# **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 of the development, against a Part L 2021 compliant scheme; and 45.3% for the APAT 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 nondomestic 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<sup>1</sup> 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;

<sup>1</sup> GLA "Part L 2021 and the Energy Assessment Guidance 2022 - Cover Note", accessed in January 2023 <u>https://www.london.gov.uk/programmesstrategies/planning/planning-applications-anddecisions/pre-planning-application-meetingservice/energy-planning-guidance</u>

- 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 <sub>2</sub> Savings at Be Lean Stage						
	SAF (Part L	2 10 . 2013)	SAP (Part L	10.2 . 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



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 <sub>2</sub> Savings at Be Green Stage						
	SA	P 10	SAP	10.2		
	(Part I	_ 2013)	(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<sub>2</sub> savings for the refurbishment are:

Refurbishment Regulated CO2 Savings					
	SAF	P 10	SAP 10.2		
	(Part L	. 2013)	(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 (Part L 1	10 2013)	SAP 1 (Part L	.0.2 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub>, 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 nondomestic portion of the scheme would be 195.3 tonnes per annum of regulated CO<sub>2</sub>, 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 dwellinas.



#### **DOMESTIC ENERGY HIERARCHY AND TARGETS - SAP 10.2**

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



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#### NON-DOMESTIC ENERGY HIERARCHY AND TARGETS - SAP 10.2

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



#### SITE WIDE ENERGY HIERARCHY AND TARGETS - SAP 10.2

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



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#### **REFURBISHMENT ONLY ENERGY HIERARCHY AND TARGETS - SAP 10.2**

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



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## 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.



## <DOCUMENT TITLE>

Site Location



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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 2<sup>nd</sup> 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 nonresidential 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.



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- 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<sub>2</sub>.
- 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 zerocarbon 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 nonresidential 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.



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### 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 onsite renewable energy technologies) applies for developments of five or more dwellings and/or more than 500sqm of any gross internal floorspace.



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#### 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 nonresidential 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.

#### Camden Planning Guidance

## Energy efficiency and adaptation

January 2021





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## 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<sub>2</sub> emissions of the proposed scheme for each of the steps of the **Energy Hierarchy**. The CO<sub>2</sub> 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.



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#### 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 nondomestic 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 airsource 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
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Domestic (U-values in W/m <sup>2</sup> .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 <sup>2</sup> .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%		



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Refurbished Building (U-values in W/m <sup>2</sup> .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 ( $\Psi$ ). 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 EnergyEfficiency for the residential portion of the scheme

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



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### **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 nonresidential 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.



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## 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/m <sup>2</sup> )	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/m <sup>2</sup> )	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/m <sup>2</sup> )		Total area weighted non- domestic cooling demand (MJ/year)	
Actual	58.5	1,245,875	
Notional	118.6	2,525,824	

## **BE LEAN CO<sub>2</sub> 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<sub>2</sub> Savings at Be Lean Stage

Regulated CO <sub>2</sub> Savings at Be Lean Stage					
SAP 10 (Part L 2013) (		SAP 10 (Part L 2013)		10.2 . 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.



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## 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<sub>2</sub> 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<sub>2</sub> 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
РЛ		Adopted - PV panels can be integrated on available roof space and can provide additional CO <sub>2</sub> 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	KI	Not adopted - Wind turbines located at the site will have a significant visual impact on the site and surroundings.	25 yrs.	Med	High	1



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# DETAILED ASSESSMENT OF PHOTOVOLTAIC PANELS

Four types of solar cells are available on the market at present and these are mono-crystalline, polycrystalline, 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<sub>2</sub> 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	S	outh
Predicted site solar energy	951	kWh/m².yr
System losses	20	%
System peak power	24.70	kWp
Array area	130	m <sup>2</sup>
Primary energy offset by PV	18,784	kWh/yr.
Total CO <sub>2</sub> savings	4.4	t/yr.
Regulated baseline CO <sub>2</sub> emissions	723.1	t/yr.
Total baseline CO <sub>2</sub> emissions	1,059.2	t/yr.
% Regulated CO <sub>2</sub> reduction*	0.6	%
% Total CO <sub>2</sub> reduction*	0.4	%

\* % reduction from site baseline



Figure 7: Monocrystalline PV arrays



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## **ENERGY STATEMENT**



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



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## 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.



330 Gray's Inn Road Page 35 of 56 Table 13: Summary of technical/operational data and estimated  $\mbox{CO}_2$  savings for ASHP

ASHP for domestic spa	ices
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 <sub>2</sub> savings	19.8 t/yr.
Regulated baseline CO <sub>2</sub> emissions	428.1 t/yr.
Total baseline CO <sub>2</sub> emissions	815.2 t/yr.
% Regulated CO <sub>2</sub> reduction*	4.2 %
% Total CO <sub>2</sub> reduction*	2.2 %
ASHP for non-domesti	c spaces
COP heating	4.6
COP cooling	5.9
Carbon intensity of electricity	0.233 kgCO <sub>2</sub> /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 <sub>2</sub> savings	197.0 t/yr.
Regulated baseline CO <sub>2</sub> emissions	428.1 t/yr.
Total baseline CO <sub>2</sub> emissions	815.2 t/yr.

% Regulated CO <sub>2</sub> reduction*	23.1 %
% Total CO <sub>2</sub> 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<sub>2</sub> 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 nondomestic 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.



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## **ENERGY STATEMENT**

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%



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# **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 postconstruction 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.



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## **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 postconstruction 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.

		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

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



# 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 CO2 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		SAP 10.2	
	(Part	L 2013)	(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

Refurbishment Regulated CO2 Savings				
	SAF	° 10	SAP 10.2	
	(Part L	. 2013)	(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

The regulated CO<sub>2</sub> savings for the refurbishment are:

### OFF SITE CO<sub>2</sub> 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<sub>2</sub> savings, of which 9% reduction is generated from onsite 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.



330 Gray's Inn Road Page 41 of 56 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<sub>2</sub> emissions after each step of the Energy Hierarchy for the domestic part of the development

	Carbon dioxide emissions for domestic buildings (tonnes CO2 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<sub>2</sub> savings from each stage of the Energy Hierarchy for the domestic part of the development

	Regulated domestic carbon dioxide savings		
	Tonnes CO <sub>2</sub> 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	for offset payments 834 tonnes over 30 years		

## NON-DOMESTIC CUMULATIVE SAVINGS

Table 18: CO<sub>2</sub> 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 <sub>2</sub> 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	



## **ENERGY STATEMENT**

Table 19: Regulated CO<sub>2</sub> 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		over 30 years	

## SITE-WIDE CUMULATIVE SAVINGS

Table 20: Site wide regulated  $CO_2$  emissions and savings

	Total regulated emissions (tonnes CO₂/year)	Regulated CO <sub>2</sub> savings (tonnes CO <sub>2</sub> /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-do	omestic to zero carbon	5,858 tonnes over 30 years	

## **REFURBISHMENT ONLY SAVINGS**

Table 21: Site wide regulated CO<sub>2</sub> emissions and savings

	Total regulated emissions (tonnes CO <sub>2</sub> /year)	Regulated CO <sub>2</sub> savings (tonnes CO <sub>2</sub> /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**

XC<sub>2</sub>

330 Gray's Inn Road



## **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<sup>1</sup> performance recommendations. These are rigorous targets that determine the acceptability of overheating based on the temperature differential between the internal and the external environment ( $\Delta$ T), 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<sup>2</sup> were also applied within this assessment. Approved Document Part O (AD O) was first published on 15<sup>th</sup> December 2021 and came into effect in England on 15<sup>th</sup> 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:

<sup>&</sup>lt;sup>1</sup> CIBSE TM59:2017 – Design Methodology for the assessment of overheating risk in homes

<sup>&</sup>lt;sup>2</sup> 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 I/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  $\Delta T$ , 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)
Ш	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.

<sup>&</sup>lt;sup>3</sup> 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.

 $<sup>^4</sup>$  T<sub>max</sub> 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	0.10	
Roof	0.10		
	U-value [W/m².K]	g-value	
Window	1.20	0.40	
	Air permeability (@50Pa)		
	3.0 m <sup>3</sup> /m <sup>2</sup> .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/m <sup>2</sup>	150 W sensible, 110 W latent	80 W		
Single Bedroom	2.0 W/m <sup>2</sup>	75 W sensible, 55 W latent	80 W		
1Bed Living/kitchen/dining area	2.0 W/m <sup>2</sup>	75 W sensible, 55 W latent	450 W		

2Bed Living/kitchen/dining area	2.0 W/m <sup>2</sup>	150 W sensible, 110 W latent	450 W
3Bed Living/kitchen/dining area	2.0 W/m <sup>2</sup>	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 6<sup>th</sup> and 11<sup>th</sup> 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 <sup>2</sup> ]	People [peak W]	Pipework [peak W]	
Corridor	2.0 W/m <sup>2</sup>	-	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 14<sup>th</sup> 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.

#### Openings to rooms above ground floor level

- 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.

#### Openings to rooms at ground floor level, unoccupied at night

- 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.

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 ope and p	ening degree profile				No. of roo	ms not meeti	ng 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

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

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 I/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.

Bedrooms KLDs Bedrooms TM59 TM52 Cooling KI Ds Bedrooms night-time TM52 Criterion Design Internal Coil 26°C ID g-value Criterion 1 1 change Doors Flow criterion Rate Window opening degree and No. of rooms not meeting criteria profile 90° (Part O 90° (Part O Open DSY2 6 07 19/19 7/19 9/9 No Profile) Profile) (day) 90° (Part O 90° (Part O Open 7 DSY3 0.7 No 18/19 13/19 9/9 Profile) Profile) (day) Yes 10° (Part O 10° (Part O Open 8 DSY2 0.4 (100 -17/190/19 0/9 daytime only) daytime only) (day) 110 l/s) Yes 10° (Part O 10° (Part O Open 9 DSY3 0.4 (100 -17/19 0/19 2/9 daytime only) daytime only) (day) 110 l/s)

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

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 6<sup>th</sup> and 11<sup>th</sup> 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*".

ID	Design change	Internal Gains from Communal Corridor	Weather File	Annual Hours T <sub>op</sub> > 28 °C	Criteria Met
10	Communal Corridor (No Environmental Fan)	Y	DSY1	25.9	Y
11	Environmental Fan 10I/s	Y	DSY1	12.2	Y
12	Environmental Fan 201/s	Y	DSY1	6.7	Y
13	Environmental Fan 30I/s	Y	DSY1	4	Y
14	Environmental Fan 40I/s	Y	DSY1	2.7	Y
15	DSY2 Weather File	Y	DSY2	4	Ν
16	DSY3 Weather File	Y	DSY3	5.2	Ν

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

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 I/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<sup>5</sup>.

<sup>&</sup>lt;sup>5</sup> 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 I/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.

Measure	Implementation
Minimise internal heat generation through energy efficient	cient 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.

Table 9: Summary of recommendations for the proposed development.



## **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 ( $\Delta$ T), 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<sub>e</sub>):

The number of hours ( $H_e$ ) during which  $\Delta T$  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<sub>e</sub>):

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<sub>upp</sub>):

To set an absolute maximum value for the indoor operative temperature, the value of  $\Delta T$  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]	U-value [W/m <sup>2</sup> .K]		
External Walls	0.15			
Ground Floor	0.10	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 m <sup>3</sup> /m <sup>2</sup> .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.

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.

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

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

#### 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.

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 <sup>2</sup>	13I/s/person	g-value 0.3	No	198 / 198
2	20%	5.20 W/m <sup>2</sup>	13I/s/person	g-value 0.3	No	12/ 198
3	0%	5.20 W/m <sup>2</sup>	13I/s/person	g-value 0.3	Yes	0/ 198

Table 4: Overheating assessment results for the hotel building.

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 <sup>2</sup>	13I/s/person	g-value 0.3	No	198 / 198	
2	20%	5.20 W/m <sup>2</sup>	13I/s/person	g-value 0.3	No	12/ 198	
3	0%	5.20 W/m <sup>2</sup>	13I/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.

