
               32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (57)
Primary loss   23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
              124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (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
              124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
                                                                                    Total per year (kWh/year) = Sum(64)m =   1308.8255 (64)
12Total per year (kWh/year)                                                                                                     1309 (64)
Electric shower(s)
               73.6804    65.6499    71.6871    68.4101    69.6938    66.4812    68.6972    69.6938    68.4101    71.6871    70.3391    73.6804 (64a)
                                                  Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    838.1104 (64a)
Heat gains from water heating, kWh/month
               85.5877    76.2355    82.7919    77.5677    78.3122    73.9913    75.7323    76.9752    75.8142    80.3740    80.2706    85.3269 (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         141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              138.4026   153.2315   138.4026   143.0161   138.4026   143.0161   138.4026   138.4026   143.0161   138.4026   143.0161   138.4026 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              274.3987   277.2461   270.0707   254.7953   235.5127   217.3898   205.2826   202.4352   209.6106   224.8861   244.1686   262.2915 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316 (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)
             -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
              115.0372   113.4457   111.2795   107.7330   105.2583   102.7657   101.7908   103.4613   105.2975   108.0296   111.4869   114.6868 (72)
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total internal gains	593.2333	609.3180	585.1475	570.9390	544.5683	528.5663	510.8707	509.6939	523.3188	536.7130	564.0663	580.7756	(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	8.5700	10.6334	0.4000	0.8000	0.7700	20.2086	(74)
South	15.2800	46.7521	0.4000	0.8000	0.7700	158.4190	(78)
North	2.1300	26.0000	0.4000	0.7000	1.0000	13.9558	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	192.5834	327.0542	447.6459	559.4518	634.2937	633.9533	609.3668	552.3024	485.8676	361.2385	230.4236	165.0075	(83)
Total gains	785.8166	936.3723	1032.7934	1130.3908	1178.8620	1162.5196	1120.2376	1061.9962	1009.1864	897.9515	794.4898	745.7831	(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	96.8543	97.3646	97.8803	100.5429	101.0929	103.9358	103.9358	104.5236	102.7797	101.0929	99.9989	98.9282	
alpha	7.4570	7.4910	7.5254	7.7029	7.7395	7.9291	7.9291	7.9682	7.8520	7.7395	7.6666	7.5952	
util living area	0.9922	0.9729	0.9250	0.7868	0.6019	0.4118	0.2939	0.3223	0.5160	0.8285	0.9732	0.9943	(86)
MIT	20.4167	20.6100	20.7951	20.9513	20.9938	20.9997	21.0000	21.0000	20.9985	20.9412	20.6786	20.3963	(87)
Th 2	20.3258	20.3292	20.3325	20.3491	20.3524	20.3691	20.3691	20.3724	20.3624	20.3524	20.3457	20.3391	(88)
util rest of house	0.9900	0.9660	0.9083	0.7541	0.5617	0.3713	0.2518	0.2783	0.4689	0.7924	0.9651	0.9926	(89)
MIT 2	19.6472	19.8916	20.1173	20.3045	20.3477	20.3689	20.3690	20.3724	20.3615	20.3004	19.9929	19.6323	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	19.7778	20.0134	20.2323	20.4142	20.4573	20.4759	20.4761	20.4788	20.4696	20.4091	20.1092	19.7619	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7778	20.0134	20.2323	20.4142	20.4573	20.4759	20.4761	20.4788	20.4696	20.4091	20.1092	19.7619	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9877	0.9622	0.9055	0.7575	0.5683	0.3781	0.2589	0.2858	0.4769	0.7957	0.9616	0.9908	(94)
Useful gains	776.1533	900.9675	935.1846	856.2545	669.9278	439.5878	290.0523	303.5039	481.2493	714.5278	764.0142	738.9041	(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	1242.9244	1207.3067	1091.2003	890.7134	673.7589	439.7106	290.0571	303.5140	482.0112	754.6798	1011.8388	1223.4799	(97)
Space heating kWh	347.2777	205.8599	116.0757	24.8104	2.8503	0.0000	0.0000	0.0000	0.0000	29.8731	178.4337	360.5244	(98a)
Space heating requirement - total per year (kWh/year)												1265.7052	
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	347.2777	205.8599	116.0757	24.8104	2.8503	0.0000	0.0000	0.0000	0.0000	29.8731	178.4337	360.5244	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1265.7052	
Space heating per m2											(98c) / (4) =	11.3009	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	703.4258	553.7608	565.5286	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9959	0.9990	0.9984	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	700.5422	553.2038	564.5982	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1271.9489	1226.0126	1163.0526	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	411.4128	500.5697	445.2500	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction										fC = cooled area / (4) =		0.9821	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	101.0165	122.9077	109.3248	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												333.2491	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (301)

Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Boilers-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system	1.1500	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

Space heating requirement													
	347.2777	205.8599	116.0757	24.8104	2.8503	0.0000	0.0000	0.0000	0.0000	29.8731	178.4337	360.5244	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.15													
307a	399.3693	236.7389	133.4870	28.5320	3.2779	0.0000	0.0000	0.0000	0.0000	34.3540	205.1988	414.6031	
Space heating requirement													
	399.3693	236.7389	133.4870	28.5320	3.2779	0.0000	0.0000	0.0000	0.0000	34.3540	205.1988	414.6031	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

Annual water heating requirement													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15													
310a	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	
Water heating fuel													
	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)
Cooling System Energy Efficiency Ratio												2.6000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	38.8525	47.2722	42.0480	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	24.0336	21.7078	24.0336	23.2584	24.0336	23.2584	24.0336	24.0336	23.2584	24.0336	23.2584	24.0336	(331)
Lighting	26.7589	21.4670	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)

Annual totals kWh/year		
Space heating fuel - community heating	1455.5610	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	1505.1494	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	14.5556	(313)
Space cooling fuel	128.1727	(321)

Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)		
mechanical ventilation fans (SFP = 0.6820)	282.9768	(330a)
Total electricity for the above, kWh/year	282.9768	(331)
Electricity for lighting (calculated in Appendix L)	215.9594	(332)

Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	4425.9296	(338)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			89.5000	(367)
Space and Water heating from Boilers	3308.0563	0.2100	341.5283	(367)
Electrical energy for heat distribution (space & water)	14.5556	0.0000	4.4214	(372)
Overall CO2 factor for heat network			0.2361	(386)
Total CO2 associated with community systems			699.1133	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			699.1133	(376)
Space cooling	128.1727	0.1141	14.6189	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			900.7538	(383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			8.0400	(384)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Boilers			89.5000	(467a)
Space and Water heating from Boilers	3308.0563	1.1300	1837.7474	(467)
Electrical energy for heat distribution (space & water)	14.5556	0.0000	45.9642	(472)
Overall CO2 factor for heat network			1.2781	(486)

Total CO2 associated with community systems			3784.0678 (473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792 (278a)
Space and water heating			3784.0678 (476)
Space cooling	128.1727	1.4204	182.0541 (477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873 (478)
Energy for lighting	215.9594	1.5338	331.2457 (479)
Total Primary energy kWh/year			5994.6341 (483)
Dwelling Primary energy Rate (DPER)			53.5200 (484)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (5)

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2. Ventilation rate

		m3 per hour
Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	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) =	0.1176 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.3676 (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) =	0.3676 (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	0.4687	0.4595	0.4503	0.4044	0.3952	0.3492	0.3492	0.3400	0.3676	0.3952	0.4136	0.4319	(22b)
Effective ac	0.6098	0.6056	0.6014	0.5818	0.5781	0.5610	0.5610	0.5578	0.5676	0.5781	0.5855	0.5933	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			2.0000	1.0000	2.0000			(26)
TER Opening Type (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	2.0221	4.3070			(27a)
Floor to unheated			61.0000	0.1300	7.9300			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1800	2.9142			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1800	4.7448			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1100	0.5544			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	49.7595			(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)	22.4000	0.1600	3.5840
E1 Steel lintel with perforated steel base plate	11.7600	0.0500	0.5880
E3 Sill	10.7600	0.0500	0.5380
E4 Jamb	36.9600	0.0500	1.8480

E5 Ground floor (normal)	10.9000	0.1600	1.7440	
E6 Intermediate floor within a dwelling	11.5000	0.0000	0.0000	
E18 Party wall between dwellings	24.4000	0.0600	1.4640	
R11 Upstands or kerbs of rooflights	7.8600	0.0800	0.6288	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				10.3948 (36)
Point Thermal bridges			(36a) =	0.0000
Total fabric heat loss			(33) + (36) + (36a) =	60.1543 (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	68.4445	67.9658	67.4965	65.2926	64.8802	62.9606	62.9606	62.6052	63.7000	64.8802	65.7144	66.5865	(38)
Heat transfer coeff	128.5988	128.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408	(39)
Average = Sum(39)m / 12 =												125.4449	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1482	1.1439	1.1397	1.1201	1.1164	1.0992	1.0992	1.0961	1.1058	1.1164	1.1238	1.1316	(40)
HLP (average)												1.1200	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Assumed occupancy												2.8263	(42)
Hot water usage for mixer showers	92.0047	90.6220	88.6072	84.7523	81.9074	78.7349	76.9316	78.9311	81.1230	84.5294	88.4671	91.6522	(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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												124.4382	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	135.5789	132.6118	129.0125	123.5730	119.1436	114.3866	112.5833	116.1673	119.9437	124.9346	130.4569	135.2264	(44)
Energy conte	214.7239	188.8374	198.2874	169.1653	160.3902	140.6516	136.1597	143.8394	147.9026	169.5351	185.8597	211.7319	(45)
Energy content (annual)											Total = Sum(45)m =	2067.0843	
Distribution loss (46)m = 0.15 x (45)m	32.2086	28.3256	29.7431	25.3748	24.0585	21.0977	20.4240	21.5759	22.1854	25.4303	27.8790	31.7598	(46)
Water storage loss:													
Store volume												150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3938	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7527	(55)
Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	261.3188	230.9231	244.8823	214.2571	206.9851	185.7435	182.7546	190.4343	192.9945	216.1300	230.9516	258.3268	(62)
WWHRS	-42.0607	-37.1988	-38.9525	-32.2542	-30.0597	-25.7223	-24.1106	-25.6392	-26.6133	-31.3742	-35.5431	-41.2818	(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	219.2581	193.7243	205.9298	182.0029	176.9254	160.0211	158.6440	164.7951	166.3811	184.7558	195.4085	217.0450	(64)
								Total per year (kWh/year) = Sum(64)m =				2224.8913	(64)
12Total per year (kWh/year)												2225	(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	108.6716	96.4570	103.2065	92.3209	90.6057	82.8401	82.5490	85.1025	85.2511	93.6463	97.8718	107.6768	(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	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	138.4026	153.2315	138.4026	143.0161	138.4026	143.0161	138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	274.3987	277.2461	270.0707	254.7953	235.5127	217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	37.1316	(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)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)	146.0640	143.5372	138.7184	128.2235	121.7818	115.0557	110.9530	114.3851	118.4043	125.8687	135.9331	144.7269	(72)
Total internal gains	627.2600	642.4095	615.5864	594.4295	564.0919	540.8563	520.0330	520.6177	536.4256	557.5521	591.5125	613.8157	(73)

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6. Solar gains

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[Jan]                                          Area         Solar flux              g               FF            Access            Gains
                                                 m2           Table 6a    Specific data    Specific data          factor                W
                                                                  W/m2      or Table 6b      or Table 6c        Table 6d
---------------------------------------------------------------------------------------------------
North                                        8.5700            10.6334           0.6300           0.7000          0.7700          27.8500 (74)
South                                       15.2800            46.7521           0.6300           0.7000          0.7700         218.3212 (78)
North                                        2.1300            26.0000           0.6300           0.7000          1.0000          21.9803 (82)
---------------------------------------------------------------------------------------------------

Solar gains    268.1515   456.4280   627.0567   786.8457   894.4255   894.8018   859.7562   777.7326   681.7389   504.8063   321.0397   229.6201 (83)
Total gains    895.4115  1098.8376  1242.6432  1381.2752  1458.5174  1435.6581  1379.7891  1298.3503  1218.1645  1062.3584   912.5522   843.4358 (84)



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7. Mean internal temperature (heating season)
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Temperature during heating periods in the living area from Table 9, Th1 (C)                                                   21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau           60.4809    60.7069    60.9301    62.0006    62.2050    63.1749    63.1749    63.3578    62.7978    62.2050    61.7928    61.3676
alpha          5.0321     5.0471     5.0620     5.1334     5.1470     5.2117     5.2117     5.2239     5.1865     5.1470     5.1195     5.0912
util living area
               0.9928     0.9801     0.9520     0.8737     0.7303     0.5377     0.3908     0.4317     0.6641     0.9091     0.9826     0.9946 (86)

MIT           19.7950    20.0555    20.3595    20.7007    20.9059    20.9846    20.9976    20.9960    20.9559    20.6778    20.1798    19.7608 (87)
Th 2          19.9617    19.9651    19.9685    19.9845    19.9875    20.0015    20.0015    20.0040    19.9961    19.9875    19.9814    19.9751 (88)
util rest of house
               0.9905     0.9741     0.9377     0.8397     0.6701     0.4587     0.3031     0.3400     0.5818     0.8760     0.9762     0.9928 (89)
MIT 2         18.5769    18.9080    19.2868    19.6997    19.9148    19.9934    20.0007    20.0027    19.9695    19.6871    19.0800    18.5432 (90)
Living area fraction                                                                                fLA = Living area / (4) =      0.1696 (91)
MIT           18.7835    19.1026    19.4688    19.8695    20.0829    20.1615    20.1698    20.1712    20.1368    19.8552    19.2665    18.7498 (92)
Temperature adjustment                                                                                                          0.0000
adjusted MIT  18.7835    19.1026    19.4688    19.8695    20.0829    20.1615    20.1698    20.1712    20.1368    19.8552    19.2665    18.7498 (93)



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

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation    0.9868     0.9674     0.9292     0.8354     0.6761     0.4716     0.3180     0.3555     0.5940     0.8709     0.9702     0.9898 (94)
Useful gains  883.6075  1063.0075  1154.6362  1153.8896   986.1738   677.0737   438.7286   461.5899   723.5409   925.2185   885.3618   834.8320 (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
            1862.5657  1819.6422  1655.4743  1376.0913  1048.1525   684.7061   439.5001   462.9552   747.6851  1157.2139  1531.3861  1844.0509 (97)
Space heating kWh
             728.3449   508.4585   372.6235   159.9852    46.1121     0.0000     0.0000     0.0000     0.0000   172.6046   465.1375   750.8588 (98a)
Space heating requirement - total per year (kWh/year)                                                                        3204.1252
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
             728.3449   508.4585   372.6235   159.9852    46.1121     0.0000     0.0000     0.0000     0.0000   172.6046   465.1375   750.8588 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                               3204.1252
Space heating per m2                                                                                      (98c) / (4) =     28.6083 (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
             728.3449   508.4585   372.6235   159.9852    46.1121     0.0000     0.0000     0.0000     0.0000   172.6046   465.1375   750.8588 (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)
             789.1061   550.8760   403.7091   173.3318    49.9590     0.0000     0.0000     0.0000     0.0000   187.0039   503.9410   813.4982 (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
             219.2581   193.7243   205.9298   182.0029   176.9254   160.0211   158.6440   164.7951   166.3811   184.7558   195.4085   217.0450 (64)
Efficiency of water heater                                                                                                     79.8000 (216)
(217)m        86.5416    86.1203    85.3728    83.7719    81.5079    79.8000    79.8000    79.8000    79.8000    83.9075    85.9329    86.6096 (217)
Fuel for water heating, kWh/month
             253.3556   224.9460   241.2123   217.2601   217.0653   200.5277   198.8020   206.5102   208.4977   220.1899   227.3965   250.6016 (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	28.7573	23.0702	20.7722	15.2186	11.7553	9.6042	10.7235	13.9389	18.1052	23.7550	26.8312	29.5566	(232)