	De	sign Summer Yea	r 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 <sup>2</sup>	13I/s/person	g-value 0.3	No	28 / 28
2	20%	11.25 W/m <sup>2</sup>	13I/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m <sup>2</sup>	13I/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m <sup>2</sup>	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m <sup>2</sup>	13I/s/person	g-value 0.3	Yes	0/ 28

Table 6: Overheating assessment results for the office building.

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.

	De	sign Summer Yea	r 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 <sup>2</sup>	13I/s/person	g-value 0.3	No	28 / 28
3	20%	7.5 W/m <sup>2</sup>	13I/s/person	g-value 0.3	No	28 / 28
4	20%	7.5 W/m <sup>2</sup>	18l/s/person	g-value 0.3	No	28 / 28
5	0%	11.25 W/m <sup>2</sup>	13I/s/person	g-value 0.3	Yes	2/ 28

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

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  $\mbox{\rm CO}_2$  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 <sub>2</sub> savings	209.2	t/yr.
Regulated baseline CO <sub>2</sub> emissions	723.1	t/yr.
Total baseline CO <sub>2</sub> emissions	1,059.2	t/yr.
% Regulated CO <sub>2</sub> reduction*	28.9	%
% Total CO <sub>2</sub> reduction*	19.8	%





#### 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<sub>2</sub> 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<sub>2</sub> 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  $\mbox{\rm CO}_2$  savings for solar thermal

Solar thermal			
Collector type	Evacuated tube		
System efficiency	40	%	
Orientation	South		
Predicted site solar energy	1079.5	kWh/m².yr	
Solar fraction	1.0	%	
Total collector area	100	m <sup>2</sup>	
Primary gas energy offset by solar thermal system	47,976	kWh/yr.	
Total CO <sub>2</sub> savings	10.1	t/yr.	
Regulated baseline CO <sub>2</sub> emissions	723.1	t/yr.	
Total baseline CO <sub>2</sub> emissions	1,059.2	t/yr.	
% Regulated CO <sub>2</sub> reduction*	1.4	%	
% Total CO <sub>2</sub> reduction*	1.0	%	





#### 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  $\mbox{CO}_2$  savings for GSHP

GSHP			
COP heating	3.5		
COP cooling	6.0		
Carbon intensity of electricity	0.233	kgCO <sub>2</sub> /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 <sub>2</sub> savings	369.8	t/yr.	
Regulated baseline CO <sub>2</sub> emissions	723.1	t/yr.	
Total baseline CO <sub>2</sub> emissions	1,059.2	t/yr.	
% Regulated CO <sub>2</sub> reduction*	51.1	%	
% Total CO <sub>2</sub> reduction*	34.9	%	





#### 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  $\mbox{CO}_2$  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 <sub>2</sub> /kWh
Total CO <sub>2</sub> savings	0.37	t/yr.
Regulated baseline CO <sub>2</sub> emissions	723.1	t/yr.
Total baseline CO <sub>2</sub> emissions	1,059.2	t/yr.
% Regulated CO <sub>2</sub> reduction*	0.0	%
% Total CO <sub>2</sub> 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 <sub>2</sub> /kWh
Total CO <sub>2</sub> savings		
	0.93	t/yr.
Regulated baseline CO <sub>2</sub> emissions	0.93 723.1	t/yr. t/yr.
Regulated baseline CO <sub>2</sub> emissions Total baseline CO <sub>2</sub> emissions	0.93 723.1 1,059.2	t/yr. t/yr. t/yr.
Regulated baseline CO <sub>2</sub> emissions Total baseline CO <sub>2</sub> emissions % Regulated CO <sub>2</sub> reduction*	0.93 723.1 1,059.2 0.1	t/yr. t/yr. %



# **APPENDIX C – DHN COMMUNICATION**



330 Gray's Inn Road

#### Nuno Correia

From:Alex NealSent:04 February 2020 12:04To:Sara Godinho; Nuno Correia; Ray Choi; Stefano Vegezzi; Merrick Odam; Matthew<br/>HartCc:Sophie HardySubject: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







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

#### <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



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# **APPENDIX D – ENERGY CENTRE**

XC<sub>@2</sub>

330 Gray's Inn Road
# **Basement 3**





	 	 	 	 	 		]

CONSULTANTS	NAME	NOTE	LOCATION V
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		proceedings and expenses arising out of reliance on such information - any scaling from this drawing other than by the local planning authority solely for	FI DE
		the purposes of the planning application to which it relates	

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#### **APPENDIX E – GLA ENERGY SUMMARY TABLES**

XC<sub>@2</sub>

330 Gray's Inn Road

#### Part L 2021 Performance Non-residential

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

	Carbon Dioxide Emission (Tonnes CO	s for residential buildings 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	

Residential

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

	Regulated residential carbon dioxide savings			
	(Tonnes CO <sub>2</sub> 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			
	(Tonne	s CO <sub>2</sub> )		
Cumulative savings for off-set payment	834			
Cash in-lieu contribution (£)	79,210			
*carbon price is based on G dioxide unless Local Planning	LA recommended price of £9 g Authority price is inputted in	5 per tonne of carbon the 'Development		



#### SITE-WIDE

	Total regulated emissions (Tonnes CO <sub>2</sub> / year)	CO <sub>2</sub> savings (Tonnes CO <sub>2</sub> / 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 <sub>2</sub> savings off-set (Tonnes CO <sub>2</sub> )	-
Off-set	-	6,691.5	-

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

	Carbon Dioxide Emissi build (Tonnes CO	ons for non-residential lings 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-residentia	Regulated non-residential carbon dioxide savings			
	(Tonnes CO <sub>2</sub> 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 <sub>2</sub> )				
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



	Target Fabric Energy	Dwelling Fabric Energy	Improvement
	Efficiency (kWh/m <sup>2</sup> )	Efficiency (kWh/m <sup>2</sup> )	(%)
Development total	17.63	15.66	11%

	Area weighted non-residential cooling demand (MJ/m <sup>2</sup> )	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/m <sup>2</sup> /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/m <sup>2</sup> /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/m <sup>2</sup> /year) (excluding renewable energy)	Space heating demand (kWh/m <sup>2</sup> /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/m <sup>2</sup> /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**

XC<sub>@2</sub>

330 Gray's Inn Road

#### 9\_370 - Gray's Inn Road SAP Calculation Assumptions



#### 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.

Opague Elements		
U-Values new elements		
Floors		
Ground and exposed floors	0.1 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage
Floor to commercial	0.2 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage
Walls	2	
External walls	0.15 W/m².K	Based on best judgement on Planning Stage
Walls to unneated corridors, stairs & litts	0.3 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage
Wall to commercial	0.2 W/m <sup>+</sup> .K	Based on best judgement on Planning Stage
Party Walls - Unit to Unit	Zero heat loss - Pully filled cavity	Based on best judgement on Flamming Stage
Roofs / Ceilings		
Flat roofs	0.1 W/m <sup>2</sup> .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		
Elat deors to external or corridors	1 W/m <sup>2</sup> K	Based on best judgement on Planning Stage
That doors to external of condors	- W/III .K	based on best judgement on hanning stage
Windows	1.2 W/m <sup>2</sup> 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
M		
Ventilation	Voc	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	ves	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
A is a sum on hilling		
Air permeability	2 3/4 3	Paced on best judgement on Dianning Stage
Design air permeability rate (max) for new build	3 11 /1111	Based on best judgement on Flamming 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 neating	Yes	Based on best judgement on Planning Stage
I RVS Brogrammer	fes	Based on best judgement on Planning Stage
Hosting fuel	Electricity	Based on best judgement on Planning Stage
ricding fact	Electricity	Based on best judgement on Flamming 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	pased 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 pest judgement on Planning Stage
Renewable Technologies		
Total PV output	16.15 kWn	Based on best judgement on Planning Stage
PV efficiency	19 %	Based on best judgement on Planning Stage
PV area	85 m <sup>2</sup>	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
		Record on bost judgement on Planning Stage
Orientation	Southwest	based on best judgement on Flamming Stage
Orientation	Southwest	based on best judgement on Praining Stage
Orientation Lighting Low concern lights	Southwest	Based on best judgement on Planning Stage
Orientation Lighting Low energy lights	Southwest	Based on best judgement on Planning Stage
Orientation Lighting Low energy lights Domestic water consumption	Southwest	Based on best judgement on Planning Stage

Water consumption in dwellings to be less than 110 litres/person/day

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



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 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 <sup>2</sup> .K	Based on best judgement on Planning Stage	
External walls	0.15 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage	
Roofs	0.1 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage	
Openings			
Doors			
U-Value	1.6 W/m <sup>2</sup> .K	Based on best judgement on Planning Stage	
Windows			
	$1.2  W/m^2 K$	Based on best judgement on Planning Stage	
Transmittance Factor (d value)	30 %	Based on best judgement on Planning Stage	
Frame Factor	30 /8	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	
Туре	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 <sup>3</sup> /hm <sup>2</sup>	Example with as low as 2.	
Heating/ DHW			
Electric ASHP			
HVAC system type	Split or multi-split system		
Seasonal efficiency	5.0	non dom Service Compliance Guide 2013 figures	
Seasonal EER in cooling mode	5.9	CLASSA Balaan	6.2
Seasonal COP in heating mode	4.0	GLA 2.04 - De 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	
Weather compensation control	no	Based on best judgement on Planning Stage Based on best judgement on Planning Stage	
Hot Water			
	ЛСЦП	Record on host judgement on Dianning Chara	
Generator efficiency		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	

<u>Electric Boiler</u>		
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

Yes Class D Based on best judgement on Planning Stage 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

XCO2 Energy

#### **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<sub>2</sub> 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.

		Be Lea	In	Be Cle	an	Be Green		
SAP Ref No.	TER (kgCO <sub>2</sub> /m <sup>2</sup> /yr)	DER (kgCO <sub>2</sub> /m²/y r)	% CO2 reductio n	DER (kgCO <sub>2</sub> /m²/y r)	% CO <sub>2</sub> reduction	DER (kgCO <sub>2</sub> /m²/ yr)	% CO <sub>2</sub> 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%	





Property Reference		A-GF	-02_Copy_Copy						Issued	on Date	20	/02/2023	
Assessment Referen	ice	A-GF	-02 BeGreen				Prop	Type Ref	01				
Property													
SAP Rating				83	B	DER % DE	R < TER	4.45		TER		10.63 58 14	
CO <sub>2</sub> Emissions (t/yea	ar)			0.4	14	DFEE		31.00		TFEE		34.81	
Compliance Check				Se	e BREL	% DF	EE < TFEE					10.92	
% DPER < TPER				15	.88	DPER		47.29		TPER		56.21	
Assessor Details		Mr. Andrew	Jones							Assessor II	)	N955-0001	
SAP 10 WORKSHEE CALCULATION OF 	T FOR New Bu: DWELLING EMI 	ild (As D SSIONS FO	esigned) ( R REGULATIO	Version 10 IS COMPLIAN	.2, February E	2022)							
Ground floor First floor Total floor are Dwelling volume	a TFA = (1a)-	+(1b)+(1c	)+(1d)+(1e)	(1n)	11	2.0000		Area (m2) 61.0000 51.0000	Store (1b) x (1c) x 3a)+(3b)+(3c)+	y height (m) 2.9000 3.2000 (3d)+(3e)	(2b) = (2c) = )(3n) =	Volume (m3) 176.9000 163.2000	(1b) - (1c) - (4) (5)
2. Ventilation	rate											m3 per hour	
Number of open Number of open Number of chinn Number of flues Number of block Number of inter Number of passi Number of fluel	chimneys flues eys / flues a attached to attached to ed chimneys mittent extra ve vents ess gas fires	attached solid fu other he act fans s	to closed fi el boiler ater	ire							0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 20 = 0 * 35 = 0 * 20 = 0 * 10 = 0 * 10 = 0 * 40 =	0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000	) (6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration du Pressure test Pressure Test M Measured/design Infiltration ra Number of sides	e to chimneys ethod AP50 te sheltered	s, flues	and fans =	= (6a)+(6b)·	+(6c)+(6d)+(	6e)+(6f)+(6	ig)+(7a)+(7	'b)+(7c) =		0.000	Air chan ð / (5) =	nges per hour 0.0000 Yes Blower Door 3.0000 0.1500	) (8) ) (17) ) (18) ) (19)
Shelter factor Infiltration ra	te adjusted 1	to includ	e shelter fa	actor					(20) = 1 - (21	[0.075 ) ) = (18)	x (19)] = x (20) =	1.0000 0.1500	(20) (21)
Wind speed Wind factor	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.500 1.125	Dec 00 4.7000 50 1.1750	(22) (22a)
Dolo	0.1912	0.1875	0.1837	0.1650	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.168	0.1762	(22b)
Balanced mecha If mechanical v If exhaust air If balanced wit	nıcaı ventila entilation heat pump us: h heat recove	ation wit ing Appen ery: effi	n neat recov dix N, (23b) ciency in %	very ) = (23a) x allowing fo	Fmv (equati or in-use fa	on (N5)), c ctor (from	otherwise ( Table 4h)	23b) = (2 =	3a)			0.5000 0.5000 84.6000	) (23a) ) (23b) ) (23c)
Effective ac	0.2682	0.2645	0.2607	0.2420	0.2382	0.2195	0.2195	0.2157	0.2270	0.2382	0.245	0.2532	(25)
3. Heat losses Element	and heat loss	s paramet	er	Gross m2	Openings m2	Net/	mea m2	U-value W/m2K	A x U W/K	,	<-value kJ/m2K	A x k kJ/k	
Front Door Window (Uw = 1.	20)					2.6 23.8	1000 1500	1.0000 1.1450	2.0000 27.3092				(26) (27)