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

(233a)m	-24.2411	-36.0429	-54.5965	-64.7809	-72.8175	-69.0204	-68.1451	-62.8406	-54.0402	-42.6574	-27.2943	-20.7435	(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	-8.5569	-18.4125	-37.3867	-57.3445	-77.0239	-77.8638	-76.9820	-64.6553	-46.6833	-26.7529	-11.5553	-6.7386	(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	3471.4250	(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	2666.3651	(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)	232.0882	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1107.1761	(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	5348.7021	(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	3471.4250	0.2100	728.9992	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2666.3651	0.2100	559.9367	(264)
Space and water heating			1288.9359	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	232.0882	0.1443	33.4975	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-597.2204	0.1335	-79.7287	
PV Unit electricity exported	-509.9557	0.1253	-63.8843	
Total			-143.6129	(269)
Total CO2, kg/year			1190.7498	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.6300	(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	3471.4250	1.1300	3922.7102	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2666.3651	1.1300	3012.9925	(278)
Space and water heating			6935.7027	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	232.0882	1.5338	355.9846	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-597.2204	1.4933	-891.8472	
PV Unit electricity exported	-509.9557	0.4598	-234.4834	
Total			-1126.3305	(283)
Total Primary energy kWh/year			6295.4576	(286)
Target Primary Energy Rate (TPER)			56.2100	(287)

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

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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) =	0.1176 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		3.0000 (17)
Infiltration rate		0.2676 (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) =	0.2676 (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	0.3412	0.3345	0.3278	0.2944	0.2877	0.2542	0.2542	0.2475	0.2676	0.2877	0.3011	0.3144 (22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective ac	0.5582	0.5560	0.5537	0.5433	0.5414	0.5323	0.5323	0.5306	0.5358	0.5414	0.5453	0.5494 (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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)		5.4628 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	50.1974 (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	62.6497	62.3960	62.1473	60.9793	60.7608	59.7435	59.7435	59.5551	60.1354	60.7608	61.2029	61.6650 (38)
Heat transfer coeff	112.8471	112.5934	112.3447	111.1767	110.9582	109.9409	109.9409	109.7525	110.3328	110.9582	111.4003	111.8624 (39)
Average = Sum(39)m / 12 =												111.1757

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.0076	1.0053	1.0031	0.9926	0.9907	0.9816	0.9816	0.9799	0.9851	0.9907	0.9946	0.9988 (40)
HLP (average)												0.9926
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (42a)
Hot water usage for baths	30.9169	30.4578	29.8112	28.6190	27.7263	26.7364	26.2017	26.8438	27.5429	28.6021	29.8188	30.8124 (42b)

```
Hot water usage for other uses
               43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (42c)
Average daily hot water use (litres/day)                                                                                                 68.2778 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
               74.4912    72.4475    70.2164    67.4397    64.9624    62.3881    61.8534    64.0800    66.3636    69.0073    71.8086    74.3867 (44)
Energy conte  117.9758   103.1643   107.9200    92.3215    87.4519    76.7134    74.8063    79.3444    81.8329    93.6423   102.3045   116.4715 (45)
Energy content (annual)                                                                                      Total = Sum(45)m =    1133.9488
Distribution loss  (46)m = 0.15 x (45)m
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (46)
Water storage loss:
Total storage loss
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (56)
If cylinder contains dedicated solar storage
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (57)
Primary loss    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (59)
Combi loss      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
              100.2794    87.6896    91.7320    78.4733    74.3341    65.2064    63.5854    67.4427    69.5580    79.5959    86.9588    99.0008 (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
              100.2794    87.6896    91.7320    78.4733    74.3341    65.2064    63.5854    67.4427    69.5580    79.5959    86.9588    99.0008 (64)
                                                                                    Total per year (kWh/year) = Sum(64)m =      963.8565 (64)
12Total per year (kWh/year)                                                                                                          964 (64)
Electric shower(s)
               57.3459    51.0957    55.7945    53.2440    54.2431    51.7427    53.4674    54.2431    53.2440    55.7945    54.7454    57.3459 (64a)
                                                Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =     652.3063 (64a)
Heat gains from water heating, kWh/month
               39.4063    34.6963    36.8816    32.9293    32.1443    29.2373    29.2632    30.4215    30.7005    33.8476    35.4260    39.0867 (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         141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              138.4026   153.2315   138.4026   143.0161   138.4026   143.0161   138.4026   138.4026   143.0161   138.4026   143.0161   138.4026 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              274.3987   277.2461   270.0707   254.7953   235.5127   217.3898   205.2826   202.4352   209.6106   224.8861   244.1686   262.2915 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316 (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)
             -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
               52.9655    51.6314    49.5721    45.7352    43.2047    40.6073    39.3323    40.8891    42.6396    45.4941    49.2028    52.5359 (72)
Total internal gains
              531.1615   547.5037   523.4402   508.9412   482.5148   466.4079   448.4122   447.1216   460.6609   474.1775   501.7822   518.6247 (73)


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6. Solar gains
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[Jan]                                      Area        Solar flux                g               FF            Access              Gains
                                             m2          Table 6a    Specific data    Specific data            factor                  W
                                                             W/m2      or Table 6b      or Table 6c          Table 6d
------------------------------------------------------------------------------------------------
North                                    8.5700           10.6334           0.4000           0.8000            0.7700            20.2086 (74)
South                                   15.2800           46.7521           0.4000           0.8000            0.7700           158.4190 (78)
North                                    2.1300           26.0000           0.4000           0.7000            1.0000            13.9558 (82)
------------------------------------------------------------------------------------------------

Solar gains   192.5834   327.0542   447.6459   559.4518   634.2937   633.9533   609.3668   552.3024   485.8676   361.2385   230.4236   165.0075 (83)
Total gains   723.7449   874.5580   971.0860  1068.3930  1116.8085  1100.3612  1057.7790   999.4240   946.5285   835.4160   732.2058   683.6321 (84)


------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                              21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau            68.9232    69.0785    69.2314    69.9587    70.0965    70.7451    70.7451    70.8665    70.4938    70.0965    69.8183    69.5298
alpha           5.5949     5.6052     5.6154     5.6639     5.6731     5.7163     5.7163     5.7244     5.6996     5.6731     5.6546     5.6353
util living area
                0.9971     0.9912     0.9771     0.9289     0.8146     0.6206     0.4545     0.5001     0.7450     0.9500     0.9923     0.9979 (86)

MIT            19.8573    20.0702    20.3312    20.6523    20.8796    20.9795    20.9970    20.9950    20.9446    20.6449    20.1905    19.8218 (87)
Th 2           20.0770    20.0789    20.0808    20.0895    20.0911    20.0987    20.0987    20.1001    20.0958    20.0911    20.0878    20.0844 (88)
util rest of house
                0.9961     0.9884     0.9697     0.9064     0.7634     0.5412     0.3629     0.4049     0.6689     0.9294     0.9894     0.9972 (89)
MIT 2          19.0360    19.2487    19.5064    19.8179    20.0137    20.0898    20.0979    20.0987    20.0677    19.8183    19.3762    19.0065 (90)
Living area fraction                                                                               fLA = Living area / (4) =      0.1696 (91)
MIT            19.1753    19.3880    19.6463    19.9595    20.1606    20.2407    20.2505    20.2508    20.2165    19.9586    19.5144    19.1448 (92)
Temperature adjustment                                                                                                            0.0000
```

```
adjusted MIT     19.1753    19.3880    19.6463    19.9595    20.1606    20.2407    20.2505    20.2508    20.2165    19.9586    19.5144    19.1448 (93)


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

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9948     0.9857     0.9653     0.9027     0.7677     0.5541     0.3785     0.4211     0.6798     0.9257     0.9869     0.9962 (94)
Useful gains   720.0118   862.0324   937.4087   964.4461   857.3372   609.7182   400.3554   420.8573   643.4252   773.3293   722.6132   681.0071 (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
              1678.6386  1631.2556  1476.9188  1229.5569   938.7736   620.1440   401.3350   422.6308   674.8469  1038.4084  1382.9630  1671.7589 (97)
Space heating kWh
               713.2183   516.9180   401.3956   190.8797    60.5887     0.0000     0.0000     0.0000     0.0000   197.2188   475.4519   737.1193 (98a)
Space heating requirement - total per year (kWh/year)                                                                                3292.7903
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
               713.2183   516.9180   401.3956   190.8797    60.5887     0.0000     0.0000     0.0000     0.0000   197.2188   475.4519   737.1193 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                       3292.7903
Space heating per m2                                                                                          (98c) / (4) =      29.3999 (99)


-----------------------------------------------------------------------------------------------------
8c. Space cooling requirement
-----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.       4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000
Heat loss rate W
                 0.0000     0.0000     0.0000     0.0000     0.0000  1033.4446   813.5628   834.1192     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation      0.0000     0.0000     0.0000     0.0000     0.0000     0.9097     0.9575     0.9418     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss      0.0000     0.0000     0.0000     0.0000     0.0000   940.1094   778.9705   785.5839     0.0000     0.0000     0.0000     0.0000 (102)
Total gains      0.0000     0.0000     0.0000     0.0000     0.0000  1211.3498  1165.2390  1102.6705     0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000   195.2931   287.3838   235.9125     0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                     fC = cooled area / (4) =      1.0000 (105)
Intermittency factor (Table 10b)
                 0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500 (106)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000    48.8233    71.8460    58.9781     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                          179.6473 (107)
Energy for space heating                                                                                                            29.3999 (99)
Energy for space cooling                                                                                                             1.6040 (108)
Total                                                                                                                               31.0039 (109)
Fabric Energy Efficiency (DFEE)                                                                                                       31.0 (109)


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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY
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-----------------------------------------------------------------------------------------------------
1. Overall dwelling characteristics
-----------------------------------------------------------------------------------------------------
                                                                                                  Area         Storey height             Volume
                                                                                                  (m2)               (m)                  (m3)
Ground floor                                                                                   61.0000 (1b)   x      2.9000 (2b)   =    176.9000 (1b) -
First floor                                                                                    51.0000 (1c)   x      3.2000 (2c)   =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)              112.0000                                                                  (4)
Dwelling volume                                                                                      (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (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) =       0.1176 (8)
```

Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.3676 (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) =	0.3676 (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	0.4687	0.4595	0.4503	0.4044	0.3952	0.3492	0.3492	0.3400	0.3676	0.3952	0.4136	0.4319	(22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.6098	0.6056	0.6014	0.5818	0.5781	0.5610	0.5610	0.5578	0.5676	0.5781	0.5855	0.5933	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			2.0000	1.0000	2.0000			(26)
TER Opening Type (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	2.0221	4.3070			(27a)
Floor to unheated			61.0000	0.1300	7.9300			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1800	2.9142			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1800	4.7448			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1100	0.5544			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	49.7595			(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)	22.4000	0.1600	3.5840
E1 Steel lintel with perforated steel base plate	11.7600	0.0500	0.5880
E3 Sill	10.7600	0.0500	0.5380
E4 Jamb	36.9600	0.0500	1.8480
E5 Ground floor (normal)	10.9000	0.1600	1.7440
E6 Intermediate floor within a dwelling	11.5000	0.0000	0.0000
E18 Party wall between dwellings	24.4000	0.0600	1.4640
R11 Upstands or kerbs of rooflights	7.8600	0.0800	0.6288

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		10.3948 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	60.1543 (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	68.4445	67.9658	67.4965	65.2926	64.8802	62.9606	62.9606	62.6052	63.7000	64.8802	65.7144	66.5865	(38)
Heat transfer coeff	128.5988	128.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408	(39)
Average = Sum(39)m / 12 =												125.4449	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1482	1.1439	1.1397	1.1201	1.1164	1.0992	1.0992	1.0961	1.1058	1.1164	1.1238	1.1316	(40)
HLP (average)												1.1200	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	30.9169	30.4578	29.8112	28.6190	27.7263	26.7364	26.2017	26.8438	27.5429	28.6021	29.8188	30.8124	(42b)
Hot water usage for other uses	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												68.2778	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	74.4912	72.4475	70.2164	67.4397	64.9624	62.3881	61.8534	64.0800	66.3636	69.0073	71.8086	74.3867	(44)
Energy conte	117.9758	103.1643	107.9200	92.3215	87.4519	76.7134	74.8063	79.3444	81.8329	93.6423	102.3045	116.4715	(45)
Energy content (annual)											Total = Sum(45)m =	1133.9488	
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	100.2794	87.6896	91.7320	78.4733	74.3341	65.2064	63.5854	67.4427	69.5580	79.5959	86.9588	99.0008	(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
              100.2794    87.6896    91.7320    78.4733    74.3341    65.2064    63.5854    67.4427    69.5580    79.5959    86.9588    99.0008 (64)
                                                                                          Total per year (kWh/year) = Sum(64)m =   963.8565 (64)
12Total per year (kWh/year)                                                                                                             964 (64)
Electric shower(s)
               57.3459    51.0957    55.7945    53.2440    54.2431    51.7427    53.4674    54.2431    53.2440    55.7945    54.7454    57.3459 (64a)
                                                 Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    652.3063 (64a)
Heat gains from water heating, kWh/month
               39.4063    34.6963    36.8816    32.9293    32.1443    29.2373    29.2632    30.4215    30.7005    33.8476    35.4260    39.0867 (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         141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156   141.3156 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
              138.4026   153.2315   138.4026   143.0161   138.4026   143.0161   138.4026   138.4026   143.0161   138.4026   143.0161   138.4026 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              274.3987   277.2461   270.0707   254.7953   235.5127   217.3898   205.2826   202.4352   209.6106   224.8861   244.1686   262.2915 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316    37.1316 (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)
             -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
               52.9655    51.6314    49.5721    45.7352    43.2047    40.6073    39.3323    40.8891    42.6396    45.4941    49.2028    52.5359 (72)
Total internal gains
              531.1615   547.5037   523.4402   508.9412   482.5148   466.4079   448.4122   447.1216   460.6609   474.1775   501.7822   518.6247 (73)



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6. Solar gains
-----------------------------------------------------------------------------------------------------
[Jan]                                         Area       Solar flux                g                FF            Access              Gains
                                                m2         Table 6a    Specific data     Specific data            factor                  W
                                                               W/m2      or Table 6b       or Table 6c          Table 6d
-----------------------------------------------------------------------------------------------------
North                                       8.5700          10.6334           0.6300            0.7000            0.7700            27.8500 (74)
South                                      15.2800          46.7521           0.6300            0.7000            0.7700           218.3212 (78)
North                                       2.1300          26.0000           0.6300            0.7000            1.0000            21.9803 (82)
-----------------------------------------------------------------------------------------------------

Solar gains   268.1515   456.4280   627.0567   786.8457   894.4255   894.8018   859.7562   777.7326   681.7389   504.8063   321.0397   229.6201 (83)
Total gains   799.3130  1003.9318  1150.4969  1295.7869  1376.9403  1361.2097  1308.1684  1224.8542  1142.3998   978.9838   822.8219   748.2448 (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            60.4809    60.7069    60.9301    62.0006    62.2050    63.1749    63.1749    63.3578    62.7978    62.2050    61.7928    61.3676
alpha           5.0321     5.0471     5.0620     5.1334     5.1470     5.2117     5.2117     5.2239     5.1865     5.1470     5.1195     5.0912
util living area
                0.9956     0.9863     0.9639     0.8954     0.7593     0.5642     0.4116     0.4566     0.6979     0.9305     0.9888     0.9968 (86)

MIT            19.7058    19.9723    20.2885    20.6558    20.8871    20.9808    20.9969    20.9948    20.9447    20.6250    20.0998    19.6715 (87)
Th 2           19.9617    19.9651    19.9685    19.9845    19.9875    20.0015    20.0015    20.0040    19.9961    19.9875    19.9814    19.9751 (88)
util rest of house
                0.9942     0.9819     0.9525     0.8650     0.7004     0.4825     0.3195     0.3601     0.6151     0.9030     0.9845     0.9958 (89)
MIT 2          18.7942    19.0603    19.3708    19.7250    19.9183    19.9935    20.0007    20.0027    19.9694    19.7084    19.2012    18.7706 (90)
Living area fraction                                                                                fLA = Living area / (4) =           0.1696 (91)
MIT            18.9488    19.2150    19.5264    19.8829    20.0826    20.1610    20.1697    20.1710    20.1349    19.8639    19.3536    18.9234 (92)
Temperature adjustment                                                                                                                   0.0000
adjusted MIT   18.9488    19.2150    19.5264    19.8829    20.0826    20.1610    20.1697    20.1710    20.1349    19.8639    19.3536    18.9234 (93)