Opening Floor to unheat External Wall L External Wall L LGF Roof Total net area Fabric heat los	ed GF JGF of externa ss, W/K = S	l elements um (A x U)	Aum(A, m2)	31.6000 36.8000 7.1700	15.4100 10.4400 2.1300	2. 61. 16. 26. 5. 136.	1300 0000 1900 3600 0400 5700 (26)(	1.1450 0.1000 0.1500 0.1500 0.1000 30) + (32)	2.43 6.10 2.42 3.95 0.50 = 44.73	89 00 85 40 40			(27a) (28a) (29a) (29a) (30) (31) (33)
Thermal mass pa Thermal bridges Point Thermal b Total fabric he	arameter (T ; (User def pridges eat loss	MP = Cm / T ined value	[FA) in kJ/n 0.040 * to	m2K tal exposed	d area)				(	33) + (36)	(36a) = + (36a) =	250.0000 5.4628 0.0000 50.1974	(35) (36) (37)
Ventilation hea	at loss cal	culated mor	nthly (38)m Mar	= 0.33 x	(25)m x (5) Mav	Jup	101	Διισ	Sen	Oct	Nov	Dec	
(38)m Heat transfer o	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)
Average = Sum(3	80.3039 89)m / 12 =	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204 77.2526	(39)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
HLP HLP (average)	0.7170	0.7132	0.7095	0.6907	0.6869	0.6681	0.6681	0.6644	0.6757	0.6869	0.6945	0.7020 0.6898	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heatir	ng energy r	equirements	6 (kWh/year	)									
Assumed occupar Hot water usage	cy for mixer	showers										2.8263	(42)
Hot water usage	0.0000 for baths	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	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)
Average daily h	43.5743 not water u	41.9897 se (litres/	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (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 content Distribution lo	(annual) oss (46)m	= 0.15 x (4	15)m	55.1450	50.1271	45.6575	43.1170	40.1002	47.8098	Total = S	um(45)m =	657.9858	(45)
Water storage l	10.3516 .oss:	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
Store volume b) If manufac	turer decl:	ared loss f	Factor is n	ot known :								110.0000	(47)
Hot water sto Volume factor	orage loss from Tabl	factor from e 2a	n Table 2 (	kWh/litre/o	day)							0.0152 1.0294	(51) (52)
Temperature f Enter (49) or (	actor from 54) in (55	Table 2b )										0.6000 1.0327	(53) (55)
Total storage l	.oss 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 cor	itains dedi 32.0144	cated solar 28.9162	r storage 32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss Combi loss	23.2624 0.0000	21.0112 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	(59) (61)
Total heat requ	ired for w	ater heatin	ng calculat	ed for each	1 month 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 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	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) (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)
	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) (64)
12Total per yea	ar (kWh/yea	r)						iocar p	er year (kw	nyyear) = 5	um(04)m =	1309	(64)
Electric shower	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)
Heat gains from	water hea	ting, kWh/m	nonth	77 5677	Lai Energy us	72 0012	75 7222	76 9752	75 9142	year) = Su	80 2706	858.1104	(644)
	1,001,00	70.2355	82.7919	//.50//	78.3122	75.5515	/3./325	70.9752	75.8142	80.3740	80.2700	83.3209	(05)
5. Internal gai	ns (see Ta	ble 5 and 5	5a)										
Metabolic gains	G (Table 5) Jan	, Watts Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m Lighting gains	141.3156 (calculate	141.3156 d in Append	141.3156 dix L, equa	141.3156 tion L9 or	141.3156 L9a), also s	141.3156 ee Table 5	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Appliances gair	138.4026 ns (calcula	153.2315 ted in Appe	138.4026 endix L, eq	143.0161 uation L13	138.4026 or L13a), al	143.0161 so see Tabl	138.4026 Le 5	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Cooking gains (	274.3987 calculated	277.2461 in Appendi	270.0707 ix L, equat	254.7953 ion L15 or	235.5127 L15a), also	217.3898 see Table 5	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Pumps, fans	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	(69) (70)

-113.0525

102.7657

-113.0525

105.2583

-113.0525

101.7908

-113.0525

103.4613

-113.0525

105.2975

-113.0525

111.4869

-113.0525

108.0296

Losses e.g. evaporation (negative values) (Table 5) -113.0525 -113.0525 -113.0525 -113.0525 Water heating gains (Table 5) 115.0372 113.4457 111.2795 107.7330

-113.0525 (71)

114.6868 (72)



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]			A	rea m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab	FF data le 6c	Acce fact Table	ss or 6d	Gains W	
North South North			8.5 15.2 2.1	700 800 300	10.6334 46.7521 26.0000		0.4000 0.4000 0.4000	0 0 0	. 8000 . 8000 . 7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (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)

192.5834327.0542447.6459559.4518634.2937633.9533609.3668552.3024485.8676361.2385230.4236165.0075(83)785.8166936.37231032.79341130.39081178.86201162.51961120.23761061.99621009.1864897.9515794.4898745.7831(84) Solar gains Total gains

7. Mean internal temperature (heating season)	

Temperature	during heatin	ıg periods i	n the livi	ng area fro	m Table 9,	Th1 (C)						21.0000 (85)
Utilisation	factor for ga	ins for liv	ing 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 o	f 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	a / (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 MI	T 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	0ct	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	s 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 ra	ate 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	ng 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	ng requiremen	t - total p	er year (kWl	n/year)								1265.7052	
Solar heating	ng 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	ng contributi	on - total	per year (kl	wh/year)								0.0000	
Space heating	ng 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	ng requiremen	t after sol	ar contribu	tion - total	l per year	(kWh/year)						1265.7052	
Space heating	ng per m2									(98c	) / (4) =	11.3009	(99)

\_\_\_\_\_ 8c. Space cooling requirement

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

curcuracea .o.	sancy sary	and magabe		100								
	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 k	<wh< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></wh<>											
	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	า								fC =	cooled area	/ (4) =	0.9821 (105)
Intermittency f	factor (Tabl	le 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 k	<wh< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></wh<>											
	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 r	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 Fraction of heat from community Boilers-Space and Water Fraction of heat from community Heat pump-Space and Water Factor for control and charging method (Table 4c(3)) for space heati Factor for charging method (Table 4c(3)) for water heating Distribution loss factor (Table 4cc) for community heating system Efficiency of secondary/supplementary heating system, % Space heating:	ng						1.0000 0.5000 1.0000 1.0000 1.1500 0.0000	(302) (303a) (303b) (305) (305a) (306) (208)
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	0.0000	0.0000	0.0000	0.0000	1/.1//0	102.5554	207.5015	
307b 199.6847 118.3695 66.7435 14.2660 1.6389 Space heating requirement	0.0000	0.0000	0.0000	0.0000	17.1770	102.5994	207.3015	
Space heating (1991) and 236.7389 133.4870 28.5320 3.2779 Efficiency of secondary/supplementary heating system in % (from Tabl	0.0000 e 4a or App.	0.0000 endix E)	0.0000	0.0000	34.3540	205.1988	414.6031 0.0000	(307) (308)
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)
Waton boating								
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)
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 = $(64) \times 0.50 \times 1.00 \times 1.15$	55 0657	56 5769	59 2052	59 2940	62 2111	65 1566	71 0146	
Water heating fuel	55.9057	50.5700	30.2932	50.2040	03.3111	03.1300	/1.0140	
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)
Space coolin 0.0000 0.0000 0.0000 0.0000 0.0000	38.8525	47.2722	42.0480	0.0000	0.0000	0.0000	2.6000	(314)
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)
Electricity generated by PVs (Appendix M) (negative quantity)	8.9307	9.9/83	12.9702	10.8470	22.1042	24.9000	27.5020	(332)
(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)
(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) (neg	ative quant	ity)	0 0000	0 0000	0 0000	0 0000	0 0000	(225-)
Electricity generated by PVs (Appendix M) (negative quantity)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(5554)
(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	0.0000	(333b)
(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) (neg	ative quant a aaaa	ity) a aaaa	a aaaa	a aaaa	a aaaa	a aaaa	0 0000	(335h)
Annual totals kWh/year	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(3330)
Space heating fuel - community heating							1455.5610	(307)
Water heating fuel - community heating							1505.1494	(310)
Efficiency of water heater							0.0000	(311)
Space cooling fuel							128.1727	(313) (321)
Electricity for pumps and fans: (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP mechanical ventilation fans (SFP = 0.6820) Total electricity for the above, kWb/year	9 = 0.6820)						282.9768	(330a) (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) Electricity generated - Micro CHP (Appendix N)							0.0000	(335a) (335)
Appendix Q - special features								(22.6)
Energy saved or generated Energy used							-0.0000	(336) (337)
Total delivered energy for all uses							4425.9296	(338)
12b. Carbon dioxide emissions - Community heating scheme								
			Energy	Emiss	ion factor		Emissions	

Energy	Emission factor	Emissions
kWh/year	kg CO2/kWh	kg CO2/year
		100.0000 (367)
1480.3552	0.1588	115.5746 (367)
		310.0000 (367)
477.5339	0.1588	37.2821 (368)
14.5556	0.0000	4.4214 (372)
		0.1002 (386)
		296.8075 (373)
838.1104	0.1391	116.5997 (264a)
		296.8075 (376)
128.1727	0.1141	14.6189 (377)
282.9768	0.1387	39.2524 (378)
215.9594	0.1443	31.1696 (379)
		498.4481 (383)
		4.4500 (384)
	Energy kWh/year 1480.3552 477.5339 14.5556 838.1104 128.1727 282.9768 215.9594	Energy         Emission factor           kwh/year         kg C02/kwh           1480.3552         0.1588           477.5339         0.1588           14.5556         0.0000           838.1104         0.1391           128.1727         0.1141           282.9768         0.1387           215.9594         0.1443

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13b. Primary energy - Community heating scheme