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

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation     0.9923     0.9778     0.9465     0.8615     0.7063     0.4959     0.3352     0.3765     0.6273     0.8989     0.9809     0.9943 (94)
Useful gains  793.1211   981.6432  1088.9633  1116.3297   972.5461   675.0365   438.4932   461.1370   716.5845   880.0251   807.0979   743.9538 (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
             1883.8223  1834.0374  1662.8371  1377.7678  1048.1163   684.6413   439.4858   462.9272   747.4470  1158.3118  1542.3479  1866.0598 (97)
Space heating kWh
              811.4817   572.8089   426.9621   188.2354    56.2242     0.0000     0.0000     0.0000     0.0000   207.0454   529.3799   834.8469 (98a)
Space heating requirement - total per year (kWh/year)                                                                                3626.9847
Solar heating kWh
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (98b)
Solar heating contribution - total per year (kWh/year)                                                                                  0.0000
```

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating kWh	811.4817	572.8089	426.9621	188.2354	56.2242	0.0000	0.0000	0.0000	0.0000	207.0454	529.3799	834.8469	(98c)

Space heating requirement after solar contribution - total per year (kWh/year) 3626.9847

Space heating per m2 (98c) / (4) = 32.3838 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	1157.2808	911.0508	932.9722	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9271	0.9649	0.9512	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1072.9094	879.0573	887.4822	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1505.8162	1448.0536	1357.9795	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	311.6929	423.3332	350.0500	0.0000	0.0000	0.0000	0.0000	(104)

Cooled fraction fC = cooled area / (4) = 1.0000 (105)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	77.9232	105.8333	87.5125	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling requirement	271.2690	(107)
Energy for space heating	32.3838	(99)
Energy for space cooling	2.4220	(108)
Total	34.8058	(109)
Fabric Energy Efficiency (TFEE)	34.8	(109)

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

CALCULATION OF ENERGY RATING

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 340.1000 (5)

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2. Ventilation rate

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = 0.0000 / (5) = 0.0000 (8)

Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	3.0000	(17)
Infiltration rate	0.1500	(18)
Number of sides sheltered	0	(19)

Shelter factor (20) = 1 - [0.075 x (19)] = 1.0000 (20)

Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.1500 (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	0.1912	0.1875	0.1837	0.1650	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1687	0.1762	(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) =	84.6000	(23c)

Effective ac	0.2682	0.2645	0.2607	0.2420	0.2382	0.2195	0.2195	0.2157	0.2270	0.2382	0.2457	0.2532	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area) 5.4628 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 50.1974 (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	30.1065	29.6856	29.2648	27.1604	26.7395	24.6351	24.6351	24.2143	25.4769	26.7395	27.5813	28.4230	(38)
Heat transfer coeff													
	80.3039	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204	(39)
Average = Sum(39)m / 12 =												77.2526	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.7170	0.7132	0.7095	0.6907	0.6869	0.6681	0.6681	0.6644	0.6757	0.6869	0.6945	0.7020	(40)
HLP (average)												0.6898	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	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													
	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)										Total = Sum(45)m =		657.9858	
Distribution loss (46)m = 0.15 x (45)m													
	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)

Water storage loss:
Store volume 110.0000 (47)
b) If manufacturer declared loss factor is not known :
Hot water storage loss factor from Table 2 (kWh/litre/day) 0.0152 (51)
Volume factor from Table 2a 1.0294 (52)
Temperature factor from Table 2b 0.6000 (53)
Enter (49) or (54) in (55) 1.0327 (55)

Total storage loss													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(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													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
									Total per year (kWh/year) = Sum(64)m =			1308.8255	(64)
Electric shower(s)													
	73.6804	65.6499	71.6871	68.4101	69.6938	66.4812	68.6972	69.6938	68.4101	71.6871	70.3391	73.6804	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							838.1104	(64a)
Heat gains from water heating, kWh/month													
	85.5877	76.2355	82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(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	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	(66)

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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                30.5713    27.1531    22.0824    16.7178    12.4968    10.5503    11.4000    14.8181    19.8888    25.2534    29.4745    31.4210 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               409.5503   413.8002   403.0907   380.2914   351.5115   324.4624   306.3920   302.1421   312.8516   335.6509   364.4308   391.4799 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842 (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)
              -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
               115.0372   113.4457   111.2795   107.7330   105.2583   102.7657   101.7908   103.4613   105.2975   108.0296   111.4869   114.6868 (72)
Total internal gains
               666.4693   665.7095   647.7630   616.0527   580.5770   549.0889   530.8932   531.7320   549.3484   580.2443   616.7026   648.8980 (73)



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6. Solar gains
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[Jan]                                        Area         Solar flux                g                 FF              Access                 Gains
                                               m2           Table 6a    Specific data      Specific data              factor                     W
                                                                W/m2       or Table 6b        or Table 6c            Table 6d
----------------------------------------------------------------------------------------------------
North                                      8.5700            10.6334           0.4000             0.8000              0.7700               20.2086 (74)
South                                     15.2800            46.7521           0.4000             0.8000              0.7700              158.4190 (78)
North                                      2.1300            26.0000           0.4000             0.7000              1.0000               13.9558 (82)
----------------------------------------------------------------------------------------------------

Solar gains    192.5834   327.0542   447.6459   559.4518   634.2937   633.9533   609.3668   552.3024   485.8676   361.2385   230.4236   165.0075 (83)
Total gains    859.0526   992.7637  1095.4089  1175.5045  1214.8707  1183.0422  1140.2600  1084.0343  1035.2160   941.4828   847.1262   813.9055 (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            96.8543    97.3646    97.8803   100.5429   101.0929   103.9358   103.9358   104.5236   102.7797   101.0929    99.9989    98.9282
alpha           7.4570     7.4910     7.5254     7.7029     7.7395     7.9291     7.9291     7.9682     7.8520     7.7395     7.6666     7.5952
util living area
                 0.9867     0.9631     0.9038     0.7637     0.5849     0.4046     0.2888     0.3157     0.5032     0.8021     0.9621     0.9901 (86)

MIT             20.4873    20.6569    20.8312    20.9601    20.9948    20.9998    21.0000    21.0000    20.9987    20.9530    20.7222    20.4633 (87)
Th 2            20.3258    20.3292    20.3325    20.3491    20.3524    20.3691    20.3691    20.3724    20.3624    20.3524    20.3457    20.3391 (88)
util rest of house
                 0.9831     0.9542     0.8842     0.7305     0.5456     0.3648     0.2474     0.2727     0.4572     0.7646     0.9514     0.9874 (89)
MIT 2           19.7360    19.9486    20.1581    20.3129    20.3485    20.3689    20.3690    20.3724    20.3616    20.3115    20.0454    19.7170 (90)
Living area fraction                                                                                          fLA = Living area / (4) =     0.1696 (91)
MIT             19.8635    20.0688    20.2723    20.4227    20.4582    20.4759    20.4761    20.4789    20.4697    20.4203    20.1602    19.8436 (92)
Temperature adjustment                                                                                                                        0.0000
adjusted MIT    19.8635    20.0688    20.2723    20.4227    20.4582    20.4759    20.4761    20.4789    20.4697    20.4203    20.1602    19.8436 (93)



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

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9801     0.9502     0.8823     0.7344     0.5521     0.3716     0.2544     0.2800     0.4650     0.7687     0.9479     0.9849 (94)
Useful gains   841.9312   943.3598   966.4632   863.2718   670.6746   439.6041   290.0530   303.5055   481.3854   723.7079   803.0237   801.5840 (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
              1249.8062  1211.7262  1094.3744   891.3708   673.8266   439.7120   290.0572   303.5141   482.0234   755.5443  1015.8073  1229.9070 (97)
Space heating kWh
               303.4591   180.3422    95.1659    20.2313     2.3451     0.0000     0.0000     0.0000     0.0000    23.6863   153.2042   318.6723 (98a)
Space heating requirement - total per year (kWh/year)                                                                                    1097.1065
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
               303.4591   180.3422    95.1659    20.2313     2.3451     0.0000     0.0000     0.0000     0.0000    23.6863   153.2042   318.6723 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                           1097.1065
Space heating per m2                                                                                                (98c) / (4) =     9.7956 (99)



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8c. Space cooling requirement
----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.      4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000
Heat loss rate W
                 0.0000     0.0000     0.0000     0.0000     0.0000   703.4258   553.7608   565.5286     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation      0.0000     0.0000     0.0000     0.0000     0.0000     0.9959     0.9990     0.9984     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss      0.0000     0.0000     0.0000     0.0000     0.0000   700.5422   553.2038   564.5982     0.0000     0.0000     0.0000     0.0000 (102)
Total gains      0.0000     0.0000     0.0000     0.0000     0.0000  1271.9489  1226.0126  1163.0526     0.0000     0.0000     0.0000     0.0000 (103)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000   411.4128   500.5697   445.2500     0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                              fC = cooled area / (4) =     0.9821 (105)
Intermittency factor (Table 10b)
```

	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	101.0165	122.9077	109.3248	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												333.2491	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Boilers-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system	1.1500	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

Space heating requirement													
	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.15													
307a	348.9779	207.3936	109.4408	23.2660	2.6969	0.0000	0.0000	0.0000	0.0000	27.2393	176.1848	366.4732	
Space heating requirement													
	348.9779	207.3936	109.4408	23.2660	2.6969	0.0000	0.0000	0.0000	0.0000	27.2393	176.1848	366.4732	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

Annual water heating requirement													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15													
310a	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	
Water heating fuel													
	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)
Cooling System Energy Efficiency Ratio												2.6000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	38.8525	47.2722	42.0480	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	24.0336	21.7078	24.0336	23.2584	24.0336	23.2584	24.0336	24.0336	23.2584	24.0336	23.2584	24.0336	(331)
Lighting	26.7589	21.4670	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)

Annual totals kWh/year

Space heating fuel - community heating	1261.6724	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	1505.1494	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	12.6167	(313)
Space cooling fuel	128.1727	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)

mechanical ventilation fans (SFP = 0.6820)	282.9768	(330a)
Total electricity for the above, kWh/year	282.9768	(331)
Electricity for lighting (calculated in Appendix L)	215.9594	(332)

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

PV generation	0.0000	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	4232.0411	(338)

10b. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Boilers	1261.6724	4.4400	56.0183	(340a)
Space heating total			56.0183	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Boilers	1505.1494	4.4400	66.8286	(342a)
Water heating total			66.8286	(342)
Energy for instantaneous electric shower(s)	838.1104	16.4900	138.2044	(347a)
Space cooling	128.1727	16.4900	21.1357	(348)
Pumps, fans and electric keep-hot	282.9768	16.4900	46.6629	(349)
Energy for lighting	215.9594	16.4900	35.6117	(350)
Additional standing charges			92.0000	(351)
Total energy cost			456.4615	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600	(356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.0467	(357)
SAP value		83.0336	
SAP rating (Section 12)		83	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			89.5000	(367)
Space and Water heating from Boilers	3091.4210	0.2100	296.0349	(367)
Electrical energy for heat distribution (space & water)	12.6167	0.0000	4.1153	(372)
Overall CO2 factor for heat network			0.2361	(386)
Total CO2 associated with community systems			653.3137	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			653.3137	(376)
Space cooling	128.1727	0.1141	14.6189	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			854.9543	(383)
CO2 emissions per m2			7.6300	(384)
EI value			92.7029	(384a)
EI rating			93	(385)
EI band			A	

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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		3.0000	(17)
Infiltration rate		0.1500	(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) =	0.1500	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.2000	4.0000	4.0000	3.7000	3.7000	3.3000	3.4000	3.2000	3.3000	3.5000	3.5000	3.8000	(22)
Wind factor	1.0500	1.0000	1.0000	0.9250	0.9250	0.8250	0.8500	0.8000	0.8250	0.8750	0.8750	0.9500	(22a)
Adj infilt rate	0.1575	0.1500	0.1500	0.1388	0.1388	0.1237	0.1275	0.1200	0.1237	0.1313	0.1313	0.1425	(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) =	84.6000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2345	0.2270	0.2270	0.2157	0.2157	0.2007	0.2045	0.1970	0.2007	0.2082	0.2082	0.2195	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000	(35)
Thermal bridges (User defined value 0.040 * total exposed area)		5.4628	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	50.1974	(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	26.3186	25.4769	25.4769	24.2143	24.2143	22.5308	22.9516	22.1099	22.5308	23.3725	23.3725	24.6351	(38)
Heat transfer coeff	76.5160	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325	(39)
Average = Sum(39)m / 12 =												74.1311	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6832	0.6757	0.6757	0.6644	0.6644	0.6494	0.6531	0.6456	0.6494	0.6569	0.6569	0.6681	(40)
HLP (average)												0.6619	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8263 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	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	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)											Total = Sum(45)m =	657.9858	
Distribution loss (46)m = 0.15 x (45)m	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)

Water storage loss:

Store volume	110.0000	(47)
b) If manufacturer declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.0152	(51)
Volume factor from Table 2a	1.0294	(52)
Temperature factor from Table 2b	0.6000	(53)
Enter (49) or (54) in (55)	1.0327	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(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	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Total per year (kWh/year) = Sum(64)m =												1308.8255	(64)
Electric shower(s)	73.6804	65.6499	71.6871	68.4101	69.6938	66.4812	68.6972	69.6938	68.4101	71.6871	70.3391	73.6804	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =												838.1104	(64a)
Heat gains from water heating, kWh/month	85.5877	76.2355	82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(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	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	30.5713	27.1531	22.0824	16.7178	12.4968	10.5503	11.4000	14.8181	19.8888	25.2534	29.4745	31.4210	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	409.5503	413.8002	403.0907	380.2914	351.5115	324.4624	306.3920	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	(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)													
	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)													
	115.0372	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
Total internal gains													
	666.4693	665.7095	647.7630	616.0527	580.5770	549.0889	530.8932	531.7320	549.3484	580.2443	616.7026	648.8980	(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	8.5700	11.9814	0.4000	0.8000	0.7700	22.7705	(74)
South	15.2800	50.9848	0.4000	0.8000	0.7700	172.7617	(78)
North	2.1300	30.0000	0.4000	0.7000	1.0000	16.1028	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	211.6350	323.4846	438.5844	568.4742	631.7399	677.5182	643.4626	593.4386	517.1329	381.7370	259.4024	179.6047	(83)
Total gains	878.1043	989.1941	1086.3474	1184.5269	1212.3169	1226.6071	1174.3557	1125.1706	1066.4813	961.9814	876.1050	828.5027	(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	101.6490	102.7797	102.7797	104.5236	104.5236	106.9431	106.3278	107.5656	106.9431	105.7195	105.7195	103.9358	
alpha	7.7766	7.8520	7.8520	7.9682	7.9682	8.1295	8.0885	8.1710	8.1295	8.0480	8.0480	7.9291	
util living area													
	0.9766	0.9455	0.8616	0.6849	0.4902	0.2965	0.1931	0.2056	0.3954	0.7039	0.9243	0.9821	(86)
MIT	20.6244	20.7589	20.9024	20.9845	20.9989	21.0000	21.0000	21.0000	20.9999	20.9849	20.8458	20.6053	(87)
Th 2	20.3557	20.3624	20.3624	20.3724	20.3724	20.3858	20.3824	20.3891	20.3858	20.3791	20.3791	20.3691	(88)
util rest of house													
	0.9705	0.9332	0.8369	0.6497	0.4521	0.2600	0.1546	0.1664	0.3536	0.6622	0.9059	0.9772	(89)
MIT 2	19.9328	20.1015	20.2659	20.3593	20.3717	20.3858	20.3824	20.3891	20.3857	20.3672	20.2211	19.9207	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9670	0.9299	0.8373	0.6550	0.4585	0.2662	0.1612	0.1730	0.3607	0.6686	0.9042	0.9741	(94)
Useful gains	849.1664	919.8603	909.6463	775.8392	555.8471	326.5423	189.2509	194.7062	384.6626	643.1713	792.1827	807.0712	(95)
Ext temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	(96)
Heat loss rate W													
	1143.9218	1105.8306	981.7877	786.1877	556.4556	326.5474	189.2509	194.7063	384.7244	652.7086	906.9047	1117.7639	(97)
Space heating kWh													
	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98a)
Space heating requirement - total per year (kWh/year)												726.6980	
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													
	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												726.6980	
Space heating per m2										(98c) / (4) =		6.4884	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	
Heat loss rate W													
	0.0000	0.0000	0.0000	0.0000	0.0000	581.8253	446.2091	448.3052	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9993	0.9999	0.9998	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	581.4113	446.1459	448.2205	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1321.3284	1264.5960	1209.6840	0.0000	0.0000	0.0000	0.0000	(103)

```
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000   532.7403   608.9269   566.5288     0.0000     0.0000     0.0000     0.0000 (104)
Cooled fraction                                                                                                fC = cooled area / (4) =     0.9821 (105)
Intermittency factor (Table 10b)
                0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500     0.2500 (106)
Space cooling kWh
                0.0000     0.0000     0.0000     0.0000     0.0000   130.8068   149.5133   139.1031     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling requirement                                                                                                                 419.4231 (107)



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9b. Energy requirements
----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                                       0.0000 (301)
Fraction of space heat from community system                                                                                                1.0000 (302)
Fraction of heat from community Boilers-Space and Water                                                                                     1.0000 (303a)
Factor for control and charging method (Table 4c(3)) for space heating                                                                      1.0000 (305)
Factor for charging method (Table 4c(3)) for water heating                                                                                  1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system                                                                           1.1500 (306)
Efficiency of secondary/supplementary heating system, %                                                                                     0.0000 (208)
Space heating:
Space heating requirement
              219.2980   124.9721    53.6732     7.4509     0.4527     0.0000     0.0000     0.0000     0.0000     7.0958    82.5999   231.1554 (98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.15
307a          252.1927   143.7179    61.7242     8.5685     0.5207     0.0000     0.0000     0.0000     0.0000     8.1601    94.9899   265.8287
Space heating requirement
              252.1927   143.7179    61.7242     8.5685     0.5207     0.0000     0.0000     0.0000     0.0000     8.1601    94.9899   265.8287 (307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)                                                     0.0000 (308)
Space heating fuel for secondary/supplementary system
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (309)

Water heating
Annual water heating requirement
              124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15
310a          142.9310   126.1783   134.9849   122.6329   121.2145   111.9313   113.1536   116.5904   116.5680   126.6223   130.3131   142.0291
Water heating fuel
              142.9310   126.1783   134.9849   122.6329   121.2145   111.9313   113.1536   116.5904   116.5680   126.6223   130.3131   142.0291 (310)
Cooling System Energy Efficiency Ratio                                                                                                      2.6000 (314)
Space coolin    0.0000     0.0000     0.0000     0.0000     0.0000    50.3103    57.5051    53.5012     0.0000     0.0000     0.0000     0.0000 (315)
Pumps and Fa   24.0336    21.7078    24.0336    23.2584    24.0336    23.2584    24.0336    24.0336    23.2584    24.0336    23.2584    24.0336 (331)
Lighting       26.7589    21.4670    19.3286    14.1610    10.9383     8.9367     9.9783    12.9702    16.8470    22.1042    24.9666    27.5026 (332)
Electricity generated by PVs (Appendix M) (negative quantity)
(333a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335a)
Electricity generated by PVs (Appendix M) (negative quantity)
(333b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(334b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(335b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (335b)
Annual totals kWh/year
Space heating fuel - community heating                                                                                                    835.7027 (307)
Space heating fuel - secondary                                                                                                              0.0000 (309)
Water heating fuel - community heating                                                                                                   1505.1494 (310)
Efficiency of water heater                                                                                                                  0.0000 (311)
Electricity used for heat distribution                                                                                                      8.3570 (313)
Space cooling fuel                                                                                                                        161.3166 (321)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)
   mechanical ventilation fans (SFP =        0.6820)                                                                                      282.9768 (330a)
Total electricity for the above, kWh/year                                                                                                 282.9768 (331)
Electricity for lighting (calculated in Appendix L)                                                                                       215.9594 (332)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                               0.0000 (333)
Wind generation                                                                                                                             0.0000 (334)
Hydro-electric generation (Appendix N)                                                                                                      0.0000 (335a)
Electricity generated - Micro CHP (Appendix N)                                                                                              0.0000 (335)
Appendix Q - special features
Energy saved or generated                                                                                                                  -0.0000 (336)
Energy used                                                                                                                                 0.0000 (337)
Total delivered energy for all uses                                                                                                      3839.2152 (338)



----------------------------------------------------------------------------------------------------
10b. Fuel costs - using BEDF prices (511)
----------------------------------------------------------------------------------------------------
                                                                                                    Fuel            Fuel price             Fuel cost
                                                                                                kWh/year                 p/kWh                £/year
Space heating from Boilers                                                                      835.7027                3.5000               29.2496 (340a)
Space heating total                                                                                                                          29.2496 (340)
Total CO2 associated with community systems                                                                                                   0.0000 (473)
Space heating - secondary                                                                         0.0000                0.0000                0.0000 (341)
Water heating from Boilers                                                                     1505.1494                3.5000               52.6802 (342a)
Water heating total                                                                                                                          52.6802 (342)
Energy for instantaneous electric shower(s)                                                     838.1104               18.3900              154.1285 (347a)
Space cooling                                                                                   161.3166               18.3900               29.6661 (348)
Pumps, fans and electric keep-hot                                                               282.9768               18.3900               52.0394 (349)
```

Energy for lighting	215.9594	18.3900	39.7149 (350)
Additional standing charges			94.0000 (351)
Total energy cost			451.4788 (355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Boilers			89.5000 (367)
Space and Water heating from Boilers	2615.4772	0.2100	196.0867 (367)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	3.4462 (372)
Overall CO2 factor for heat network			0.2361 (386)
Total CO2 associated with community systems			552.6964 (373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997 (264a)
Space and water heating			552.6964 (376)
Space cooling	161.3166	0.1141	18.4124 (377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524 (378)
Energy for lighting	215.9594	0.1443	31.1696 (379)
Total CO2, kg/year			758.1305 (383)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Efficiency of heat source Boilers			89.5000 (467a)
Space and Water heating from Boilers	2615.4772	1.1300	1055.1330 (467)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	36.1556 (472)
Overall CO2 factor for heat network			1.2780 (486)
Total CO2 associated with community systems			2991.6448 (473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792 (278a)
Space and water heating			2991.6448 (476)
Space cooling	161.3166	1.4207	229.1765 (477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873 (478)
Energy for lighting	215.9594	1.5338	331.2457 (479)
Total Primary energy kWh/year			5249.3335 (483)

SAP 10 EPC IMPROVEMENTS

A-GF-02 BeLean_Copy

Current energy efficiency rating: B 83
Current environmental impact rating: A 93

N Solar water heating	Not applicable
U Solar photovoltaic panels	Not applicable
V2 Wind turbine	Not applicable

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

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

Potential energy efficiency rating: B 83
Potential environmental impact rating: A 93

Fuel prices for cost data on this page from database revision number 511 TEST (31 Jan 2023)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, Thames Valley):

	Current	Potential	Saving
Electricity	£276	£276	£0
Community scheme	£176	£176	£0
Space heating	£175	£175	£0
Space cooling	£30	£30	£0
Water heating	£207	£207	£0
Lighting	£40	£40	£0
Total cost of fuels	£452	£452	£0
Total cost of uses	£452	£452	£0
Delivered energy	34 kWh/m²	34 kWh/m²	0 kWh/m²
Carbon dioxide emissions	0.8 tonnes	0.8 tonnes	0.0 tonnes
CO2 emissions per m²	7 kg/m²	7 kg/m²	0 kg/m²
Primary energy	47 kWh/m²	47 kWh/m²	0 kWh/m²

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	61.0000 (1b)	x	2.9000 (2b)	=	176.9000 (1b) -
First floor	51.0000 (1c)	x	3.2000 (2c)	=	163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 112.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	340.1000 (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		3.0000 (17)
Infiltration rate		0.1500 (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) =	0.1500 (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	0.1912	0.1875	0.1837	0.1650	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1687	0.1762	(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) =	84.6000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.2682	0.2645	0.2607	0.2420	0.2382	0.2195	0.2195	0.2157	0.2270	0.2382	0.2457	0.2532	(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	
Front Door			2.0000	1.0000	2.0000			(26)
Window (Uw = 1.20)			23.8500	1.1450	27.3092			(27)
Opening			2.1300	1.1450	2.4389			(27a)
Floor to unheated			61.0000	0.1000	6.1000			(28a)
External Wall LGF	31.6000	15.4100	16.1900	0.1500	2.4285			(29a)
External Wall UGF	36.8000	10.4400	26.3600	0.1500	3.9540			(29a)
LGF Roof	7.1700	2.1300	5.0400	0.1000	0.5040			(30)
Total net area of external elements Aum(A, m2)			136.5700					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	44.7346			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)		5.4628 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	50.1974 (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	30.1065	29.6856	29.2648	27.1604	26.7395	24.6351	24.6351	24.2143	25.4769	26.7395	27.5813	28.4230	(38)
Heat transfer coeff	80.3039	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204	(39)