Efficiency of he Space and Water Efficiency of he Space and Water Electrical energ Overall CO2 fact Total CO2 associ Energy for inst Space cooling Pumps, fans and Energy for light Total Primary er Dwelling Primary	eat source heating fr eat source heating fr gy for heat .ated with intaneous e heating electric k ting ergy kWh/y r energy Ra	Boilers om Boilers Heat pump om Heat pum distributi t network community s lectric sho eep-hot ear te (DPER)	np ion (space systems ower(s)	& water)				Energy kWh/year 1480.3552 477.5339 14.5556 838.1104 128.1727 282.9768 215.9594	Primary energ kg	y factor CO2/kWh 1.5878 1.5878 0.0000 1.5143 1.4204 1.5128 1.5338	Prim	ary energy kWh/year 100.0000 31155.5710 310.0000 372.7648 45.9642 1.0422 3085.5332 1269.1792 3085.5332 182.0541 428.0873 331.2457 5296.0995 47.2900	(467a) (467) (468) (472) (472) (473) (476) (477) (478) (477) (478) (479) (484)
SAP 10 WORKSHEET CALCULATION OF 1	FOR New B ARGET EMIS	uild (As De SIONS	esigned)	(Version 10	.2, February	2022)							
1. Overall dwell Ground floor First floor Total floor area Dwelling volume	ing charac	teristics 	)+(1d)+(1e)	(1n)		2.0000		Area (m2) 61.0000 51.0000	Store (1b) x (1c) x 3a)+(3b)+(3c)+	y height (m) 2.9000 3.2000 (3d)+(3e)	(2b) = (2c) = )(3n) =	Volume (m3) 176.9000 163.2000 340.1000	(1b) - (1c) - (4) (5)
2. Ventilation r	rate										m.	3 per hour	
Number of open of Number of open f Number of chimme Number of flues Number of flues Number of intern Number of passiv Number of flues	himneys Flues eys / flues attached t attached t ed chimneys hittent ext ve vents ess gas fir	attached t o solid fue o other hea ract fans es	to closed f el boiler ater	ire							$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 40.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration due Pressure test Pressure Test Me Measured/design Infiltration rat Number of sides	e to chimne ethod AP50 :e sheltered	ys, flues a	and fans	= (6a)+(6b)	+(6c)+(6d)+(	6e)+(6f)+(	6g)+(7a)+(7	7b)+(7c) =		40.000	Air change 0 / (5) = B	s per hour 0.1176 Yes lower Door 5.0000 0.3676 0	<ul> <li>(8)</li> <li>(17)</li> <li>(18)</li> <li>(19)</li> </ul>
Shelter factor Infiltration rat	e adjusted	to include	e shelter f	actor					(20) = 1 - (21	[0.075 ; .) = (18)	x (19)] = x (20) =	1.0000 0.3676	(20) (21)
Wind speed Wind factor	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (22a)
Effective ac	0.4687 0.6098	0.4595 0.6056	0.4503 0.6014	0.4044 0.5818	0.3952 0.5781	0.3492 0.5610	0.3492 0.5610	0.3400 0.5578	0.3676 0.5676	0.3952 0.5781	0.4136 0.5855	0.4319 0.5933	(22b) (25)
3. Heat losses a	nd heat lo	ss paramete	 er										
Element TER Opaque door TER Opening Type Opening Floor to unheate External Wall LO External Wall UC LGF Roof Total net area of	e (Uw = 1.2 ed FF FF external	0) elements 4	Aum(A, m2)	Gross m2 31.6000 36.8000 7.1700	Openings m2 15.4100 10.4400 2.1300	Net 2. 23. 61. 16. 26. 5. 136.	Area m2 0000 8500 1300 0000 1900 3600 0400 5700	U-value W/m2K 1.0000 1.1450 2.0221 0.1300 0.1800 0.1800 0.1100	A x L W/K 2.0000 27.3092 4.3070 7.9300 2.9142 4.7448 0.5544		K-value kJ/m2K	A x K kJ/K	(26) (27) (27a) (28a) (29a) (29a) (30) (31)



Fabric heat loss, W	I/K = Sum	(A x U)					(26)(	30) + (32)	= 49.7	595			(33)
Thermal mass parame	ter (TMP	= Cm / T	FA) in kJ/r	m2K								250.0000	(35)
List of Thermal Bri K1 Element E5 Ground f E1 Steel li E3 Sill E4 Jamb E5 Ground f E6 Intermed E18 Party w B11 Unstand	dges loor (no ntel wit loor (no liate flo all betw	rmal) h perfora rmal) or withir een dwell	ited steel   a dwelling .ings .flights	base plate g				L 22 11 10 36 10 11 24 7	ength .4000 .7600 .7600 .9600 .9000 .5000 .4000	Psi-value 0.1600 0.0500 0.0500 0.0500 0.1600 0.0000 0.0600 0.0600	Tot 3.58 0.53 1.84 1.74 0.00 1.46	al 40 80 80 80 40 00 40 88	
Thermal bridges (Su Point Thermal bridg Total fabric heat l	im (L x Ps ies ioss	i) calcul	ated using	Appendix K	)			,		(33) + (36)	(36a) = + (36a) =	10.3948 0.0000 60.1543	(36) (37)
Ventilation heat lo Ja (38)m 68.	ss calcu n 4445	lated mor Feb 67.9658	thly (38)m Mar 67.4965	= 0.33 x ( Apr 65.2926	25)m x (5) May 64.8802	Jun 62.9606	Jul 62.9606	Aug 62.6052	Sep 63.7000	Oct 64.8802	Nov 65.7144	Dec 66.5865	(38)
Heat transfer coeff 128. Average = Sum(39)m	5988 1 / 12 =	28.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408 125.4449	(39)
Ja HLP 1. HLP (average)	n 1482	Feb 1.1439	Mar 1.1397	Apr 1.1201	May 1.1164	Jun 1.0992	Jul 1.0992	Aug 1.0961	Sep 1.1058	Oct 1.1164	Nov 1.1238	Dec 1.1316 1.1200	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heating en Assumed occupancy	ergy req	uirements	(kWh/year	)								2.8263	(42)
Hot water usage for 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)
Not water usage for 0. Hot water usage for	0000 other u	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Average daily hot w	5743 ater use	41.9897 (litres/	40.4052 day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 124.4382	(42c) (43)
Ja Dailv hot water use	n	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
135. Energy conte 214. Energy content (ann	5789 1 7239 1 ual)	32.6118 88.8374	129.0125 198.2874	123.5730 169.1653	119.1436 160.3902	114.3866 140.6516	112.5833 136.1597	116.1673 143.8394	119.9437 147.9026	124.9346 169.5351 Total = S	130.4569 185.8597 um(45)m =	135.2264 211.7319 2067.0843	(44) (45)
32.	(46)m = 2086	28.3256	29.7431	25.3748	24.0585	21.0977	20.4240	21.5759	22.1854	25.4303	27.8790	31.7598	(46)
a) If manufacturer Temperature facto Enter (49) or (54)	declare r from T in (55)	d loss fa able 2b	ictor is kno	own (kWh/d	ay):							150.0000 1.3938 0.5400 0.7527	(47) (48) (49) (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)
lt cylinder contain 23.	s dedica 3325	ted solar 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. Combi loss 0.	2624 0000	21.0112	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624	(59) (61)
Total heat required	for wat	er heatin	g calculate	ed for each	month	105 7425	100 7546	100 4242	102 0045	216 1200	220 0516	250 2260	((2))
WWHRS -42.	3188 2 0607 -	30.9231 37.1988	244.8823 -38.9525	-32.2542	-30.0597	-25.7223	-24.1106	-25.6392	-26.6133	-31.3742	-35.5431	-41.2818	(62) (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)
FGHRS 0.	0000 0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63C) (63d)
Output from w/h 219.	2581 1	93.7243	205.9298	182.0029	176.9254	160.0211	158.6440	164.7951 Total p	166.3811 er year (kl	184.7558 √h/year) = S	195.4085 um(64)m =	217.0450 2224.8913	(64) (64)
Electric shower(s)	wn/year) aaaa	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	2225	(64)
Heat gains from wat	on hosti	0.0000	o.ooth	0.0000 Tot	al Energy u	sed by inst	antaneous e	lectric sho	wer(s) (kW	n/year) = Su	m(64a)m =	0.0000	(64a) (64a)
neat gains from wat 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)
5. Internal gains (	see Tabl	e 5 and 5	ia)										
Metabolic gains (Ta	ble 5),	Watts							~	<u>.</u>		-	
Ja (66)m 141.	3156 1	+eD 41.3156	Mar 141.3156	Apr 141.3156	May 141.3156	Jun 141.3156	Jui 141.3156	Aug 141.3156	Sep 141.3156	UCT 141.3156	NOV 141.3156	Dec 141.3156	(66)
Lignung gains (cal 138.	4026 1	10 Append 53.2315	138.4026	143.0161	138.4026	143.0161	138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gains (c 274.	aiculate 3987 2	u in Appe 77.2461	270.0707	254.7953	235.5127	217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
COUKING BAINS (CALC 37.	uiaced 1 1316	п аррепdi 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. Losses e.g. evapora	0000 tion (ne	3.0000 gative va	3.0000 lues) (Tab	3.0000 le 5)	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
-113.	0525 -1	13.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)



Water	heating	gains (Tabl	e 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 heatir	ng periods i	in the livir	ng area from	n Table 9, 1	「h1 (C)						21.0000 (85)
Utilisation	i factor for ga	ains for liv	/ing area, r	ni1,m (see T	Table 9a)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 o	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	ı / (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 MI	T 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)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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	e 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	requiremen	t - total p	er year (kW	h/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	contributi	on - total	per year (k	Wh/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	requiremen	t after sol	ar contribu	tion - tota	l per year	(kWh/year)						3204.1252
Space heating	per m2									(98c	) / (4) =	28.6083 (99)

9a. Energy i	requirements ·	Individua	l heating s	ystems, incl	luding micro	-CHP						
Fraction of Fraction of Efficiency of Efficiency of Efficiency of	space heat fr space heat fr of main space of main space of secondary/s	rom seconda rom main sy heating sy heating sy supplementa	ry/suppleme stem(s) stem 1 (in 2 stem 2 (in 2 ry heating	ntary systen %) %) system, %	1 (Table 11)							0.0000 (201 1.0000 (202 92.3000 (206 0.0000 (207 0.0000 (208
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec
Space heatin	ng requirement	5										
	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 heatin	ng efficiency	(main heat	ing 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 heatin	ng fuel (main	heating sy	stem)									
	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 heatin	ng efficiency	(main heat	ing 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 heatin	ng fuel (main	heating sy	stem 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 heatin	ng fuel (secor	ndary)										
	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 193.72	13 205.9298	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 86.120	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	ו										
253.3556 224.94	50 241.2123	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 0.00	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 6.59	73 7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting 28.7573 23.07	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 (Ap	oendix M) (neg	ative quant	ity)								
(233a)m -24.2411 -36.04	-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 tu	bines (Append	lix M) (nega	tive quant:	ity)							
(234a)m 0.0000 0.00	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-e.	Lectric genera	tors (Appen	dix M) (ne	gative quant	tity)	0,0000	0 0000	0 0000	0 0000	0 0000	(225-)
(235a)m 0.0000 0.000	0.0000	0.0000	0.0000 D (Annondia	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electric	Lty generated	by micro-CH	P (Appendi:	x N) (negati	ive if net g	generation)	0,0000	0,0000	0 0000	0 0000	(225.0)
(235C) M 0.0000 0.000	00 0.0000 ondix M) (nog	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(2350)
(222b)m -8 5560 -18 41	25 - 27 2867		0220	77 9629	76 0920	64 6552	16 6922	26 7520	11 5552	6 7396	(2226)
Electricity generated by wind tu	chines (Annend	iv M) (noga	tive quant	-77.8038	-70.9820	-04.0555	-40.0855	-20.7525	-11.5555	-0.7580	(2550)
(234b)m 0 0000 0 00	a aaaa			a aaaa	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	(23/h)
Electricity generated by hydro-e	lectric genera	tors (Annen	dix M) (ne	gative quant	+i+v)	0.0000	0.0000	0.0000	0.0000	0.0000	(2340)
(235b)m 0.0000 0.00	A 0.0000	0.0000	0.0000	0.0000	A. 9999	0.0000	0.0000	0.0000	0.0000	0.0000	(235h)
Electricity used or net electric	ity generated	by micro-CH	P (Appendi	x N) (negati	ive if net a	generation)	0.0000	010000	010000	0.0000	(2000)
(235d)m 0.0000 0.00	0 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	ated in Append	ix L)								232.0882	(232)
Energy saving/generation technol	ogies (Appendi	ces M ,N an	d Q)								
PV generation										-1107.1761	(233)
Wind generation										0.0000	(234)
Hydro-electric generation (Appen	dix N)									0.0000	(235a)
Electricity generated - Micro CH	(Appendix N)									0.0000	(235)
Appendix Q - special teatures										0 0000	(225)
Energy saved or generated										-0.0000	(236)
Energy used										E249 7021	(237)
iocar derivered energy ion all u	500									5540.7021	(200)

12a.	Carbon	dioxide	emissions	-	Individual	heating	systems	including	micro-CH	IP		

	Energy	Emission factor	Emissions
	kWh/year	kg CO2/kWh	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 F	Primary energy	factor	Primary energy	
	kwn/year	ĸg	LUZ/KWI	Kwn/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)

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SAP 10 Online 2.3.6



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SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF FABRIC ENERGY EFFICIENCY 1. Overall dwelling characteristics Area Storey height Volume (m2) (m) (m3) 2.9000 176.9000 (1b) -Ground floor 61.0000 (1b) (2b) First floor Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)51.0000 (1c) 3.2000 (2c) 163.2000 (1c) 112,0000 (4)340.1000 (5) Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =2. Ventilation rate m3 per hour Number of open chimneys 0 \* 80 = 0.0000 (6a) Number of open flues Number of chimneys / flues attached to closed fire 0 \* 20 = 0.0000 (6b) 0 \* 10 = 0.0000 (6c) Number of flues attached to solid fuel boiler 0 \* 20 = 0.0000 (6d) 0 \* 35 = Number of flues attached to other heater 0.0000 (6e) 0 \* 20 Number of blocked chimneys 0.0000 (6f) = Number of intermittent extract fans 4 \* 10 = 40.0000 (7a) Number of passive vents Number of flueless gas fires 0 \* 10 = 0.0000 (7b) 0 \* 40 = 0.0000 (7c) Air changes per hour 40.0000 / (5) = Infiltration due to chimnevs, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =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  $(21) = (18) \times (20)$ = 0.2676 (21) Jan Feb Mar Apr May 4.3000 Jun Jul Aug 3.7000 0ct Nov Dec 4.7000 (22) Sep 4.4000 Wind speed 5.1000 5.0000 4.9000 3.8000 3.8000 4.0000 4.3000 4.5000 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 If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) Effective ac 0.5582 0.5560 0.5537 0.5433 0.5414 0.5323 0.5323 = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b) 0.0000 (23c) 0.5306 0.5358 0.5414 0.5453 0.5494 (25) 3. Heat losses and heat loss parameter Element **Openings** NetArea U-value A x U K-value Gross АхК m2 m2 m2 W/m2K W/K kJ/m2K kJ/K 2.0000 1.0000 2.0000 (26) Front Door Window (Uw = 1.20) (27) 23.8500 1.1450 27.3092 Opening 2.1300 1.1450 2,4389 (27a) Floor to unheated 0.1000 (28a) 61.0000 6.1000 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) 5.0400 (30) LGF Roof 7.1700 2.1300 0.1000 0.5040 Total net area of external elements Aum(A, m2) 136.5700 (31) Fabric heat loss,  $W/K = Sum (A \times U)$ (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) Point Thermal bridges 5.4628 (36) (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 Мау Jun Jul Aug Sep 0ct 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 Feb Mar Jun Jul 0ct Jan Apr May Aug Sep Nov Dec 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 HLP (average)

31

28

31

30

31

30

31

31

30

31

Days in mont

0.9926

31

30



#### 4. Water heating energy requirements (kWh/year)

Assumed occur	ancy											2 8263	(42)
Hot water usa	ge for mixer	- showers										2.0205	(42)
not nater aso	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 usa	ge for baths	5											
	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 usa	ge for other	r 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 u	use (litres	/day)									68.2778	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Daily hot wat	er use			·	,			0					
	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 conten	t (annual)									Total = S	um(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 c	ontains dedi	icated sola	r 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 re	quired for w	water heati	ng calculate	ed 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 pe	er year (kW	h/year) = S	um(64)m =	963.8565	(64)
12Total per y	ear (kWh/yea	ar)										964	(64)
Electric show	er(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)
				Tota	al Energy u	sed by insta	antaneous el	lectric show	ver(s) (kWh	/year) = Su	m(64a)m =	652.3063	(64a)
Heat gains fr	om water hea	ating, 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

May 141.3156 Dec 141.3156 (66) Jan Feb 141.3156 141.3156 Mar Apr Jun Jul Aug Sep 0ct Nov 141.3156 141.3156 (66)m 141.3156 141.3156 141.3156 141.3156 141.3156 141.3156 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 205 205.2826 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 (69) 0.0000 (70) 37.1316 37.1316 37.1316 37.1316 37.1316 Pumps, fans 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 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 (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	Solar flux	g	FF	Access
	m2	Table 6a	Specific data	Specific data	factor

			iii Z		W/m2		or Table 6b		le 6c	Table	6d	W		
North			8.5	700	10.6334		0.4000	0	.8000	0.77	00	20.2086	(74)	
South			15.2	800	46.7521	L	0.4000	0	.8000	0.77	00	158.4190	(78)	
North			2.1	.300	26.0000	)	0.4000	0	.7000	1.00	00	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 int	ernal temperat	ure (heatin	ng season)									
Temperature Utilisation	e during heatin n factor for ga	ng periods i nins for liv	in the livir ing area, r	ig area from ii1,m (see 1	n Table 9, 1 Table 9a)	Th1 (C)						21.0000 (85)
	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	g 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)

Gains



MIT Th 2	19.8573 20.0770	20.0702 20.0789	20.3312 20.0808	20.6523 20.0895	20.8796 20.0911	20.9795 20.0987	20.9970 20.0987	20.9950 20.1001	20.9446 20.0958	20.6449 20.0911	20.1905 20.0878	19.8218 20.0844	(87) (88)
util rest of h	0.9961 19.0360	0.9884 19.2487	0.9697	0.9064	0.7634	0.5412	0.3629	0.4049 20.0987	0.6689	0.9294	0.9894 19.3762	0.9972	(89) (90)
Living area fr MIT	action 19.1753	19.3880	19.6463	19.9595	20.1606	20.2407	20.2505	20.2508	fLA = 20.2165	Living are 19.9586	a / (4) = 19.5144	0.1696 19.1448	(91) (92)
Temperature ad adjusted MIT	justment 19.1753	19.3880	19.6463	19.9595	20.1606	20.2407	20.2505	20.2508	20.2165	19.9586	19.5144	0.0000 19.1448	(93)
8. Space heati	ng requireme	ent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	()
Utilisation Useful gains Ext temp.	0.9948 720.0118 4.3000	0.9857 862.0324 4.9000	0.9653 937.4087 6.5000	0.9027 964.4461 8.9000	0.7677 857.3372 11.7000	0.5541 609.7182 14.6000	0.3785 400.3554 16.6000	0.4211 420.8573 16.4000	0.6798 643.4252 14.1000	0.9257 773.3293 10.6000	0.9869 722.6132 7.1000	0.9962 681.0071 4.2000	(94) (95) (96)
Heat loss rate	W 1678.6386 1	.631.2556	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 er vear (kWh	190.8797	60.5887	0.0000	0.0000	0.0000	0.0000	197.2188	475.4519	737.1193	(98a)
Solar heating	kWh 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating Space heating	contribution kWh 713 2183	1 - total µ 516 9180	per year (kh 401 3956	lh/year) 190 8797	60 5887	0 0000	0 0000	0 0000	0 0000	197 2188	475 4519	0.0000	(98c)
Space heating Space heating	requirement per m2	after sola	ar contribut	ion - total	per year	(kWh/year)	0.0000	0.0000	0.0000	(98c	) / (4) =	3292.7903 29.3999	(99)
8c. Space cool	ing requirem	ient											
Calculated for	June, July	and August	t. See Table	10b		_						-	
Ext. temp. Heat loss rate	Jan 4.3000 W	Feb 4.9000	Mar 6.5000	Apr 8.9000	May 11.7000	Jun 14.6000	Jul 16.6000	Aug 16.4000	Sep 14.1000	Oct 10.6000	Nov 7.1000	Dec 4.2000	
Utilication	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)
Useful loss Total gains	0.0000 0.0000	0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	940.1094 1211.3498	778.9705	785.5839	0.0000 0.0000	0.0000	0.0000	0.0000 0.0000	(101) (102) (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)
Intermittency	n factor (Tabl 0.2500	e 10b) 0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	+C = 0.2500	0.2500	a / (4) = 0.2500	0.2500	(105)
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 Energy for spa Energy for spa Total	requirement ice heating ice cooling											179.6473 29.3999 1.6040 31.0039	(107) (99) (108) (109)
Fabric Energy	Efficiency (	DFEE)										31.0	(109)
SAP 10 WORKSHE	ET FOR New B	Build (As I	Designed)	(Version 10	.2, Februa	ary 2022)							
1. Overall dwe	lling charac	teristics											
								Area (m2)	Sto	rey height (m)		Volume (m3)	
Ground floor First floor								61.0000 51.0000	(1b) x (1c) x	2.9000 3.2000	(2b) = (2c) =	176.9000 163.2000	(1b) - (1c) -
Total floor ar Dwelling volum	ea TFA = (1a e	a)+(1b)+(10	c)+(1d)+(1e)	(1n)		112.0000		(	3a)+(3b)+(3c	)+(3d)+(3e)	(3n) =	340.1000	(4) (5)
<ol> <li>Ventilation</li> </ol>	rate												
											n	13 per hour	
Number of open	chimneys flues										0 * 80 = 0 * 20 =	0.0000	(6a) (6h)
Number of chim	neys / flues	attached	to closed f	ire							0 * 10 =	0.0000	(6c)