Average = Sum(39)m / 12 = 77.2526

```
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP            0.7170     0.7132     0.7095     0.6907     0.6869     0.6681     0.6681     0.6644     0.6757     0.6869     0.6945     0.7020 (40)
HLP (average)                                                                                                                         0.6898
Days in mont       31         28         31         30         31         30         31         31         30         31         30         31



----------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                     2.8263 (42)
Hot water usage for mixer showers
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (42a)
Hot water usage for baths
                 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
                43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (42c)
Average daily hot water use (litres/day)                                                                                             39.6130 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
                43.5743    41.9897    40.4052    38.8207    37.2362    35.6517    35.6517    37.2362    38.8207    40.4052    41.9897    43.5743 (44)
Energy conte   69.0110    59.7928    62.1013    53.1436    50.1271    43.8379    43.1176    46.1062    47.8698    54.8295    59.8221    68.2268 (45)
Energy content (annual)                                                                                  Total = Sum(45)m =     657.9858
Distribution loss  (46)m = 0.15 x (45)m
                10.3516     8.9689     9.3152     7.9715     7.5191     6.5757     6.4676     6.9159     7.1805     8.2244     8.9733    10.2340 (46)
Water storage loss:
Store volume                                                                                                                        110.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                          0.0152 (51)
  Volume factor from Table 2a                                                                                                         1.0294 (52)
  Temperature factor from Table 2b                                                                                                    0.6000 (53)
Enter (49) or (54) in (55)                                                                                                            1.0327 (55)
Total storage loss
                32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (56)
If cylinder contains dedicated solar storage
                32.0144    28.9162    32.0144    30.9817    32.0144    30.9817    32.0144    32.0144    30.9817    32.0144    30.9817    32.0144 (57)
Primary loss   23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Combi loss      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (61)
Total heat required for water heating calculated for each month
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (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
               124.2878   109.7203   117.3781   106.6373   105.4039    97.3316    98.3944   101.3830   101.3635   110.1063   113.3158   123.5036 (64)
                                                                                    Total per year (kWh/year) = Sum(64)m =   1308.8255 (64)
Electric shower(s)
                73.6804    65.6499    71.6871    68.4101    69.6938    66.4812    68.6972    69.6938    68.4101    71.6871    70.3391    73.6804 (64a)
                                                    Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =    838.1104 (64a)
Heat gains from water heating, kWh/month
                85.5877    76.2355    82.7919    77.5677    78.3122    73.9913    75.7323    76.9752    75.8142    80.3740    80.2706    85.3269 (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          169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788   169.5788 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                30.5713    27.1531    22.0824    16.7178    12.4968    10.5503    11.4000    14.8181    19.8888    25.2534    29.4745    31.4210 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               409.5503   413.8002   403.0907   380.2914   351.5115   324.4624   306.3920   302.1421   312.8516   335.6509   364.4308   391.4799 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842    54.7842 (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)
              -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525  -113.0525 (71)
Water heating gains (Table 5)
               115.0372   113.4457   111.2795   107.7330   105.2583   102.7657   101.7908   103.4613   105.2975   108.0296   111.4869   114.6868 (72)
Total internal gains
               666.4693   665.7095   647.7630   616.0527   580.5770   549.0889   530.8932   531.7320   549.3484   580.2443   616.7026   648.8980 (73)



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6. Solar gains
----------------------------------------------------------------------------------------------------

[Jan]                                         Area         Solar flux                g                FF             Access              Gains
                                                m2           Table 6a     Specific data    Specific data             factor                  W
                                                                 W/m2       or Table 6b       or Table 6c           Table 6d
----------------------------------------------------------------------------------------------------
North                                       8.5700            10.6334            0.4000           0.8000             0.7700            20.2086 (74)
South                                      15.2800            46.7521            0.4000           0.8000             0.7700           158.4190 (78)
North                                       2.1300            26.0000            0.4000           0.7000             1.0000            13.9558 (82)
----------------------------------------------------------------------------------------------------

Solar gains    192.5834   327.0542   447.6459   559.4518   634.2937   633.9533   609.3668   552.3024   485.8676   361.2385   230.4236   165.0075 (83)
Total gains    859.0526   992.7637  1095.4089  1175.5045  1214.8707  1183.0422  1140.2600  1084.0343  1035.2160   941.4828   847.1262   813.9055 (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	96.8543	97.3646	97.8803	100.5429	101.0929	103.9358	103.9358	104.5236	102.7797	101.0929	99.9989	98.9282	
alpha	7.4570	7.4910	7.5254	7.7029	7.7395	7.9291	7.9291	7.9682	7.8520	7.7395	7.6666	7.5952	
util living area	0.9867	0.9631	0.9038	0.7637	0.5849	0.4046	0.2888	0.3157	0.5032	0.8021	0.9621	0.9901	(86)
MIT	20.4873	20.6569	20.8312	20.9601	20.9948	20.9998	21.0000	21.0000	20.9987	20.9530	20.7222	20.4633	(87)
Th 2	20.3258	20.3292	20.3325	20.3491	20.3524	20.3691	20.3691	20.3724	20.3624	20.3524	20.3457	20.3391	(88)
util rest of house	0.9831	0.9542	0.8842	0.7305	0.5456	0.3648	0.2474	0.2727	0.4572	0.7646	0.9514	0.9874	(89)
MIT 2	19.7360	19.9486	20.1581	20.3129	20.3485	20.3689	20.3690	20.3724	20.3616	20.3115	20.0454	19.7170	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	19.8635	20.0688	20.2723	20.4227	20.4582	20.4759	20.4761	20.4789	20.4697	20.4203	20.1602	19.8436	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8635	20.0688	20.2723	20.4227	20.4582	20.4759	20.4761	20.4789	20.4697	20.4203	20.1602	19.8436	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9801	0.9502	0.8823	0.7344	0.5521	0.3716	0.2544	0.2800	0.4650	0.7687	0.9479	0.9849	(94)
Useful gains	841.9312	943.3598	966.4632	863.2718	670.6746	439.6041	290.0530	303.5055	481.3854	723.7079	803.0237	801.5840	(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	1249.8062	1211.7262	1094.3744	891.3708	673.8266	439.7120	290.0572	303.5141	482.0234	755.5443	1015.8073	1229.9070	(97)
Space heating kWh	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98a)
Space heating requirement - total per year (kWh/year)												1097.1065	
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	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1097.1065	
Space heating per m2											(98c) / (4) =	9.7956	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	703.4258	553.7608	565.5286	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9959	0.9990	0.9984	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	700.5422	553.2038	564.5982	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1271.9489	1226.0126	1163.0526	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	411.4128	500.5697	445.2500	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9821	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	101.0165	122.9077	109.3248	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												333.2491	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Boilers-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system	1.1500	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	303.4591	180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.15													
307a	348.9779	207.3936	109.4408	23.2660	2.6969	0.0000	0.0000	0.0000	0.0000	27.2393	176.1848	366.4732	
Space heating requirement	348.9779	207.3936	109.4408	23.2660	2.6969	0.0000	0.0000	0.0000	0.0000	27.2393	176.1848	366.4732	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Annual water heating requirement	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)

Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15

310a	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	
Water heating fuel													
	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)
Cooling System Energy Efficiency Ratio												2.6000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	38.8525	47.2722	42.0480	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	24.0336	21.7078	24.0336	23.2584	24.0336	23.2584	24.0336	24.0336	23.2584	24.0336	23.2584	24.0336	(331)
Lighting	26.7589	21.4670	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)

Annual totals kWh/year

Space heating fuel - community heating	1261.6724	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	1505.1494	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	12.6167	(313)
Space cooling fuel	128.1727	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)

mechanical ventilation fans (SFP = 0.6820)	282.9768	(330a)
Total electricity for the above, kWh/year	282.9768	(331)
Electricity for lighting (calculated in Appendix L)	215.9594	(332)

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

PV generation	0.0000	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	4232.0411	(338)

10b. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Boilers	1261.6724	4.4400	56.0183	(340a)
Space heating total			56.0183	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Boilers	1505.1494	4.4400	66.8286	(342a)
Water heating total			66.8286	(342)
Energy for instantaneous electric shower(s)	838.1104	16.4900	138.2044	(347a)
Space cooling	128.1727	16.4900	21.1357	(348)
Pumps, fans and electric keep-hot	282.9768	16.4900	46.6629	(349)
Energy for lighting	215.9594	16.4900	35.6117	(350)
Additional standing charges			92.0000	(351)
Total energy cost			456.4615	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12):		0.3600	(356)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.0467	(357)
SAP value		83.0336	
SAP rating (Section 12)		83	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			89.5000	(367)
Space and Water heating from Boilers	3091.4210	0.2100	296.0349	(367)
Electrical energy for heat distribution (space & water)	12.6167	0.0000	4.1153	(372)
Overall CO2 factor for heat network			0.2361	(386)
Total CO2 associated with community systems			653.3137	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			653.3137	(376)
Space cooling	128.1727	0.1141	14.6189	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			854.9543	(383)
CO2 emissions per m2			7.6300	(384)

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EI value                                                                                                                92.7029 (384a)
EI rating                                                                                                                    93 (385)
EI band                                                                                                                       A

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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING
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1. Overall dwelling characteristics
---------------------------------------------------------------------------------------------------
                                                                                    Area         Storey height              Volume
                                                                                    (m2)                   (m)                (m3)
Ground floor                                                                   61.0000 (1b)    x       2.9000 (2b)     =    176.9000 (1b) -
First floor                                                                    51.0000 (1c)    x       3.2000 (2c)     =    163.2000 (1c) -
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             112.0000                                                            (4)
Dwelling volume                                                                     (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    340.1000 (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                                                                                                        3.0000 (17)
Infiltration rate                                                                                                           0.1500 (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)  =      0.1500 (21)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Wind speed       4.2000     4.0000     4.0000     3.7000     3.7000     3.3000     3.4000     3.2000     3.3000     3.5000     3.5000     3.8000 (22)
Wind factor      1.0500     1.0000     1.0000     0.9250     0.9250     0.8250     0.8500     0.8000     0.8250     0.8750     0.8750     0.9500 (22a)
Adj infilt rate
                 0.1575     0.1500     0.1500     0.1388     0.1388     0.1237     0.1275     0.1200     0.1237     0.1313     0.1313     0.1425 (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) =                               84.6000 (23c)

Effective ac     0.2345     0.2270     0.2270     0.2157     0.2157     0.2007     0.2045     0.1970     0.2007     0.2082     0.2082     0.2195 (25)

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3. Heat losses and heat loss parameter
---------------------------------------------------------------------------------------------------
Element                                       Gross        Openings        NetArea        U-value          A x U         K-value           A x K
                                                 m2              m2             m2          W/m2K            W/K          kJ/m2K            kJ/K
Front Door                                                                  2.0000         1.0000         2.0000                                (26)
Window (Uw = 1.20)                                                         23.8500         1.1450        27.3092                                (27)
Opening                                                                     2.1300         1.1450         2.4389                                (27a)
Floor to unheated                                                          61.0000         0.1000         6.1000                                (28a)
External Wall LGF                           31.6000         15.4100        16.1900         0.1500         2.4285                                (29a)
External Wall UGF                           36.8000         10.4400        26.3600         0.1500         3.9540                                (29a)
LGF Roof                                     7.1700          2.1300         5.0400         0.1000         0.5040                                (30)
Total net area of external elements Aum(A, m2)                            136.5700                                                              (31)
Fabric heat loss, W/K = Sum (A x U)                                              (26)...(30) + (32) =    44.7346                                (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                         250.0000 (35)
Thermal bridges (User defined value 0.040 * total exposed area)                                                             5.4628 (36)
Point Thermal bridges                                                                                          (36a) =      0.0000
Total fabric heat loss                                                                          (33) + (36) + (36a) =     50.1974 (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	26.3186	25.4769	25.4769	24.2143	24.2143	22.5308	22.9516	22.1099	22.5308	23.3725	23.3725	24.6351	(38)
Heat transfer coeff													
	76.5160	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325	(39)
Average = Sum(39)m / 12 =												74.1311	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.6832	0.6757	0.6757	0.6644	0.6644	0.6494	0.6531	0.6456	0.6494	0.6569	0.6569	0.6681	(40)
HLP (average)												0.6619	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.8263	(42)
Hot water usage for mixer showers													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths													
	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													
	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(42c)
Average daily hot water use (litres/day)												39.6130	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	43.5743	41.9897	40.4052	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743	(44)
Energy conte	69.0110	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295	59.8221	68.2268	(45)
Energy content (annual)										Total = Sum(45)m =		657.9858	
Distribution loss (46)m = 0.15 x (45)m													
	10.3516	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
Water storage loss:													
Store volume												110.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0152	(51)
Volume factor from Table 2a												1.0294	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.0327	(55)
Total storage loss													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage													
	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(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													
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
								Total per year (kWh/year) = Sum(64)m =				1308.8255	(64)
Electric shower(s)													
	73.6804	65.6499	71.6871	68.4101	69.6938	66.4812	68.6972	69.6938	68.4101	71.6871	70.3391	73.6804	(64a)
					Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =							838.1104	(64a)
Heat gains from water heating, kWh/month													
	85.5877	76.2355	82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(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	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	30.5713	27.1531	22.0824	16.7178	12.4968	10.5503	11.4000	14.8181	19.8888	25.2534	29.4745	31.4210	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	409.5503	413.8002	403.0907	380.2914	351.5115	324.4624	306.3920	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	(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)													
	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating gains (Table 5)													
	115.0372	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
Total internal gains													
	666.4693	665.7095	647.7630	616.0527	580.5770	549.0889	530.8932	531.7320	549.3484	580.2443	616.7026	648.8980	(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	8.5700	11.9814	0.4000	0.8000	0.7700	22.7705	(74)
South	15.2800	50.9848	0.4000	0.8000	0.7700	172.7617	(78)
North	2.1300	30.0000	0.4000	0.7000	1.0000	16.1028	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	211.6350	323.4846	438.5844	568.4742	631.7399	677.5182	643.4626	593.4386	517.1329	381.7370	259.4024	179.6047	(83)
Total gains	878.1043	989.1941	1086.3474	1184.5269	1212.3169	1226.6071	1174.3557	1125.1706	1066.4813	961.9814	876.1050	828.5027	(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	101.6490	102.7797	102.7797	104.5236	104.5236	106.9431	106.3278	107.5656	106.9431	105.7195	105.7195	103.9358	
alpha	7.7766	7.8520	7.8520	7.9682	7.9682	8.1295	8.0885	8.1710	8.1295	8.0480	8.0480	7.9291	
util living area	0.9766	0.9455	0.8616	0.6849	0.4902	0.2965	0.1931	0.2056	0.3954	0.7039	0.9243	0.9821	(86)
MIT	20.6244	20.7589	20.9024	20.9845	20.9989	21.0000	21.0000	21.0000	20.9999	20.9849	20.8458	20.6053	(87)
Th 2	20.3557	20.3624	20.3624	20.3724	20.3724	20.3858	20.3824	20.3891	20.3858	20.3791	20.3791	20.3691	(88)
util rest of house	0.9705	0.9332	0.8369	0.6497	0.4521	0.2600	0.1546	0.1664	0.3536	0.6622	0.9059	0.9772	(89)
MIT 2	19.9328	20.1015	20.2659	20.3593	20.3717	20.3858	20.3824	20.3891	20.3857	20.3672	20.2211	19.9207	(90)
Living area fraction									fLA = Living area / (4) =			0.1696	(91)
MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9670	0.9299	0.8373	0.6550	0.4585	0.2662	0.1612	0.1730	0.3607	0.6686	0.9042	0.9741	(94)
Useful gains	849.1664	919.8603	909.6463	775.8392	555.8471	326.5423	189.2509	194.7062	384.6626	643.1713	792.1827	807.0712	(95)
Ext temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	(96)
Heat loss rate W	1143.9218	1105.8306	981.7877	786.1877	556.4556	326.5474	189.2509	194.7063	384.7244	652.7086	906.9047	1117.7639	(97)
Space heating kWh	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98a)
Space heating requirement - total per year (kWh/year)												726.6980	
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	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												726.6980	
Space heating per m2											(98c) / (4) =	6.4884	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	5.1000	5.6000	7.4000	9.9000	13.0000	16.0000	17.9000	17.8000	15.2000	11.6000	8.0000	5.1000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	581.8253	446.2091	448.3052	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9993	0.9999	0.9998	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	581.4113	446.1459	448.2205	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1321.3284	1264.5960	1209.6840	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	532.7403	608.9269	566.5288	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			0.9821	(105)
Intermittency factor (Table 10b)	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	130.8068	149.5133	139.1031	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												419.4231	(107)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(301)
Fraction of space heat from community system	1.0000	(302)
Fraction of heat from community Boilers-Space and Water	1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating	1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating	1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system	1.1500	(306)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	219.2980	124.9721	53.6732	7.4509	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.15													
307a	252.1927	143.7179	61.7242	8.5685	0.5207	0.0000	0.0000	0.0000	0.0000	8.1601	94.9899	265.8287	
Space heating requirement	252.1927	143.7179	61.7242	8.5685	0.5207	0.0000	0.0000	0.0000	0.0000	8.1601	94.9899	265.8287	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)

Water heating

Annual water heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)

Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15

310a	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	

Water heating fuel

	142.9310	126.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)
Cooling System Energy Efficiency Ratio												2.6000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	50.3103	57.5051	53.5012	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	24.0336	21.7078	24.0336	23.2584	24.0336	23.2584	24.0336	24.0336	23.2584	24.0336	23.2584	24.0336	(331)
Lighting	26.7589	21.4670	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)

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

(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)

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

(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)

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

(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)

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

(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)

Annual totals kWh/year

Space heating fuel - community heating	835.7027	(307)
Space heating fuel - secondary	0.0000	(309)
Water heating fuel - community heating	1505.1494	(310)
Efficiency of water heater	0.0000	(311)
Electricity used for heat distribution	8.3570	(313)
Space cooling fuel	161.3166	(321)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820)

mechanical ventilation fans (SFP = 0.6820)	282.9768	(330a)
Total electricity for the above, kWh/year	282.9768	(331)
Electricity for lighting (calculated in Appendix L)	215.9594	(332)

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

PV generation	0.0000	(333)
Wind generation	0.0000	(334)
Hydro-electric generation (Appendix N)	0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(335)
Appendix Q - special features		
Energy saved or generated	-0.0000	(336)
Energy used	0.0000	(337)
Total delivered energy for all uses	3839.2152	(338)

10b. Fuel costs - using BEDF prices (511)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating from Boilers	835.7027	3.5000	29.2496	(340a)
Space heating total			29.2496	(340)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	0.0000	0.0000	0.0000	(341)
Water heating from Boilers	1505.1494	3.5000	52.6802	(342a)
Water heating total			52.6802	(342)
Energy for instantaneous electric shower(s)	838.1104	18.3900	154.1285	(347a)
Space cooling	161.3166	18.3900	29.6661	(348)
Pumps, fans and electric keep-hot	282.9768	18.3900	52.0394	(349)
Energy for lighting	215.9594	18.3900	39.7149	(350)
Additional standing charges			94.0000	(351)
Total energy cost			451.4788	(355)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			89.5000	(367)
Space and Water heating from Boilers	2615.4772	0.2100	196.0867	(367)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	3.4462	(372)
Overall CO2 factor for heat network			0.2361	(386)
Total CO2 associated with community systems			552.6964	(373)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997	(264a)
Space and water heating			552.6964	(376)
Space cooling	161.3166	0.1141	18.4124	(377)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524	(378)
Energy for lighting	215.9594	0.1443	31.1696	(379)
Total CO2, kg/year			758.1305	(383)

13b. Primary energy - Community heating scheme

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

Efficiency of heat source Boilers			89.5000 (467a)
Space and Water heating from Boilers	2615.4772	1.1300	1055.1330 (467)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	36.1556 (472)
Overall CO2 factor for heat network			1.2780 (486)
Total CO2 associated with community systems			2991.6448 (473)
Energy for instantaneous electric shower(s)	838.1104	1.5143	1269.1792 (278a)
Space and water heating			2991.6448 (476)
Space cooling	161.3166	1.4207	229.1765 (477)
Pumps, fans and electric keep-hot	282.9768	1.5128	428.0873 (478)
Energy for lighting	215.9594	1.5338	331.2457 (479)
Total Primary energy kWh/year			5249.3335 (483)

APPENDIX H – SBEM RESULTS

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_Refurb Hotel_Baseline

As designed

Date: Mon Feb 13 16:35:43 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m^2]: 150.13

The CO_2 emission and primary energy rates of the building must not exceed the targets

The building does not comply with England Building Regulations Part L 2021

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	16.78	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	45.69	
Target primary energy rate (TPER), $kWh_{PE}/m^2.annum$	121.79	
Building primary energy rate (BPER), $kWh_{PE}/m^2.annum$	330.99	
Do the building's emission and primary energy rates exceed the targets?	BER > TER	BPER > TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.55	0.55	L0000002:Surf[3]
Floors	0.18	0.31	1.2	L0000007:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	2.3	2.3	L000000A:Surf[0]
Windows** and roof windows	1.6	1.62	1.8	L0000002:Surf[0]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m^{2}K)]

U_{a-Calc} = Calculated area-weighted average U-values [W/(m^{2}K)]

U_{i-Calc} = Calculated maximum individual element U-values [W/(m^{2}K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m^{2}K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	25

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Boilers - Existing

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.84	2.6	0	-	-
Standard value	1	1.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

"No HWS in project, or hot water is provided by HVAC system"

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter
NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.	

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
L01_Refurb_Circulation	-	-	2.2	-	-	-	-	-	-	-	N/A
L02_Refurb_Circulation	-	-	2.2	-	-	-	-	-	-	-	N/A
L03_Refurb_FoodBev	-	-	2.2	-	-	-	-	-	-	-	N/A
L03_Refurb_Circ	-	-	2.2	-	-	-	-	-	-	-	N/A
L04_Refurb_FoodBev	-	-	2.2	-	-	-	-	-	-	-	N/A
L04_Refurb_Circ	-	-	2.2	-	-	-	-	-	-	-	N/A
LGF_Refurb_Kitch BOH	-	-	2.2	-	-	-	-	-	-	-	N/A
UGF_Refurb_Reception	-	-	2.2	-	-	-	-	-	-	-	N/A
UGF_Refurb_Cafe	-	-	2.2	-	-	-	-	-	-	-	N/A
L01_Refurb_Meeting	-	-	2.2	-	-	-	-	-	-	-	N/A
L01_Refurb_WC	-	-	2.2	-	-	-	-	-	-	-	N/A
L01_Refurb_Meeting	-	-	2.2	-	-	-	-	-	-	-	N/A
L02_Refurb_Meeting	-	-	2.2	-	-	-	-	-	-	-	N/A
L02_Refurb_Meeting	-	-	2.2	-	-	-	-	-	-	-	N/A
L02_Refurb_WC	-	-	2.2	-	-	-	-	-	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L01_Refurb_Circulation	51	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L02_Refurb_Circulation	51	-	-
L03_Refurb_FoodBev	51	-	-
L03_Refurb_Circ	51	-	-
L04_Refurb_FoodBev	51	-	-
L04_Refurb_Circ	51	-	-
LGF_Refurb_Kitch BOH	51	-	-
UGF_Refurb_Reception	51	15	9
UGF_Refurb_Cafe	51	15	10
L01_Refurb_Meeting	51	-	-
L01_Refurb_WC	51	-	-
L01_Refurb_Meeting	51	-	-
L02_Refurb_Meeting	51	-	-
L02_Refurb_Meeting	51	-	-
L02_Refurb_WC	51	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01_Refurb_Circulation	NO (-43.7%)	NO
L02_Refurb_Circulation	NO (-43.7%)	NO
L03_Refurb_FoodBev	NO (-60.5%)	NO
L03_Refurb_Circ	NO (-59.6%)	NO
L04_Refurb_FoodBev	NO (-74.2%)	NO
L04_Refurb_Circ	NO (-59.6%)	NO
LGF_Refurb_Kitch BOH	N/A	N/A
UGF_Refurb_Reception	NO (-78.9%)	NO
UGF_Refurb_Cafe	NO (-72.9%)	NO
L01_Refurb_Meeting	NO (-28.7%)	NO
L01_Refurb_WC	NO (-12.6%)	NO
L01_Refurb_Meeting	YES (+37.8%)	NO
L02_Refurb_Meeting	NO (-28.6%)	NO
L02_Refurb_Meeting	YES (+37.4%)	NO
L02_Refurb_WC	NO (-12.9%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	839.7	839.7
External area [m²]	1176.7	1176.7
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	25	3
Average conductance [W/K]	1102.57	523.93
Average U-value [W/m²K]	0.94	0.45
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
100	**Hotels**
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	104.01	26.7
Cooling	32.87	11.94
Auxiliary	11.54	4.07
Lighting	68.94	26.08
Hot water	43.54	26.91
Equipment*	143.37	143.37
TOTAL**	**260.9**	**95.69**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	511.49	326.56
Primary energy [kWh_{PE}/m^2]	330.99	121.79
Total emissions [kg/m²]	45.69	16.78

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] ASHP, [HFT] Natural Gas, [CFT] Electricity										
	Actual	293.1	218.4	104	32.9	11.5	0.78	1.85	0.84	2.6
	Notional	127.5	199.1	26.7	11.9	3	1.33	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_Refurb Hotel_Be Lean

As designed

Date: Tue Feb 14 16:31:09 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m²]: 150.13

The CO_2 emission and primary energy rates of the building must not exceed the targets

The building does not comply with England Building Regulations Part L 2021

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	11.97	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	12.9	
Target primary energy rate (TPER), $kWh_{PE}/m^2.annum$	132.5	
Building primary energy rate (BPER), $kWh_{PE}/m^2.annum$	142.14	
Do the building's emission and primary energy rates exceed the targets?	BER > TER	BPER > TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.21	0.55	GF000002:Surf[3]
Floors	0.18	0.1	0.1	L0000007:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	L000000A:Surf[0]
Windows** and roof windows	1.6	1.2	1.2	L0000002:Surf[0]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- Lean_ASHP

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	2.64	5.9	0	1.9	0.8
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- GIR - (DHW) Lean ASHP 50%, Boiler 50%

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	1.48	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**General luminaire**	**Display light source**	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