Number of flues Number of flues Number of block Number of intern Number of passi Number of fluel	attached f attached f ed chimneys mittent ext ve vents ess gas fin	to solid fu to other he s tract fans res	uel boiler eater								0 * 20 = 0 * 35 = 0 * 20 = 4 * 10 = 0 * 10 = 0 * 40 =	0.0000 0.0000 40.0000 0.0000 0.0000 0.0000	(6d) (6e) (6f) (7a) (7b) (7c)
Infiltration dua Pressure test Pressure Test Ma Measured/design Infiltration rat Number of sides	e to chimno ethod AP50 te sheltered	eys, flues	and fans	= (6a)+(6b)	+(6c)+(6d)+	(6e)+(6f)+(	(6g)+(7a)+(	(7b)+(7c) =		40.0000	Air changes / (5) = Blo	per hour 0.1176 Yes wer Door 5.0000 0.3676 0	(8) (17) (18) (19)
Shelter factor Infiltration rat	te adjuste	d to includ	de shelter t	factor				(2)	0) = 1 - (21	[0.075 x ) = (18)	(19)] = x (20) =	1.0000 0.3676	(20) (21)
Wind speed Wind factor	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (22a)
Adj infilt rate If exhaust air H If balanced with Effective ac	0.4687 heat pump n h heat reco 0.6098	0.4595 using Apper overy: effi 0.6056	0.4503 ndix N, (23 iciency in 9 0.6014	0.4044 c) = (23a) x % allowing f 0.5818	0.3952 Fmv (equat or in-use f 0.5781	0.3492 ion (N5)), actor (from 0.5610	0.3492 otherwise n Table 4h) 0.5610	0.3400 (23b) = (23a) ) = 0.5578	0.3676 0.5676	0.3952 0.5781	0.4136 0.5855	0.4319 0.0000 0.0000 0.5933	(22b) (23b) (23c) (25)
3. Heat losses a	and heat lo	oss paramet	ter										
Element				Gross	Openings	Net	tArea	U-value	AxU	к	-value	A x K	
TER Opaque door TER Opening Type Opening Floor to unheat	e (Uw = 1.2 ed	20)		m2	m2	2 23 21 61	m2 .0000 .8500 .1300 .0000	W/m2K 1.0000 1.1450 2.0221 0.1300	W/K 2.0000 27.3092 4.3070 7.9300		kJ/m2K	KJ/K	(26) (27) (27a) (28a)
External Wall LG External Wall UG LGF Roof Total net area of Eabric hoat loc	GF GF of external	l elements	Aum(A, m2)	31.6000 36.8000 7.1700	15.4100 10.4400 2.1300	16 26 5 136	.1900 .3600 .0400 .5700	0.1800 0.1800 0.1100	2.9142 4.7448 0.5544				(29a) (29a) (30) (31) (22)
Thermal mass par	rameter (TI	MP = Cm / 1	TFA) in k]/r	n2K			(20)(	,50) (52) =	43.7555			250.0000	(35)
		/											(/
List of Thermal K1 Eleme E5 Group E1 Stee E3 Sill E4 Jamb E5 Group E6 Inter E18 Parir R11 Upst Thermal bridges Point Thermal	Bridges ent nd floor (i l lintel w: nd floor (i rmediate f: ty wall be tands or ki (Sum(L x 1)	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul	ated steel H n a dwelling lings oflights lated using	base plate g Appendix K)				Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8	gth Ps 000 600 600 600 000 000 000 600 500	i-value 0.1600 0.0500 0.0500 0.1600 0.1600 0.0600 0.0600 0.0800	Total 3.5840 0.5880 0.5380 1.8480 1.7440 0.0000 1.4640 0.6288	10.3948	(36)
List of Thermal K1 Eleme E5 Groun E1 Steei E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upst Thermal bridges Point Thermal br Total fabric her	Bridges ent nd floor (n l lintel w: nd floor (n rmediate f: ty wall be tands or ka (Sum(L x l ridges at loss	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul	ated steel H n a dwelling lings oflights lated using	base plate g Appendix K)				Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8	gth Ps 600 600 600 600 800 800 800 600 600 (33	i-value 0.1600 0.0500 0.0500 0.1600 0.0600 0.0600 0.0800 ) + (36)	Total 3.5840 0.5880 0.5380 1.8480 0.0000 1.4640 0.6288 (36a) = + (36a) =	10.3948 0.0000 60.1543	(36) (37)
List of Thermal K1 Eleme E5 Group E1 Steei E3 Sill E4 Jamb E5 Group E6 Inter E18 Part R11 Upsi Thermal bridges Point Thermal b Total fabric heat (38)m	Bridges ent nd floor (i l lintel w: nd floor (i rmediate f: ty wall be tands or kk (Sum(L x H ridges at loss t loss calo Jan 68.4445 coff	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul culated mor Feb 67.9658	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965	base plate g Appendix K) = 0.33 x (2 Apr 65.2926	5)m x (5) May 64.8802	Jun 62.9606	Ju1 62.9606	Len 22.4 11.7 36.9 10.9 11.5 24.4 7.8 4 Aug 62.6052	gth Ps 000 600 600 600 000 000 600 600 (33 Sep 63.7000	i-value 0.1600 0.0500 0.0500 0.0500 0.1600 0.0600 0.0800 ) + (36) Oct 64.8802	Total 3.5840 0.5880 0.5380 1.8480 0.0000 1.4640 0.6288 (36a) = + (36a) = Nov 65.7144	10.3948 0.0000 60.1543 Dec 66.5865	(36) (37) (38)
List of Thermal K1 Eleme E5 Groun E1 Stee: E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upst Thermal bridges Point Thermal br Total fabric heat (38)m Heat transfer c Average = Sum(39)	Bridges ent nd floor (n rmediate f: ty wall be tands or ka (Sum(L × 1 ridges at loss t loss calo Jan 68.4445 oeff 128.5988 9)m / 12 =	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul culated mor Feb 67.9658 128.1201	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509	<pre>base plate g Appendix K) = 0.33 x (2</pre>	5)m x (5) May 64.8802 125.0346	Jun 62.9606 123.1150	Jul 62.9606 123.1150	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 62.6052 122.7595	gth Ps 000 600 600 600 000 000 600 600 (33 Sep 63.7000 123.8544	i-value 0.1600 0.0500 0.0500 0.1600 0.0600 0.0600 0.0800 ) + (36) Oct 64.8802 125.0346	Total 3.5840 0.5880 0.5380 1.8480 0.0000 1.4640 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449	(36) (37) (38) (39)
List of Thermal K1 Eleme E5 Groun E1 Stee: E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upst Thermal bridges Point Thermal br Total fabric heat (38)m Heat transfer cc Average = Sum(35)	Bridges ent nd floor (1 rmediate f: ty wall be tands or ku (Sum(L x 1 ridges at loss t loss calu Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482	normal) ith perfora normal) loor withir tween dwell erbs of roo Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397	<pre>base plate g Appendix K) = 0.33 x (2</pre>	25)m x (5) May 64.8802 125.0346 May 1.1164	Jun 62.9606 123.1150 Jun 1.0992	Jul 62.9606 123.1150 Jul 1.0992	Len 22.4 11.7 10.7 36.9 11.5 24.4 7.8 62.6052 122.7595 122.7595	gth Ps 000 600 600 600 000 000 600 (33 Sep 63.7000 123.8544 Sep 1.1058	i-value 0.1600 0.0500 0.0500 0.1600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164	Total 3.5840 0.5880 0.5880 1.8480 1.7440 0.0000 1.4640 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316	(36) (37) (38) (39) (40)
List of Thermal K1 Eleme E5 Group E1 Stee E3 Sill E4 Jamb E5 Group E6 Inter E18 Part R11 Ups Thermal bridges Point Thermal bi Total fabric heat (38)m Heat transfer cc Average = Sum(39) HLP HLP (average) Days in mont	Bridges ent nd floor (( 1 lintel w: nd floor () rmediate f: ty wall be tands or k (Sum(L x H ridges at loss t loss cal Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31	normal) ith perfora normal) loor withir tween dwell erbs of roco Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28	ated steel k n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31	<pre>pase plate g Appendix K) = 0.33 x (2     Apr     65.2926 125.4469     Apr     1.1201     30</pre>	25)m x (5) May 64.8802 125.0346 May 1.1164 31	Jun 62.9606 123.1150 Jun 1.0992 30	Jul 62.9606 123.1150 Jul 1.0992 31	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 62.6052 122.7595 122.7595	gth Ps 000 600 600 000 000 000 600 (33 Sep 63.7000 123.8544 Sep 1.1058 30	i-value 0.1600 0.0500 0.0500 0.1600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31	Total 3.5840 0.5880 0.5880 0.5880 0.6000 1.4640 0.6288 (36a) = + (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31	(36) (37) (38) (39) (40)
List of Thermal K1 Eleme E5 Groun E1 Steei E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upsi Thermal bridges Point Thermal bridges Point Thermal bridges Ventilation heat (38)m Heat transfer co (38)m Heat transfer co Average = Sum(39) HLP HLP (average) Days in mont	Bridges ent nd floor (1 rmediate f: ty wall be tands or kk (Sum(L x H ridges at loss t loss cald Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy re cy for mixer	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 28 equirements	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 31	B Appendix K) = 0.33 x (2 Apr 65.2926 125.4469 Apr 1.1201 30	25)m x (5) May 64.8802 125.0346 May 1.1164 31	Jun 62.9606 123.1150 Jun 1.0992 30	Jul 62.9606 123.1150 Jul 1.0992 31	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 62.6052 122.7595 Aug 1.0961 31	gth Ps 000 600 600 600 000 000 600 (33 Sep 63.7000 123.8544 Sep 1.1058 30	i-value 0.1600 0.0500 0.0500 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31	Total 3.5840 0.5886 0.5386 1.8480 0.0000 1.4640 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31	(36) (37) (38) (39) (40) (42)
List of Thermal K1 Eleme E5 Groun E1 Stee: E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upst Thermal bridges Point Thermal bridges Point Thermal bridges Point Thermal bridges Ventilation head (38)m Heat transfer cc (38)m Heat transfer cc Average = Sum(35) HLP HLP (average) Days in mont	Bridges ent nd floor (1 rmediate f: ty wall be tands or kd (Sum(L x 1 ridges at loss t loss calu Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy re o.0000 for mixer 0.0000	normal) ith perfora normal) loor withir tween dwell erbs of roo Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 equirements o.0000	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 s (kWh/year 0.0000	<pre>base plate g Appendix K) = 0.33 x (2     Apr     65.2926     125.4469     Apr     1.1201          30 ) 0.0000</pre>	25)m x (5) May 64.8802 125.0346 May 1.1164 31 0.0000	Jun 62.9606 123.1150 Jun 1.0992 30 0.0000	Jul 62.9606 123.1150 Jul 1.0992 31	Len 22.4 11.7 10.7 36.9 11.5 24.4 7.8 62.6052 122.7595 122.7595 31 31	gth Ps 000 600 600 600 000 000 600 (33 Sep 63.7000 123.8544 Sep 1.1058 30	i-value 0.1600 0.0500 0.0500 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31	Total 3.5840 0.5880 0.5880 1.8480 1.7440 0.0000 1.4640 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31	(36) (37) (38) (39) (40) (42) (42a)
List of Thermal K1 Eleme E5 Groun E1 Steei E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upsi Thermal bridges Point Thermal bi Total fabric heat (38)m Heat transfer co (38)m Heat tra	Bridges ent nd floor (1 rmediate f: ty wall be: ty wall be: display="block" (Sum(L x H ridges at loss t loss call Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy rc 0.0000 for baths 30.9169 for other	normal) ith perfora normal) loor withir tween dwell erbs of roco Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 equirements showers 0.0000 30.4578	ated steel k n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 5 (kWh/year 0.0000 29.8112	<pre>base plate g Appendix K) = 0.33 x (2     Apr     65.2926 125.4469     Apr     1.1201     30 ) 0.0000 28.6190</pre>	25)m x (5) May 64.8802 125.0346 May 1.1164 31 0.0000 27.7263	Jun 62.9606 123.1150 Jun 1.0992 30 0.0000 26.7364	Jul 62.9606 123.1150 Jul 1.0992 31 0.0000 26.2017	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 62.6052 122.7595 Aug 1.0961 31 31	gth Ps 000 600 600 600 000 000 600 123.8544 Sep 1.1058 30 0.0000 27.5429	i-value 0.1600 0.0500 0.0500 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31 0.0000 28.6021	Total 3.5840 0.5886 0.5386 1.8486 1.7440 0.6000 1.4640 0.6288 (36a) = + (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31 2.8263 0.0000 30.8124	(36) (37) (38) (39) (40) (42) (422) (422)
List of Thermal K1 Eleme E5 Groun E1 Steei E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upsi Thermal bridges Point Thermal bi Total fabric heat (38)m Heat transfer co (38)m Heat transfer co (38)m Heat transfer co Average = Sum(38) HLP HLP (average) Days in mont	Bridges ent nd floor (1 rmediate f: ty wall be: ty wall be: difference (Sum(L x H ridges at loss t loss calc Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy rc 0.0000 for baths 30.9169 for other 43.5743 ot water us	normal) ith perfora normal) loor within tween dwell erbs of roc Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 equirements 	ated steel H h a dwelling oflights lated using hthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 31 5 (kwh/year) 0.0000 29.8112 40.4052 /day)	<pre>base plate g Appendix K) = 0.33 x (2     Apr     65.2926 125.4469     Apr     1.1201     30 ) 0.0000 28.6190 38.8207</pre>	<pre>5)m x (5) May 64.8802 125.0346 May 1.1164 31 0.0000 27.7263 37.2362</pre>	Jun 62.9606 123.1150 Jun 1.0992 30 0.0000 26.7364 35.6517	Jul 62.9606 123.1150 Jul 1.0992 31 0.0000 26.2017 35.6517	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 Aug 1.6961 31 	gth Ps 000 600 600 600 600 600 600 123.8544 Sep 1.1058 30 0.0000 27.5429 38.8207	i-value 0.1600 0.0500 0.0500 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31 0.0000 28.6021 40.4052	Total 3.5840 0.5880 0.5880 1.8480 0.0000 1.4640 0.6288 (36a) = + (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30 0.0000 29.8188 41.9897	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31 2.8263 0.0000 30.8124 43.5743 68.2778	<ul> <li>(36)</li> <li>(37)</li> <li>(38)</li> <li>(39)</li> <li>(40)</li> <li>(42)</li> <li>(42a)</li> <li>(42b)</li> <li>(42c)</li> <li>(43)</li> </ul>
List of Thermal K1 Eleme E5 Groun E1 Stee: E3 Sill E4 Jamb E5 Groun E6 Inter E18 Part R11 Upst Thermal bridges Point Thermal bridges Point Thermal bridges Point Thermal bridges Point Thermal bridges Point Thermal bridges Ventilation head (38)m Heat transfer cc (38)m Heat transfer cc (38)m Heat transfer cc (38)m Heat transfer cc (38)m HLP HLP (average) Days in mont 4. Water heating Assumed occupant Hot water usage Hot water usage Average daily hot	Bridges ent nd floor (1 rmediate f: ty wall be tands or kd (Sum(L x 1 ridges at loss t loss calu Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy rd cy for mixer 0.0000 for baths 30.9169 for other 43.5743 ot water us Jan	normal) ith perfora normal) loor withir tween dwell erbs of roc Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 28 equirements 0.0000 30.4578 uses 41.9897 se (litres, Feb	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 31 s (kWh/year) 6.0000 29.8112 40.4052 /day) Mar	base plate g Appendix K) = 0.33 x (2 Apr 65.2926 125.4469 Apr 1.1201 30 0.0000 28.6190 38.8207 Apr	25)m x (5) May 64.8802 125.0346 May 1.1164 31 0.0000 27.7263 37.2362 May	Jun 62.9606 123.1150 Jun 1.0992 30 0.0000 26.7364 35.6517 Jun	Jul 62.9606 123.1150 Jul 1.0992 31 0.0000 26.2017 35.6517 Jul	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 62.6052 122.7595 Aug 1.0961 31 31 	gth Ps 000 600 600 600 600 000 000 123.8544 Sep 1.1058 30 0.0000 27.5429 38.8207 Sep	i-value 0.1600 0.0500 0.0500 0.0500 0.0600 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 1.1164 31 0ct 1.1164 31 0.0000 28.6021 40.4052 0ct	Total 3.5840 0.5880 0.5880 1.8480 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30 0.0000 29.8188 41.9897 Nov	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31 2.8263 0.0000 30.8124 43.5743 68.2778 Dec	<ul> <li>(36)</li> <li>(37)</li> <li>(38)</li> <li>(39)</li> <li>(40)</li> <li>(42)</li> <li>(42a)</li> <li>(42a)</li> <li>(42b)</li> <li>(42c)</li> <li>(43)</li> </ul>
List of Thermal K1 Eleme E5 Groun E1 Stee: E3 Sill E4 Jamb E5 Groun E6 Inter E18 Pari R11 Upsi Thermal bridges Point Thermal bridges Point Thermal bridges Point Thermal bridges Ventilation hear (38)m Heat transfer cd (38)m Heat transfer cd Average = Sum(39) HLP HLP (average) Days in mont	Bridges ent nd floor (1 rmediate f: ty wall be tands or kd (Sum(L x 1 ridges at loss t loss calu Jan 68.4445 oeff 128.5988 9)m / 12 = Jan 1.1482 31 g energy rd cy for mixer 0.0000 for baths 30.9169 for other 43.5743 ot water us Jan use 74.4912 117.9758 (annual)	normal) ith perform normal) loor within tween dwell erbs of roo Psi) calcul culated mor Feb 67.9658 128.1201 Feb 1.1439 28 equirements showers 0.0000 30.4578 uses 41.9897 se (litres, Feb 72.4475 103.1643	ated steel H n a dwelling oflights lated using nthly (38)m Mar 67.4965 127.6509 Mar 1.1397 31 31 5 (kWh/year) 6.0000 29.8112 40.4052 (day) Mar 70.2164 107.9200	base plate g Appendix K) = 0.33 x (2 Apr 65.2926 125.4469 Apr 1.1201 30 0.0000 28.6190 38.8207 Apr 67.4397 92.3215	<pre>15)m x (5) May 64.8802 125.0346 May 1.1164 31 0.0000 27.7263 37.2362 May 64.9624 87.4519</pre>	Jun 62.9606 123.1150 Jun 1.0992 30 0.0000 26.7364 35.6517 Jun 62.3881 76.7134	Jul 62.9606 123.1150 Jul 1.0992 31 0.0000 26.2017 35.6517 Jul 61.8534 74.8063	Len 22.4 11.7 10.7 36.9 10.9 11.5 24.4 7.8 Aug 1.0961 31 .09661 31 .09661 .0962 .0962 .0962 .0962 .0962 .0962 .0962 .0962 .0963 .09661 .09661 .09662 .0962 .09662 .09662 .09662 .09662 .09662 .09662 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .09666 .096666 .09666 .09666 .096666 .096666 .096666 .096666 .096666 .0966666 .0966666 .096666666666	gth Ps 000 600 600 600 600 600 123.8544 Sep 1.1058 30 0.0000 27.5429 38.8207 Sep 66.3636 81.8329	i-value 0.1600 0.0500 0.0500 0.0600 0.0600 0.0600 0.0600 0.0800 ) + (36) 0ct 64.8802 125.0346 0ct 1.1164 31 0.0000 28.6021 40.4052 0ct 69.0073 93.6423 Fotal = S	Total 3.5840 0.5880 0.5880 1.8480 0.6288 (36a) = + (36a) = Nov 65.7144 125.8687 Nov 1.1238 30 0.0000 29.8188 41.9897 Nov 71.8086 102.3045 um(45)m = 1	10.3948 0.0000 60.1543 Dec 66.5865 126.7408 125.4449 Dec 1.1316 1.1200 31 2.8263 0.0000 30.8124 43.5743 68.2778 Dec 74.3867 116.4715 133.9488	<ul> <li>(36)</li> <li>(37)</li> <li>(38)</li> <li>(39)</li> <li>(40)</li> <li>(42)</li> <li>(42a)</li> <li>(42b)</li> <li>(42b)</li> <li>(42c)</li> <li>(42c)</li> <li>(43)</li> <li>(44)</li> <li>(45)</li> </ul>



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 co	ontains ded: 0.0000	icated sola 0.0000	nr storage 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss 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	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) (61)
Total heat red	quired for 1 100 2794	water heati	ng calculat	ed for each	h month 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)
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	(63D) (63c)
FGHRS Output from w,	0.0000 /h	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
12Total per ye	100.2794 ear (kWh/yea	87.6896 ar)	91.7320	78.4733	74.3341	65.2064	63.5854	67.4427 Total p	69.5580 Der year (kk	79.5959 lh/year) = S	86.9588 um(64)m =	99.0008 963.8565 964	(64) (64) (64)
Electric showe	er(s) 57.3459	51.0957	55.7945	53.2440 Tot	54.2431 tal Energy u	51.7427 sed by inst	53.4674 tantaneous e	54.2431 electric sho	53.2440 wer(s) (kWh	55.7945 N/year) = Su	54.7454 m(64a)m =	57.3459 652.3063	(64a) (64a)
Heat gains fro	om water hea 39.4063	ating, kWh/ 34.6963	month 36.8816	32.9293	32.1443	29.2373	29.2632	30.4215	30.7005	33.8476	35.4260	39.0867	(65)
5. Internal ga	ains (see Ta	able 5 and	5a)										
Metabolic gair	ns (Table 5	), Watts											
(66)m	Jan 141.3156	Feb 141.3156	Mar 141.3156	Apr 141.3156	May 141.3156	Jun 141.3156	Jul 141.3156	Aug 141.3156	Sep 141.3156	0ct 141.3156	Nov 141.3156	Dec 141.3156	(66)
Lighting gains	s (calculate 138.4026	ed in Apper 153.2315	dix L, equa 138.4026	ation L9 or 143.0161	L9a), also 138.4026	see Table 5 143.0161	5 138.4026	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Appliances gai	ins (calcula 274.3987	ated in App 277.2461	endix L, ec 270.0707	uation L13 254.7953	or L13a), a 235.5127	lso see Tal 217.3898	ble 5 205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains	(calculate	d in Append	lix L, equat	ion L15 or	L15a), also	see Table	5	37,1316	37,1316	37,1316	37,1316	37,1316	(69)
Pumps, fans	0.0000	0.0000	0.0000 (Tak	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Waton hosting	-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)
Total internal	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)
iotal internal	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	s												
[Jan]			ļ	Area m2	Solar flux Table 6a W/m2	Spec: or	g ific data Table 6b	Specific or Tab	FF data ble 6c	Acce fact Table	ss or 6d	Gains W	
North			8.5	5700	10.6334		0.6300	6	0.7000	0.77	00	27.8500	(74)
South North			15.2 2.1	2800 1300	46.7521 26.0000		0.6300 0.6300	6	).7000 ).7000	0.77 1.00	00 00	218.3212 21.9803	(78) (82)
Solar gains Total gains	268.1515 799.3130	456.4280 1003.9318	627.0567 1150.4969	786.8457 1295.7869	894.4255 1376.9403	894.8018 1361.2097	859.7562 1308.1684	777.7326 1224.8542	681.7389 1142.3998	504.8063 978.9838	321.0397 822.8219	229.6201 748.2448	(83) (84)
7. Mean intern	nal tempera	ture (heati	.ng season)										
Temperature du Utilisation fa	uring heati actor for g	ng periods ains for li	in the livi	ing area fro ni1.m (see	om Table 9, Table 9a)	Th1 (C)						21.0000	(85)
tau	Jan 60,4809	Feb	Mar 60.9301	Apr 62.0006	May 62,2050	Jun 63,1749	Jul 63.1749	Aug 63, 3578	Sep 62,7978	Oct 62,2050	Nov 61,7928	Dec 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	
utii iiving a	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 Th 2	19.7058 19.9617	19.9723 19.9651	20.2885 19.9685	20.6558 19.9845	20.8871 19.9875	20.9808 20.0015	20.9969 20.0015	20.9948 20.0040	20.9447 19.9961	20.6250 19.9875	20.0998 19.9814	19.6715 19.9751	(87) (88)
utii rest of h	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 Living area fr	18.7942 raction	19.0603	19.3708	19.7250	19.9183	19,9935	20.0007	20.0027	19.9694 fLA =	19.7084 Living are	19.2012 a / (4) =	18.7706 0.1696	(90) (91)
MIT Temperature ad	18.9488 djustment	19.2150	19.5264	19.8829	20.0826	20.1610	20.1697	20.1710	20.1349	19.8639	19.3536	18.9234 0.0000	(92)
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 heat	ing require	nent											
									_			_	
Utilisation Useful gains	Jan 0.9923 793.1211	Feb 0.9778 981.6432	Mar 0.9465 1088.9633	Apr 0.8615 1116.3297	May 0.7063 972.5461	Jun 0.4959 675.0365	Jul 0.3352 438.4932	Aug 0.3765 461.1370	Sep 0.6273 716.5845	Oct 0.8989 880.0251	Nov 0.9809 807.0979	Dec 0.9943 743.9538	(94) (95)