L01_Refurb_Circulation	110	-	-
L02_Refurb_Circulation	110	-	-
L03_Refurb_FoodBev	110	-	-
L03_Refurb_Circ	110	-	-
L04_Refurb_FoodBev	110	-	-
L04_Refurb_Circ	110	-	-
LGF_Refurb_Kitch BOH	110	-	-
UGF_Refurb_Reception	110	115	1.174
UGF_Refurb_Cafe	110	115	1.304
L01_Refurb_Meeting	110	-	-
L01_Refurb_WC	110	-	-
L01_Refurb_Meeting	110	-	-
L02_Refurb_Meeting	110	-	-
L02_Refurb_Meeting	110	-	-
L02_Refurb_WC	110	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	**Solar gain limit exceeded? (%)**	**Internal blinds used?**
L01_Refurb_Circulation	NO (-81.5%)	NO
L02_Refurb_Circulation	NO (-81.5%)	NO
L03_Refurb_FoodBev	NO (-86.9%)	NO
L03_Refurb_Circ	NO (-86.7%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L04_Refurb_FoodBev	NO (-89.9%)	NO
L04_Refurb_Circ	NO (-86.7%)	NO
LGF_Refurb_Kitch BOH	N/A	N/A
UGF_Refurb_Reception	NO (-80.1%)	NO
UGF_Refurb_Cafe	NO (-74.1%)	NO
L01_Refurb_Meeting	NO (-74.2%)	NO
L01_Refurb_WC	NO (-68.4%)	NO
L01_Refurb_Meeting	NO (-51%)	NO
L02_Refurb_Meeting	NO (-74.2%)	NO
L02_Refurb_Meeting	NO (-51.2%)	NO
L02_Refurb_WC	NO (-68.6%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	839.7	839.7
External area [m^2]	1176.7	1176.7
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	288.62	523.14
Average U-value [W/m^{2}K]	0.25	0.44
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
100	**Hotels**
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	2.12	2.09
Cooling	13.49	15.98
Auxiliary	25.08	21.57
Lighting	31.49	26.08
Hot water	24.72	23.86
Equipment*	143.37	143.37
TOTAL**	**96.9**	**89.59**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	198.64	287.4
Primary energy [kWh$_{PE}$/m^2]	142.14	132.5
Total emissions [kg/m^2]	12.9	11.97

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	18.9	179.7	2.1	13.5	25.1	2.49	3.7	2.64	5.9
	Notional	21	266.4	2.1	16	20.6	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_Refurb Hotel_Be Green

As designed

Date: Tue Feb 14 16:37:37 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.19

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.19

BRUKL compliance module version: v6.1.e.0

Foundation area [m²]: 150.13

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	11.97	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	10.91	
Target primary energy rate (TPER), $kWh_{PE}/m^2.annum$	132.5	
Building primary energy rate (BPER), $kWh_{PE}/m^2.annum$	120.34	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.21	0.55	GF000002:Surf[3]
Floors	0.18	0.1	0.1	L0000007:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	L000000A:Surf[0]
Windows** and roof windows	1.6	1.2	1.2	L0000002:Surf[0]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- GIR - Green (Heating & Cooling) ASHP 100%

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.6	5.9	0	1.8	0.9
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- GIR - (DHW) Lean ASHP 50%, Boiler 50%

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1.48	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
L01_Refurb_Circulation	135	-	-
L02_Refurb_Circulation	135	-	-
L03_Refurb_FoodBev	135	-	-
L03_Refurb_Circ	135	-	-
L04_Refurb_FoodBev	135	-	-
L04_Refurb_Circ	135	-	-
LGF_Refurb_Kitch BOH	135	-	-
UGF_Refurb_Reception	135	135	1
UGF_Refurb_Cafe	135	135	1.111
L01_Refurb_Meeting	135	-	-
L01_Refurb_WC	135	-	-
L01_Refurb_Meeting	135	-	-
L02_Refurb_Meeting	135	-	-
L02_Refurb_Meeting	135	-	-
L02_Refurb_WC	135	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01_Refurb_Circulation	NO (-81.5%)	NO
L02_Refurb_Circulation	NO (-81.5%)	NO
L03_Refurb_FoodBev	NO (-86.9%)	NO
L03_Refurb_Circ	NO (-86.7%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L04_Refurb_FoodBev	NO (-89.9%)	NO
L04_Refurb_Circ	NO (-86.7%)	NO
LGF_Refurb_Kitch BOH	N/A	N/A
UGF_Refurb_Reception	NO (-80.1%)	NO
UGF_Refurb_Cafe	NO (-74.1%)	NO
L01_Refurb_Meeting	NO (-74.2%)	NO
L01_Refurb_WC	NO (-68.4%)	NO
L01_Refurb_Meeting	NO (-51%)	NO
L02_Refurb_Meeting	NO (-74.2%)	NO
L02_Refurb_Meeting	NO (-51.2%)	NO
L02_Refurb_WC	NO (-68.6%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	839.7	839.7
External area [m^2]	1176.7	1176.7
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	288.62	523.14
Average U-value [W/m^2K]	0.25	0.44
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
100	**Hotels**
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	1.02	2.09
Cooling	11.29	15.98
Auxiliary	22.57	21.57
Lighting	22.48	26.08
Hot water	24.72	23.86
Equipment*	143.37	143.37
TOTAL**	**82.08**	**89.59**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	180.86	287.4
Primary energy [kWh_{PE}/m^2]	120.34	132.5
Total emissions [kg/m^2]	10.91	11.97

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	17.3	163.6	1	11.3	22.6	4.72	4.02	4.6	5.9
	Notional	21	266.4	2.1	16	20.6	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_New Hotel_2021_Lean_Lv5_ASHP-Elec.Boiler

As designed

Date: Tue Feb 14 17:11:02 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.18

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.18

BRUKL compliance module version: v6.1.d.0

Foundation area [m²]: 434.21

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	16.42	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	16.3	
Target primary energy rate (TPER), $kWh/m^2.annum$	182.14	
Building primary energy rate (BPER), $kWh/m^2.annum$	177.46	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.14	0.15	LG000010:Surf[0]
Floors	0.18	0.1	0.1	L0000003:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	LG000008:Surf[1]
Windows** and roof windows	1.6	1.14	1.14	LG000000:Surf[2]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Lean_ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.64	6.2	0	0.9	0.9
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- Notional DHW_Pump+Electric Boiler

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1.48	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**General luminaire**	**Display light source**	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
L01_Circ	135	-	-
L01_Circ	135	-	-
L01_Circ	135	-	-
L01_Circ	135	-	-
L01_Circ	135	-	-
L10_Circ	135	-	-
L10_Circ	135	-	-
L10_Circ	135	-	-
L10_Circ	135	-	-
LGF_ Circ	135	-	-
LGF_Restaurant	135	120	1.25
LGF_Lobby	135	120	1.125
LGF_WC	135	-	-
UGF_Restaurant	135	120	1.25
UGF_Circ	135	-	-
UGF_Circ	135	-	-
LGF_Circ	135	-	-
UGF_Lobby	135	120	1.125
LGF_Hotel Lobby	135	120	1.125
BS1_HB_Store	135	-	-
BS1_HB_Store	135	-	-
BS1_HB_Kitchen	135	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
BS1_HB_Cold Store	135	-	-
BS1_HB_Laundry	135	-	-
BS1_HB_Kitchen Storage	135	-	-
BS1_HB_Switch Room	135	-	-
BS1_HB_Hotel Waste	135	-	-
BS2_HB_Hotel AHU	135	-	-
BS2_HB_Store	135	-	-
BS2_HB_Hotel Comms	135	-	-
BS2_HB_Hotel AHU	135	-	-
BS2_HB_Store	135	-	-
BS2_HB_Kitchen Air Extract	135	-	-
BS2_HB_Circulation	135	-	-
BS2_HB_Staircase	135	-	-
BS2_HB_Kitchen Supply Air	135	-	-
BS1_HB_Circulation	135	-	-
L01_HotelRoom	135	-	-
L01_Bathroom	135	-	-
L02_Circ	135	-	-
L02_Circ	135	-	-
L02_Circ	135	-	-
L02_Circ	135	-	-
L02_Circ	135	-	-
L02_HotelRoom	135	-	-
L02_Bathroom	135	-	-
L03_Circ	135	-	-
L03_Circ	135	-	-
L03_Circ	135	-	-
L03_Circ	135	-	-
L03_Circ	135	-	-
L03_HotelRoom	135	-	-
L03_Bathroom	135	-	-
L04_Circ	135	-	-
L04_Circ	135	-	-
L04_Circ	135	-	-
L04_Circ	135	-	-
L04_Circ	135	-	-
L04_HotelRoom	135	-	-
L04_Bathroom	135	-	-
L05_Circ	135	-	-
L05_Circ	135	-	-
L05_Circ	135	-	-
L05_Circ	135	-	-
L09_Circ	135	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L09_Circ	135	-	-
L09_Circ	135	-	-
L10_Bathrooms	135	-	-
L10_Hotel Rooms	135	-	-
L11_Circ	135	-	-
L11_Circ	135	-	-
L11_Circ	135	-	-
L11_Circ	135	-	-
L11_Bathrooms	135	-	-
L11_Hotel Rooms	135	-	-
L12_Circ	135	-	-
L12_Circ	135	-	-
L12_Circ	135	-	-
L12_Circ	135	-	-
L12_Bathrooms	135	-	-
L12_Hotel Rooms	135	-	-
L13_Circ	135	-	-
L13_Circ	135	-	-
L13_Circ	135	-	-
L13_Circ	135	-	-
L13_Bathrooms	135	-	-
L13_Hotel Rooms	135	-	-
L09_Circ	135	-	-
L09_Hotel Rooms	135	-	-
L09_Bathrooms	135	-	-
L05_HotelRoom	135	-	-
L06_Circ	135	-	-
L06_Circ	135	-	-
L06_Circ	135	-	-
L06_Circ	135	-	-
L06_HotelRoom	135	-	-
L07_Circ	135	-	-
L07_Circ	135	-	-
L07_Circ	135	-	-
L07_HotelRoom	135	-	-
L07_HotelRoom	135	-	-
L08_Circ	135	-	-
L08_Circ	135	-	-
L08_Circ	135	-	-
L08_HotelRoom	135	-	-
L08_HotelRoom	135	-	-
L05_Bathroom	135	-	-
L05_Circ	135	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L05_HotelRoom	135	-	-
L06_Bathroom	135	-	-
L06_HotelRoom	135	-	-
L06_Circ	135	-	-
L07_Bathroom	135	-	-
L07_HotelRoom	135	-	-
L07_Circ	135	-	-
L08_Bathroom	135	-	-
L08_HotelRoom	135	-	-
L08_Circ	135	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01_Circ	NO (-99.4%)	NO
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L10_Circ	N/A	N/A
L10_Circ	NO (-99.6%)	NO
L10_Circ	N/A	N/A
L10_Circ	N/A	N/A
LGF_ Circ	N/A	N/A
LGF_Restaurant	NO (-88.3%)	NO
LGF_Lobby	NO (-71.2%)	NO
LGF_WC	N/A	N/A
UGF_Restaurant	NO (-94.7%)	NO
UGF_Circ	NO (-95.4%)	NO
UGF_Circ	NO (-80.6%)	NO
LGF_Circ	N/A	N/A
UGF_Lobby	NO (-93.2%)	NO
LGF_Hotel Lobby	N/A	N/A
BS1_HB_Store	N/A	N/A
BS1_HB_Store	N/A	N/A
BS1_HB_Kitchen	N/A	N/A
BS1_HB_Cold Store	N/A	N/A
BS1_HB_Laundry	N/A	N/A
BS1_HB_Kitchen Storage	N/A	N/A
BS1_HB_Hotel Waste	N/A	N/A
BS2_HB_Store	N/A	N/A
BS2_HB_Store	N/A	N/A
BS2_HB_Circulation	N/A	N/A
BS2_HB_Staircase	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
BS1_HB_Circulation	N/A	N/A
L01_HotelRoom	NO (-84.1%)	NO
L01_Bathroom	N/A	N/A
L02_Circ	NO (-99.4%)	NO
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_HotelRoom	NO (-81.4%)	NO
L02_Bathroom	N/A	N/A
L03_Circ	NO (-99.4%)	NO
L03_Circ	N/A	N/A
L03_Circ	N/A	N/A
L03_Circ	N/A	N/A
L03_Circ	NO (-99.8%)	NO
L03_HotelRoom	NO (-75.7%)	NO
L03_Bathroom	N/A	N/A
L04_Circ	NO (-99.3%)	NO
L04_Circ	N/A	N/A
L04_Circ	N/A	N/A
L04_Circ	N/A	N/A
L04_Circ	NO (-99.7%)	NO
L04_HotelRoom	NO (-70.7%)	NO
L04_Bathroom	N/A	N/A
L05_Circ	NO (-100%)	NO
L05_Circ	N/A	N/A
L05_Circ	N/A	N/A
L05_Circ	NO (-99.7%)	NO
L09_Circ	N/A	N/A
L09_Circ	NO (-99.9%)	NO
L09_Circ	N/A	N/A
L10_Bathrooms	NO (-58.4%)	NO
L10_Hotel Rooms	NO (-61.2%)	NO
L11_Circ	N/A	N/A
L11_Circ	NO (-99.7%)	NO
L11_Circ	N/A	N/A
L11_Circ	N/A	N/A
L11_Bathrooms	NO (-51.1%)	NO
L11_Hotel Rooms	NO (-57.9%)	NO
L12_Circ	N/A	N/A
L12_Circ	NO (-99.6%)	NO
L12_Circ	N/A	N/A
L12_Circ	N/A	N/A
L12_Bathrooms	NO (-50.9%)	NO
L12_Hotel Rooms	NO (-57.6%)	NO
L13_Circ	N/A	N/A
L13_Circ	NO (-99.5%)	NO
L13_Circ	N/A	N/A
L13_Circ	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L13_Bathrooms	NO (-50.7%)	NO
L13_Hotel Rooms	NO (-58%)	NO
L09_Circ	NO (-99.4%)	NO
L09_Hotel Rooms	NO (-60.2%)	NO
L09_Bathrooms	NO (-57.9%)	NO
L05_HotelRoom	NO (-65.3%)	NO
L06_Circ	N/A	N/A
L06_Circ	N/A	N/A
L06_Circ	N/A	N/A
L06_Circ	NO (-99.6%)	NO
L06_HotelRoom	NO (-63.4%)	NO
L07_Circ	N/A	N/A
L07_Circ	N/A	N/A
L07_Circ	N/A	N/A
L07_HotelRoom	NO (-61.6%)	NO
L07_HotelRoom	NO (-51.9%)	NO
L08_Circ	N/A	N/A
L08_Circ	N/A	N/A
L08_Circ	N/A	N/A
L08_HotelRoom	NO (-52.3%)	NO
L08_HotelRoom	NO (-60.7%)	NO
L05_Bathroom	NO (-100%)	NO
L05_Circ	NO (-98.2%)	NO
L05_HotelRoom	NO (-79%)	NO
L06_Bathroom	NO (-100%)	NO
L06_HotelRoom	NO (-74%)	NO
L06_Circ	NO (-98.2%)	NO
L07_Bathroom	NO (-100%)	NO
L07_HotelRoom	NO (-72%)	NO
L07_Circ	NO (-98.1%)	NO
L08_Bathroom	NO (-100%)	NO
L08_HotelRoom	NO (-70.7%)	NO
L08_Circ	NO (-87.2%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	7615.7	7615.7
External area [m^2]	7412.6	7412.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	2303.49	3535.81
Average U-value [W/m^{2}K]	0.31	0.48
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
100	**Hotels**
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	8.18	6.39
Cooling	2.32	5.41
Auxiliary	8.04	12.82
Lighting	7.37	10.32
Hot water	94.28	86.24
Equipment*	39.53	39.53
TOTAL**	**120.18**	**121.18**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	114.13	154.12
Primary energy [kWh/m^2]	177.46	182.14
Total emissions [kg/m^2]	16.3	16.42

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	81	38.3	8.6	2.4	8.4	2.63	4.4	2.64	6.2
	Notional	66.8	94.3	6.7	5.7	13.2	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_New Hotel_2021_Green_Lv5

As designed

Date: Tue Feb 14 18:13:47 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.18

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.18

BRUKL compliance module version: v6.1.d.0

Foundation area [m²]: 434.21

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	16.42	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	15.51	
Target primary energy rate (TPER), $kWh/m^2.annum$	182.14	
Building primary energy rate (BPER), $kWh/m^2.annum$	169.09	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.14	0.15	LG000010:Surf[0]
Floors	0.18	0.1	0.1	L0000003:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	LG000008:Surf[1]
Windows** and roof windows	1.6	1.14	1.14	LG000000:Surf[2]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	-	-	No personnel doors in building
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- GIR - Green (Heating & Cooling) ASHP 100%

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.6	5.9	0	1.6	0.9
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- Notional DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	2.86	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**General luminaire**	**Display light source**	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
L01_Circ	125	-	-
L01_Circ	125	-	-
L01_Circ	125	-	-
L01_Circ	125	-	-
L01_Circ	125	-	-
L10_Circ	125	-	-
L10_Circ	125	-	-
L10_Circ	125	-	-
L10_Circ	125	-	-
LGF_ Circ	125	-	-
LGF_Restaurant	125	120	1.25
LGF_Lobby	125	120	1.125
LGF_WC	125	-	-
UGF_Restaurant	125	120	1.25
UGF_Circ	125	-	-
UGF_Circ	125	-	-
LGF_Circ	125	-	-
UGF_Lobby	125	120	1.125
LGF_Hotel Lobby	125	120	1.125
BS1_HB_Store	125	-	-
BS1_HB_Store	125	-	-
BS1_HB_Kitchen	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
BS1_HB_Cold Store	125	-	-
BS1_HB_Laundry	125	-	-
BS1_HB_Kitchen Storage	125	-	-
BS1_HB_Switch Room	125	-	-
BS1_HB_Hotel Waste	125	-	-
BS2_HB_Hotel AHU	125	-	-
BS2_HB_Store	125	-	-
BS2_HB_Hotel Comms	125	-	-
BS2_HB_Hotel AHU	125	-	-
BS2_HB_Store	125	-	-
BS2_HB_Kitchen Air Extract	125	-	-
BS2_HB_Circulation	125	-	-
BS2_HB_Staircase	125	-	-
BS2_HB_Kitchen Supply Air	125	-	-
BS1_HB_Circulation	125	-	-
L01_HotelRoom	125	-	-
L01_Bathroom	125	-	-
L02_Circ	125	-	-
L02_Circ	125	-	-
L02_Circ	125	-	-
L02_Circ	125	-	-
L02_Circ	125	-	-
L02_HotelRoom	125	-	-
L02_Bathroom	125	-	-
L03_Circ	125	-	-
L03_Circ	125	-	-
L03_Circ	125	-	-
L03_Circ	125	-	-
L03_Circ	125	-	-
L03_HotelRoom	125	-	-
L03_Bathroom	125	-	-
L04_Circ	125	-	-
L04_Circ	125	-	-
L04_Circ	125	-	-
L04_Circ	125	-	-
L04_Circ	125	-	-
L04_HotelRoom	125	-	-
L04_Bathroom	125	-	-
L05_Circ	125	-	-
L05_Circ	125	-	-
L05_Circ	125	-	-
L05_Circ	125	-	-
L09_Circ	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L09_Circ	125	-	-
L09_Circ	125	-	-
L10_Bathrooms	125	-	-
L10_Hotel Rooms	125	-	-
L11_Circ	125	-	-
L11_Circ	125	-	-
L11_Circ	125	-	-
L11_Circ	125	-	-
L11_Bathrooms	125	-	-
L11_Hotel Rooms	125	-	-
L12_Circ	125	-	-
L12_Circ	125	-	-
L12_Circ	125	-	-
L12_Circ	125	-	-
L12_Bathrooms	125	-	-
L12_Hotel Rooms	125	-	-
L13_Circ	125	-	-
L13_Circ	125	-	-
L13_Circ	125	-	-
L13_Circ	125	-	-
L13_Bathrooms	125	-	-
L13_Hotel Rooms	125	-	-
L09_Circ	125	-	-
L09_Hotel Rooms	125	-	-
L09_Bathrooms	125	-	-
L05_HotelRoom	125	-	-
L06_Circ	125	-	-
L06_Circ	125	-	-
L06_Circ	125	-	-
L06_Circ	125	-	-
L06_HotelRoom	125	-	-
L07_Circ	125	-	-
L07_Circ	125	-	-
L07_Circ	125	-	-
L07_HotelRoom	125	-	-
L07_HotelRoom	125	-	-
L08_Circ	125	-	-
L08_Circ	125	-	-
L08_Circ	125	-	-
L08_HotelRoom	125	-	-
L08_HotelRoom	125	-	-
L05_Bathroom	125	-	-
L05_Circ	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
L05_HotelRoom	125	-	-
L06_Bathroom	125	-	-
L06_HotelRoom	125	-	-
L06_Circ	125	-	-
L07_Bathroom	125	-	-
L07_HotelRoom	125	-	-
L07_Circ	125	-	-
L08_Bathroom	125	-	-
L08_HotelRoom	125	-	-
L08_Circ	125	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01_Circ	NO (-99.4%)	NO
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L01_Circ	N/A	N/A
L10_Circ	N/A	N/A
L10_Circ	NO (-99.6%)	NO
L10_Circ	N/A	N/A
L10_Circ	N/A	N/A
LGF_ Circ	N/A	N/A
LGF_Restaurant	NO (-88.3%)	NO
LGF_Lobby	NO (-71.2%)	NO
LGF_WC	N/A	N/A
UGF_Restaurant	NO (-94.7%)	NO
UGF_Circ	NO (-95.4%)	NO
UGF_Circ	NO (-80.6%)	NO
LGF_Circ	N/A	N/A
UGF_Lobby	NO (-93.2%)	NO
LGF_Hotel Lobby	N/A	N/A
BS1_HB_Store	N/A	N/A
BS1_HB_Store	N/A	N/A
BS1_HB_Kitchen	N/A	N/A
BS1_HB_Cold Store	N/A	N/A
BS1_HB_Laundry	N/A	N/A
BS1_HB_Kitchen Storage	N/A	N/A
BS1_HB_Hotel Waste	N/A	N/A
BS2_HB_Store	N/A	N/A
BS2_HB_Store	N/A	N/A
BS2_HB_Circulation	N/A	N/A
BS2_HB_Staircase	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
BS1_HB_Circulation	N/A	N/A
L01_HotelRoom	NO (-84.1%)	NO
L01_Bathroom	N/A	N/A
L02_Circ	NO (-99.4%)	NO
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_Circ	N/A	N/A
L02_HotelRoom	NO (-81.4%)	NO
L02_Bathroom	N/A	N/A
L03_Circ	NO (-99.4%)	NO
L03_Circ	N/A	N/A
L03_Circ	N/A	N/A
L03_Circ	N/A	N/A
L03_Circ	NO (-99.8%)	NO
L03_HotelRoom	NO (-75.7%)	NO
L03_Bathroom	N/A	N/A
L04_Circ	NO (-99.3%)	NO
L04_Circ	N/A	N/A
L04_Circ	N/A	N/A
L04_Circ	N/A	N/A
L04_Circ	NO (-99.7%)	NO
L04_HotelRoom	NO (-70.7%)	NO
L04_Bathroom	N/A	N/A
L05_Circ	NO (-100%)	NO
L05_Circ	N/A	N/A
L05_Circ	N/A	N/A
L05_Circ	NO (-99.7%)	NO
L09_Circ	N/A	N/A
L09_Circ	NO (-99.9%)	NO
L09_Circ	N/A	N/A
L10_Bathrooms	NO (-58.4%)	NO
L10_Hotel Rooms	NO (-61.2%)	NO
L11_Circ	N/A	N/A
L11_Circ	NO (-99.7%)	NO
L11_Circ	N/A	N/A
L11_Circ	N/A	N/A
L11_Bathrooms	NO (-51.1%)	NO
L11_Hotel Rooms	NO (-57.9%)	NO
L12_Circ	N/A	N/A
L12_Circ	NO (-99.6%)	NO
L12_Circ	N/A	N/A
L12_Circ	N/A	N/A
L12_Bathrooms	NO (-50.9%)	NO
L12_Hotel Rooms	NO (-57.6%)	NO
L13_Circ	N/A	N/A
L13_Circ	NO (-99.5%)	NO
L13_Circ	N/A	N/A
L13_Circ	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L13_Bathrooms	NO (-50.7%)	NO
L13_Hotel Rooms	NO (-58%)	NO
L09_Circ	NO (-99.4%)	NO
L09_Hotel Rooms	NO (-60.2%)	NO
L09_Bathrooms	NO (-57.9%)	NO
L05_HotelRoom	NO (-65.3%)	NO
L06_Circ	N/A	N/A
L06_Circ	N/A	N/A
L06_Circ	N/A	N/A
L06_Circ	NO (-99.6%)	NO
L06_HotelRoom	NO (-63.4%)	NO
L07_Circ	N/A	N/A
L07_Circ	N/A	N/A
L07_Circ	N/A	N/A
L07_HotelRoom	NO (-61.6%)	NO
L07_HotelRoom	NO (-51.9%)	NO
L08_Circ	N/A	N/A
L08_Circ	N/A	N/A
L08_Circ	N/A	N/A
L08_HotelRoom	NO (-52.3%)	NO
L08_HotelRoom	NO (-60.7%)	NO
L05_Bathroom	NO (-100%)	NO
L05_Circ	NO (-98.2%)	NO
L05_HotelRoom	NO (-79%)	NO
L06_Bathroom	NO (-100%)	NO
L06_HotelRoom	NO (-74%)	NO
L06_Circ	NO (-98.2%)	NO
L07_Bathroom	NO (-100%)	NO
L07_HotelRoom	NO (-72%)	NO
L07_Circ	NO (-98.1%)	NO
L08_Bathroom	NO (-100%)	NO
L08_HotelRoom	NO (-70.7%)	NO
L08_Circ	NO (-87.2%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	7615.7	7615.7
External area [m²]	7412.6	7412.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2303.49	3535.81
Average U-value [W/m²K]	0.31	0.48
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
100	**Hotels**
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	4.99	6.39
Cooling	2.76	5.41
Auxiliary	15.04	12.82
Lighting	7.88	10.32
Hot water	85.04	86.24
Equipment*	39.53	39.53
TOTAL**	**115.72**	**121.18**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	1.1	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*1.1*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	114.16	154.12
Primary energy [kWh/m²]	169.09	182.14
Total emissions [kg/m²]	15.51	16.42

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	80.5	38.9	5.2	2.9	15.7	4.28	3.74	4.6	5.9
	Notional	66.8	94.3	6.7	5.7	13.2	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_Office_Lean_LV5_VRF_ASHP-Elec.Boiler

As designed

Date: Tue Feb 14 16:16:44 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.18

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.18

BRUKL compliance module version: v6.1.d.0

Foundation area [m²]: 1606.66

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	3.52	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	3.32	
Target primary energy rate (TPER), $kWh/m^2.annum$	38.84	
Building primary energy rate (BPER), $kWh/m^2.annum$	36.55	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	LG000000:Surf[1]
Floors	0.18	0.1	0.1	LG000000:Surf[0]
Pitched roofs	0.16	0.1	0.1	L0000006:Surf[60]
Flat roofs	0.18	0.1	0.1	GF000003:Surf[0]
Windows** and roof windows	1.6	1.14	1.14	LG000002:Surf[1]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	1.6	1.6	LG000002:Surf[2]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.64	5.9	0	1.8	0.9
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- Notional DHW-ASHP 50%, Boiler 50%

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1.48	-
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	**Zone**	**Standard**
BS1_OB_Office & Lab Waste	-	-	0.3	-	-	-	-	-	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
LGF_Circ	125	-	-
UGF_Gym	125	-	-
LGF_Circ	125	-	-
UGF_Office	125	-	-
UGF_Office	125	-	-
UGF_Office	125	-	-
UGF_Loading Bay	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
UGF_WC	125	-	-
UGF_WC	125	-	-
UGF_Circ	125	-	-
L02_WC	125	-	-
L02_WC	125	-	-
L02_Circ	125	-	-
L02_Office	125	-	-
L03_WC	125	-	-
L03_WC	125	-	-
L03_Circ	125	-	-
L03_Office	125	-	-
L04_WC	125	-	-
L04_WC	125	-	-
L04_Circ	125	-	-
L04_Office	125	-	-
L05_WC	125	-	-
L05_WC	125	-	-
L05_Circ	125	-	-
L05_Office	125	-	-
L06_Office	125	-	-
L06_WC	125	-	-
L06_WC	125	-	-
L06_Circ	125	-	-
L07_Office	125	-	-
L07_WC	125	-	-
L07_Circ	125	-	-
LGF_Entrance/Circulation	125	-	-
LGF_CycleStorage	125	-	-
LGF_WC	125	-	-
LGF_WC	125	-	-
LGF_Reception Cafe	125	-	-
LGF_Circulation Corridor	125	-	-
LGF_Office	125	-	-
BS1_OB_WC	125	-	-
BS1_OB_Circulation	125	-	-
BS1_OB_Male Showers	125	-	-
BS1_OB_Office & Lab Waste	125	-	-
BS1_OB_Telecom Intake Room	125	-	-
BS1_OB_Cycle Store	125	-	-
BS1_OB_Lab	125	-	-
BS1_OB_UKPN Room	125	-	-
BS1_OB_Circulation	125	-	-
BS1_OB_Ass Shower	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
BS1_OB_Male Showers	125	-	-
BS1_OB_Changing Room Female	125	-	-
BS1_OB_Female Showers	125	-	-
BS1_OB_Changing Room Male	125	-	-
BS1_OB_Male WC	125	-	-
BS1_OB_Female Showers	125	-	-
BS1_OB_Female WC	125	-	-
BS1_RB_Teaching	125	-	-
BS1_RB_Ciruclation	125	-	-
BS1_RB_Store	125	-	-
BS1_RB_Office	125	-	-
BS1_RB_Audiology	125	-	-
BS1_RB_Admin & Teaching	125	-	-
BS1_RB_WCs	125	-	-
BS1_RB_Circulation	125	-	-
BS2_RB_Ciruclation	125	-	-
BS2_RB_Store	125	-	-
BS2_RB_BSU	125	-	-
BS2_RB_WCs	125	-	-
BS2_RB_Staircase	125	-	-
BS2_OB_Staircase	125	-	-
BS3_OB_Staircase	125	-	-
BS3_OB_Core Circulation	125	-	-
BS3_OB_Lab AHU	125	-	-
BS3_OB_Water Tank Room	125	-	-
BS3_OB_Energy Center	125	-	-
BS3_OB_Attenuation Tank Room	125	-	-
BS3_OB_Rain Water Harvesting Tank	125	-	-
BS3_OB_Office Switch Room	125	-	-
BS3_OB_Smoke Extract Room	125	-	-
BS3_OB_FM Room	125	-	-
BS3_OB_Office Comms	125	-	-
BS3_OB_BCO Office AHU	125	-	-
BS3_OB_Commercial Springler Tank Room	125	-	-
BS2_OB_Lab	125	-	-
BS2_OB_Core Circulation	125	-	-
BS2_OB_WCs	125	-	-
BS1_OB_Circulation	125	-	-
LGF_RB_WCs	125	-	-
LGF_RB_Reception	125	120	1.125
LGF_RB_Core Circulation	125	-	-
LGF_RB_Store	125	-	-
LGF_RB_Office stairs	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
LGF_RB_Office	125	-	-
BS3_RB_Plant	125	-	-
BS3_RB_Circulation Corridor	125	-	-
BS3_RB_Core Circulation	125	-	-
BS3_RB_Store	125	-	-
BS2_RB_Core Corridor	125	-	-
BS2_RB_Lab	125	-	-
L01_WC	125	-	-
L01_WC	125	-	-
L01_Circ	125	-	-
L01_Office	125	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
LGF_Circ	N/A	N/A
UGF_Gym	NO (-95.8%)	NO
LGF_Circ	N/A	N/A
UGF_Office	NO (-85.4%)	NO
UGF_Office	NO (-84.6%)	NO
UGF_Office	NO (-86.3%)	NO
UGF_Loading Bay	NO (-86.5%)	NO
UGF_WC	N/A	N/A
UGF_WC	N/A	N/A
UGF_Circ	N/A	N/A
L02_WC	N/A	N/A
L02_WC	N/A	N/A
L02_Circ	N/A	N/A
L02_Office	NO (-75.4%)	NO
L03_WC	N/A	N/A
L03_WC	N/A	N/A
L03_Circ	N/A	N/A
L03_Office	NO (-70.7%)	NO
L04_WC	N/A	N/A
L04_WC	N/A	N/A
L04_Circ	N/A	N/A
L04_Office	NO (-70.7%)	NO
L05_WC	N/A	N/A
L05_WC	N/A	N/A
L05_Circ	N/A	N/A
L05_Office	NO (-69.1%)	NO
L06_Office	NO (-68.6%)	NO
L06_WC	N/A	N/A
L06_WC	NO (-86%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L06_Circ	NO (-67.7%)	NO
L07_Office	NO (-76.5%)	NO
L07_WC	N/A	N/A
L07_Circ	NO (-83.6%)	NO
LGF_Entrance/Circulation	NO (-87.7%)	NO
LGF_CycleStorage	N/A	N/A
LGF_WC	N/A	N/A
LGF_WC	N/A	N/A
LGF_Reception Cafe	NO (-82.6%)	NO
LGF_Circulation Corridor	N/A	N/A
LGF_Office	NO (-91.4%)	NO
BS1_OB_WC	N/A	N/A
BS1_OB_Circulation	N/A	N/A
BS1_OB_Male Showers	N/A	N/A
BS1_OB_Office & Lab Waste	N/A	N/A
BS1_OB_Cycle Store	N/A	N/A
BS1_OB_Lab	N/A	N/A
BS1_OB_Circulation	N/A	N/A
BS1_OB_Ass Shower	N/A	N/A
BS1_OB_Male Showers	N/A	N/A
BS1_OB_Changing Room Female	N/A	N/A
BS1_OB_Female Showers	N/A	N/A
BS1_OB_Changing Room Male	N/A	N/A
BS1_OB_Male WC	N/A	N/A
BS1_OB_Female Showers	N/A	N/A
BS1_OB_Female WC	N/A	N/A
BS1_RB_Teaching	N/A	N/A
BS1_RB_Ciruclation	N/A	N/A
BS1_RB_Store	N/A	N/A
BS1_RB_Office	N/A	N/A
BS1_RB_Audiology	N/A	N/A
BS1_RB_Admin & Teaching	N/A	N/A
BS1_RB_WCs	N/A	N/A
BS1_RB_Circulation	N/A	N/A
BS2_RB_Ciruclation	N/A	N/A
BS2_RB_Store	N/A	N/A
BS2_RB_BSU	N/A	N/A
BS2_RB_WCs	N/A	N/A
BS2_RB_Staircase	N/A	N/A
BS2_OB_Staircase	N/A	N/A
BS3_OB_Staircase	N/A	N/A
BS3_OB_Core Circulation	N/A	N/A
BS2_OB_Lab	N/A	N/A
BS2_OB_Core Circulation	N/A	N/A
BS2_OB_WCs	N/A	N/A
BS1_OB_Circulation	N/A	N/A
LGF_RB_WCs	N/A	N/A
LGF_RB_Reception	N/A	N/A
LGF_RB_Core Circulation	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
LGF_RB_Store	N/A	N/A
LGF_RB_Office stairs	N/A	N/A
LGF_RB_Office	N/A	N/A
BS3_RB_Circulation Corridor	N/A	N/A
BS3_RB_Core Circulation	N/A	N/A
BS3_RB_Store	N/A	N/A
BS2_RB_Core Corridor	N/A	N/A
BS2_RB_Lab	N/A	N/A
L01_WC	N/A	N/A
L01_WC	N/A	N/A
L01_Circ	N/A	N/A
L01_Office	NO (-72.7%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	21297	21297
External area [m²]	15399.6	15399.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	3935.48	5542.94
Average U-value [W/m²K]	0.26	0.36
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
80	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
20	**Residential Institutions: Universities and Colleges**
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	0.99	0.89
Cooling	3.89	6.39
Auxiliary	6.48	4.93
Lighting	8.44	9.36
Hot water	5.09	4.73
Equipment*	50.63	50.63
TOTAL**	**24.9**	**26.29**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	60.89	115.41
Primary energy [kWh/m²]	36.55	38.84
Total emissions [kg/m²]	3.32	3.52

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	9.8	58	1.1	4.3	7.2	2.48	3.71	2.64	5.9
	Notional	9.9	118.6	1	7.1	5.4	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

9370_GIR_Office_Green_LV5

As designed

Date: Tue Feb 14 15:37:41 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.18

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.18

BRUKL compliance module version: v6.1.d.0

Foundation area [m²]: 1606.66

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	3.52	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	3.15	
Target primary energy rate (TPER), $kWh/m^2.annum$	38.84	
Building primary energy rate (BPER), $kWh/m^2.annum$	34.76	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	LG000000:Surf[1]
Floors	0.18	0.1	0.1	LG000000:Surf[0]
Pitched roofs	0.16	0.1	0.1	L0000006:Surf[60]
Flat roofs	0.18	0.1	0.1	GF000003:Surf[0]
Windows** and roof windows	1.6	1.14	1.14	LG000002:Surf[1]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	1.6	1.6	LG000002:Surf[2]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- GIR - Green (Heating & Cooling) 100% ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.6	5.9	0	1.6	0.9
Standard value	2.5*	N/A	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

"No HWS in project, or hot water is provided by HVAC system"

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	**Zone**	**Standard**
BS1_OB_Office & Lab Waste	-	-	0.3	-	-	-	-	-	-	-	N/A

General lighting and display lighting

Zone name	General luminaire	Display light source	
	Efficacy [lm/W]	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
LGF_Circ	125	-	-
UGF_Gym	125	-	-
LGF_Circ	125	-	-
UGF_Office	125	-	-
UGF_Office	125	-	-
UGF_Office	125	-	-
UGF_Loading Bay	125	-	-
UGF_WC	125	-	-
UGF_WC	125	-	-
UGF_Circ	125	-	-
L02_WC	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
L02_WC	125	-	-
L02_Circ	125	-	-
L02_Office	125	-	-
L03_WC	125	-	-
L03_WC	125	-	-
L03_Circ	125	-	-
L03_Office	125	-	-
L04_WC	125	-	-
L04_WC	125	-	-
L04_Circ	125	-	-
L04_Office	125	-	-
L05_WC	125	-	-
L05_WC	125	-	-
L05_Circ	125	-	-
L05_Office	125	-	-
L06_Office	125	-	-
L06_WC	125	-	-
L06_WC	125	-	-
L06_Circ	125	-	-
L07_Office	125	-	-
L07_WC	125	-	-
L07_Circ	125	-	-
LGF_Entrance/Circulation	125	-	-
LGF_CycleStorage	125	-	-
LGF_WC	125	-	-
LGF_WC	125	-	-
LGF_Reception Cafe	125	-	-
LGF_Circulation Corridor	125	-	-
LGF_Office	125	-	-
BS1_OB_WC	125	-	-
BS1_OB_Circulation	125	-	-
BS1_OB_Male Showers	125	-	-
BS1_OB_Office & Lab Waste	125	-	-
BS1_OB_Telecom Intake Room	125	-	-
BS1_OB_Cycle Store	125	-	-
BS1_OB_Lab	125	-	-
BS1_OB_UKPN Room	125	-	-
BS1_OB_Circulation	125	-	-
BS1_OB_Ass Shower	125	-	-
BS1_OB_Male Showers	125	-	-
BS1_OB_Changing Room Female	125	-	-
BS1_OB_Female Showers	125	-	-
BS1_OB_Changing Room Male	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
BS1_OB_Male WC	125	-	-
BS1_OB_Female Showers	125	-	-
BS1_OB_Female WC	125	-	-
BS1_RB_Teaching	125	-	-
BS1_RB_Ciruclation	125	-	-
BS1_RB_Store	125	-	-
BS1_RB_Office	125	-	-
BS1_RB_Audiology	125	-	-
BS1_RB_Admin & Teaching	125	-	-
BS1_RB_WCs	125	-	-
BS1_RB_Circulation	125	-	-
BS2_RB_Ciruclation	125	-	-
BS2_RB_Store	125	-	-
BS2_RB_BSU	125	-	-
BS2_RB_WCs	125	-	-
BS2_RB_Staircase	125	-	-
BS2_OB_Staircase	125	-	-
BS3_OB_Staircase	125	-	-
BS3_OB_Core Circulation	125	-	-
BS3_OB_Lab AHU	125	-	-
BS3_OB_Water Tank Room	125	-	-
BS3_OB_Energy Center	125	-	-
BS3_OB_Attenuation Tank Room	125	-	-
BS3_OB_Rain Water Harvesting Tank	125	-	-
BS3_OB_Office Switch Room	125	-	-
BS3_OB_Smoke Extract Room	125	-	-
BS3_OB_FM Room	125	-	-
BS3_OB_Office Comms	125	-	-
BS3_OB_BCO Office AHU	125	-	-
BS3_OB_Commercial Springler Tank Room	125	-	-
BS2_OB_Lab	125	-	-
BS2_OB_Core Circulation	125	-	-
BS2_OB_WCs	125	-	-
BS1_OB_Circulation	125	-	-
LGF_RB_WCs	125	-	-
LGF_RB_Reception	125	120	1.125
LGF_RB_Core Circulation	125	-	-
LGF_RB_Store	125	-	-
LGF_RB_Office stairs	125	-	-
LGF_RB_Office	125	-	-
BS3_RB_Plant	125	-	-
BS3_RB_Circulation Corridor	125	-	-
BS3_RB_Core Circulation	125	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
BS3_RB_Store	125	-	-
BS2_RB_Core Corridor	125	-	-
BS2_RB_Lab	125	-	-
L01_WC	125	-	-
L01_WC	125	-	-
L01_Circ	125	-	-
L01_Office	125	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
LGF_Circ	N/A	N/A
UGF_Gym	NO (-95.9%)	NO
LGF_Circ	N/A	N/A
UGF_Office	NO (-85.6%)	NO
UGF_Office	NO (-84.9%)	NO
UGF_Office	NO (-86.5%)	NO
UGF_Loading Bay	NO (-86.8%)	NO
UGF_WC	N/A	N/A
UGF_WC	N/A	N/A
UGF_Circ	N/A	N/A
L02_WC	N/A	N/A
L02_WC	N/A	N/A
L02_Circ	N/A	N/A
L02_Office	NO (-75.8%)	NO
L03_WC	N/A	N/A
L03_WC	N/A	N/A
L03_Circ	N/A	N/A
L03_Office	NO (-71.2%)	NO
L04_WC	N/A	N/A
L04_WC	N/A	N/A
L04_Circ	N/A	N/A
L04_Office	NO (-71.2%)	NO
L05_WC	N/A	N/A
L05_WC	N/A	N/A
L05_Circ	N/A	N/A
L05_Office	NO (-69.6%)	NO
L06_Office	NO (-69.1%)	NO
L06_WC	N/A	N/A
L06_WC	NO (-86.2%)	NO
L06_Circ	NO (-68.2%)	NO
L07_Office	NO (-76.8%)	NO
L07_WC	N/A	N/A
L07_Circ	NO (-83.9%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
LGF_Entrance/Circulation	NO (-87.9%)	NO
LGF_CycleStorage	N/A	N/A
LGF_WC	N/A	N/A
LGF_WC	N/A	N/A
LGF_Reception Cafe	NO (-82.9%)	NO
LGF_Circulation Corridor	N/A	N/A
LGF_Office	NO (-91.6%)	NO
BS1_OB_WC	N/A	N/A
BS1_OB_Circulation	N/A	N/A
BS1_OB_Male Showers	N/A	N/A
BS1_OB_Office & Lab Waste	N/A	N/A
BS1_OB_Cycle Store	N/A	N/A
BS1_OB_Lab	N/A	N/A
BS1_OB_Circulation	N/A	N/A
BS1_OB_Ass Shower	N/A	N/A
BS1_OB_Male Showers	N/A	N/A
BS1_OB_Changing Room Female	N/A	N/A
BS1_OB_Female Showers	N/A	N/A
BS1_OB_Changing Room Male	N/A	N/A
BS1_OB_Male WC	N/A	N/A
BS1_OB_Female Showers	N/A	N/A
BS1_OB_Female WC	N/A	N/A
BS1_RB_Teaching	N/A	N/A
BS1_RB_Ciruclation	N/A	N/A
BS1_RB_Store	N/A	N/A
BS1_RB_Office	N/A	N/A
BS1_RB_Audiology	N/A	N/A
BS1_RB_Admin & Teaching	N/A	N/A
BS1_RB_WCs	N/A	N/A
BS1_RB_Circulation	N/A	N/A
BS2_RB_Ciruclation	N/A	N/A
BS2_RB_Store	N/A	N/A
BS2_RB_BSU	N/A	N/A
BS2_RB_WCs	N/A	N/A
BS2_RB_Staircase	N/A	N/A
BS2_OB_Staircase	N/A	N/A
BS3_OB_Staircase	N/A	N/A
BS3_OB_Core Circulation	N/A	N/A
BS2_OB_Lab	N/A	N/A
BS2_OB_Core Circulation	N/A	N/A
BS2_OB_WCs	N/A	N/A
BS1_OB_Circulation	N/A	N/A
LGF_RB_WCs	N/A	N/A
LGF_RB_Reception	N/A	N/A
LGF_RB_Core Circulation	N/A	N/A
LGF_RB_Store	N/A	N/A
LGF_RB_Office stairs	N/A	N/A
LGF_RB_Office	N/A	N/A
BS3_RB_Circulation Corridor	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
BS3_RB_Core Circulation	N/A	N/A
BS3_RB_Store	N/A	N/A
BS2_RB_Core Corridor	N/A	N/A
BS2_RB_Lab	N/A	N/A
L01_WC	N/A	N/A
L01_WC	N/A	N/A
L01_Circ	N/A	N/A
L01_Office	NO (-73.1%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	21297	21297
External area [m²]	15399.6	15399.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	3940.06	5542.94
Average U-value [W/m²K]	0.26	0.36
Alpha value* [%]	25	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
80	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
20	**Residential Institutions: Universities and Colleges**
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	0.57	0.89
Cooling	3.9	6.39
Auxiliary	5.77	4.93
Lighting	8.85	9.36
Hot water	4.62	4.73
Equipment*	50.63	50.63
TOTAL**	**23.7**	**26.29**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	61.21	115.41
Primary energy [kWh/m²]	34.76	38.84
Total emissions [kg/m²]	3.15	3.52

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	9.7	58.5	0.6	4.3	6.4	4.28	3.74	4.6	5.9
	Notional	9.9	118.6	1	7.1	5.4	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

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