Ext temp. Heat loss rate	4.3000 W	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Cases besting	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	811.4817 requirement	572.8089 - total pe	426.9621 er year (kWł	188.2354 n/year)	56.2242	0.0000	0.0000	0.0000	0.0000	207.0454	529.3799	834.8469 3626.9847	(98a)
Solar heating	contribution	0.0000 n - total p	0.0000 per year (kl	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
Space heating	811.4817 requirement	572.8089 after sola	426.9621 ar contribut	188.2354 tion - total	56.2242 l per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	207.0454	529.3799	834.8469 3626.9847	(98c)
Space heating	per m2									(98c)	) / (4) =	32.3838	(99)
8c. Space cool	ing require	nent											
Calculated for	lune lulv	and August	t See Table	 - 10h									
Ext. temp.	Jan 4.3000	Feb 4.9000	Mar 6.5000	Apr 8.9000	May 11.7000	Jun 14.6000	Jul 16.6000	Aug 16.4000	Sep 14.1000	Oct 10.6000	Nov 7.1000	Dec 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	(100)
Useful loss Total gains	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000	1072.9094 1505.8162	879.0573 1448.0536	887.4822	0.0000 0.0000	0.0000 0.0000	0.0000	0.0000	(102)
Space cooling	kWh	0.0000	0.0000	0.0000	0.0000	1909.0102	1440.0000	1557.5755	0.0000	0.0000	0.0000	0.0000	(105)
Cooled fractio	0.0000 n factor (Tab	0.0000	0.0000	0.0000	0.0000	311.6929	423.3332	350.0500	0.0000 fC =	0.0000 cooled area	0.0000 a / (4) =	0.0000 1.0000	(104) (105)
Space cooling	0.2500 kWh	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 Energy for spa Energy for spa Total	0.0000 requirement ice heating ice cooling	0.0000	0.0000	0.0000	0.0000	77.9232	105.8333	87.5125	0.0000	0.0000	0.0000	0.0000 271.2690 32.3838 2.4220 34.8058	(107) (107) (99) (108) (109)
SAP 10 WORKSHE CALCULATION OF	ET FOR New I ENERGY RAT	Build (As [ [NG	Designed)	(Version 10	ð.2, Februa	iry 2022)							
1. Overall dwe	lling charac	teristics											
								Ano	5+0	nov hoight		Volumo	
Ground floor First floor Total floor ar	ea TFA = (1a	a)+(1b)+(10	c)+(1d)+(1e)	)(1n)		112.0000		(m2) 61.0000 51.0000	(1b) x (1c) x	(m) 2.9000 3.2000	(2b) = (2c) =	(m3) 176.9000 163.2000	(1b) - (1c) - (4)
Dwelling volum	le							(1	3a)+(3b)+(3c	)+(3d)+(3e)	(3n) =	340.1000	(5)
2 Ventilation													
											m	3 per hour	
Number of open	chimneve										0 * 20 -	a aaaa	(62)
Number of open Number of chim Number of flue Number of flue Number of bloc Number of inte	influes ineys / flues is attached is attached iked chimneys irmittent ext	s attached to solid fu to other he s tract fans	to closed H uel boiler eater	fire							0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 0 * 20 = 0 * 10 =	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(6b) (6c) (6d) (6e) (6f) (7a)
Number of pass Number of flue	ive vents less gas fi	res									0 * 10 = 0 * 40 =	0.0000 0.0000	(7b) (7c)
Infiltration d Pressure test	lue to chimne	eys, flues	and fans	= (6a)+(6b)	)+(6c)+(6d)	+(6e)+(6f)+	(6g)+(7a)+(	7b)+(7c) =		0.0000	Air change / (5) =	s per hour 0.0000 Yes	(8)
Measured/desig Infiltration r Number of side	n AP50 ate s sheltered										В	3.0000 0.1500 0	(17) (18) (19)
Shelter factor Infiltration r	ate adjuste	d to inclu	de shelter t	factor					(20) = 1 (	- [0.075 x 21) = (18) x	(19)] = < (20) =	1.0000 0.1500	(20) (21)
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	0ct	Nov	Dec	



Wind speed Wind factor Adi infilt rate	5.1000 1.2750	5.0000 1.2500	4.9000 1.2250	4.4000 1.1000	4.3000 1.0750	3.8000 0.9500	3.8000 0.9500	3.7000 0.9250	4.0000 1.0000	4.3000 1.0750	4.5000 1.1250	4.7000 1.1750	(22) (22a)
Balanced mecha	0.1912 nical vent	0.1875 ilation wit	0.1837 th heat rec	0.1650 overy	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1687	0.1762	(22b)
If exhaust air If balanced wit	heat pump u h heat reco	using Apper overy: effi	ndix N, (23 iciency in 1	b) = (23a) % allowing	x Fmv (equati for in-use fa	ion (N5)), actor (from	otherwise 1 Table 4h)	(23b) = (23a) =	)			0.5000 0.5000 84.6000	(23b) (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 lo	oss paramet											
Element				Gross	Openings	Net	Area	U-value	A x	и к	-value	АхК	
Front Door Window (Uw = 1. Opening Floor to unheat External Wall U LGF Roof Total net area Fabric heat los	20) GF GF of external s. W/K = Su	L elements Jm (A x U)	Aum(A, m2)	m2 31.6000 36.8000 7.1700	m2 15.4100 10.4400 2.1300	2. 23. 2. 61. 16. 26. 5. 136.	m2 0000 8500 1300 0000 1900 3600 0400 5700 (26)(	W/m2K 1.0000 1.1450 1.1450 0.1000 0.1500 0.1500 0.1500 0.1000 30) + (32) =	W/ 2.000 27.309 2.438 6.100 2.428 3.954 0.504 44.734	YK 90 92 39 90 85 10 10 10	kJ/m2K	kJ/K	(26) (27) (27a) (28a) (29a) (29a) (30) (31) (33)
Thermal mass na	rameter (TM	4P = Cm / 1	(FA) in k1/	m2K								250,0000	(35)
Thermal bridges Point Thermal b Total fabric he	(User def: ridges at loss	ined value	0.040 * to	tal exposed	area)				(3	33) + (36)	(36a) = + (36a) =	5.4628 0.0000 50.1974	(36) (37)
Ventilation hea	t loss cal	culated mor	nthly (38)m	= 0.33 x (	25)m x (5)	_			<i>c</i>			-	
(38)m	Jan 30.1065	Feb 29.6856	Mar 29.2648	Apr 27.1604	мау 26.7395	Jun 24.6351	Jul 24.6351	Aug 24.2143	Sep 25.4769	0ct 26.7395	NOV 27.5813	Dec 28.4230	(38)
Average = Sum(3)	oett 80.3039 9)m / 12 =	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204 77.2526	(39)
HLP	Jan 0.7170	Feb 0.7132	Mar 0.7095	Apr 0.6907	May 0.6869	Jun 0.6681	Jul 0.6681	Aug 0.6644	Sep 0.6757	Oct 0.6869	Nov 0.6945	Dec 0.7020	(40)
HLP (average) Days in mont	31	28	31	30	31	30	31	31	30	31	30	0.6898 31	
4. Water heatin Assumed occupan	g energy re	equirements	s (kWh/year	)								2.8263	(42)
Hot water usage	for mixer 0.0000	showers 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 Average daily h	for other 43.5743 ot water us	uses 41.9897 se (litres/	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (43)
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy conte	use 43.5743 69.0110 (annual)	41.9897 59.7928	40.4052 62.1013	38.8207 53.1436	37.2362 50.1271	35.6517 43.8379	35.6517 43.1176	37.2362 46.1062	38.8207 47.8698	40.4052 54.8295 Total = S	41.9897 59.8221 um(45)m =	43.5743 68.2268 657.9858	(44) (45)
Distribution lo	ss (46)m = 10.3516	= 0.15 x (4 8.9689	45)m 9.3152	7,9715	7,5191	6.5757	6.4676	6.9159	7.1805	8,2244	8,9733	10.2340	(46)
Water storage l Store volume	oss:											110.0000	(47)
b) If manufac Hot water sto Volume factor Temperature f Enter (49) or ( Total stoppage)	turer decla rage loss f from Table actor from 54) in (55)	ared loss f factor from 2a Table 2b )	Factor is n n Table 2 (	ot known : kWh/litre/d	ay)							0.0152 1.0294 0.6000 1.0327	(51) (52) (53) (55)
Tf cylindon con	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)
Primary 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	(57) (59)
Combi loss Total heat requ	0.0000 ired for wa	0.0000 ater heatir	0.0000 ng calculat	0.0000 ed for each	0.0000 month	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
WWHRS PV diverter Solar input FGHRS	124.2878 0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000 0.0000	106.6373 0.0000 0.0000 0.0000 0.0000	105.4039 0.0000 0.0000 0.0000 0.0000	97.3316 0.0000 0.0000 0.0000 0.0000	98.3944 0.0000 0.0000 0.0000 0.0000	101.3830 0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000 0.0000	113.3158 0.0000 0.0000 0.0000 0.0000	123.5036 0.0000 0.0000 0.0000 0.0000	(62) (63a) (63b) (63c) (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)
Electric shower	(S)	65 6400	71 6071	60 1101	60 6029	66 4017	60 6070	iotal per	• year (KWh	1/year) = S	um(64)M =	1308.8255	(64)
Heat gains from	vater heat	00.0499	1.0011	08.4101 Tot	al Energy use	oo.4812 ed by insta	antaneous e	lectric showe	er(s) (kWh/	/1.08/1 /year) = Su	m(64a)m =	73.6804 838.1104	(64a) (64a)
HEAL BATHE LLOW	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 Jul Jan Feb Mar Apr Mav Jun Aug Sep 0ct Nov Dec 169.5788 169.5788 169.5788 169.5788 169.5788 169.5788 169.5788 169.5788 169.5788 (66) (66)m 169.5788 169.5788 169.5788 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 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 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 -113.0525 (71) Water heating gains (Table 5) 113.4457 115.0372 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	Speci or	g Specific data or Table 6b		FF data le 6c	Acce fact Table	ss or 6d	Gains W		
North South North			8.5 15.2 2.1	700 800 300	10.6334 46.7521 26.0000		0.4000 0.4000 0.4000	e e e	0.8000 0.8000 0.7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (82)	
Solar gains Total gains	192.5834 859.0526	327.0542 992.7637	447.6459 1095.4089	559.4518 1175.5045	634.2937 1214.8707	633.9533 1183.0422	609.3668 1140.2600	552.3024 1084.0343	485.8676 1035.2160	361.2385 941.4828	230.4236 847.1262	165.0075 813.9055	(83) (84)	

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7. Mean inter	rnal temperat	ure (heatin	ıg season)									
Temperature d	during heatin	ng periods i	n the livi	ng area fro	m Table 9,	Th1 (C)						21.0000 (85)
Utilisation H	factor for ga	ins for liv	ing 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 a	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)
МІТ	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 f	fraction								fLA =	Living area	a / (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 a	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	0ct	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 rat	e 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	requiremen	t - total p	er year (kW	n/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	contributi	on - total	per year (kl	√h/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	requiremen	t after sol	ar contribut	tion - total	l per year	(kWh/year)						1097.1065
Space heating	per m2									(98c	) / (4) =	9.7956 (99)

#### 8c. Space cooling requirement

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

Carcuraceu 101	Julie, July	anu August	· See lable	100								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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					702 4050							(100)
0.000 Utilisation 0.000	0 0.0000 0 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	703.4258 0.9959	553.7608 0.9990	565.5286 0.9984	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	(100) (101)
Useful loss 0.000	0 0.0000	0.0000	0.0000	0.0000	700.5422	553.2038	564.5982	0.0000	0.0000	0.0000	0.0000	(102)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	12/1.9409	1220.0120	1103.0320	0.0000	0.0000	0.0000	0.0000	(103)
0.000 Cooled fraction	0 0.0000 Table 10b)	0.0000	0.0000	0.0000	411.4128	500.5697	445.2500	0.0000 fC =	0.0000 cooled are	0.0000 a / (4) =	0.0000 0.9821	(104) (105)
0.250	0 0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	(106)
0.000	0 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 requirem	ent										333.2491	(107)
9b. Energy requirement	s											
Fraction of space heat	from secondar	y/suppleme	ntary system	m (Table 11	)						0.0000	(301)
Fraction of space heat Fraction of heat from	from communit community Boil	y system ers-Space a	and Water								1.0000 0.5000	(302) (303a)
Fraction of heat from	community Heat	pump-Space	e and Water	enaco hoati	na						0.5000	(303b)
Factor for charging me	thod (Table 4c	(3) for wa	ater heating	g	че						1.0000	(305a)
Distribution loss fact Efficiency of secondar	or (Table 12c) v/supplementar	for communers for communers for communers for the formula of the second se	nity heatiną system, %	g system							1.1500 0.0000	(306) (208)
Space heating:		, 0										. ,
303.459	1 180.3422	95.1659	20.2313	2.3451	0.0000	0.0000	0.0000	0.0000	23.6863	153.2042	318.6723	(98)
Space heat from Boiler 307a 174.489	s = (98) x 0.5 0 103.6968	0 x 1.00 x 54.7204	1.15 11.6330	1.3485	0.0000	0.0000	0.0000	0.0000	13.6196	88.0924	183.2366	
Space heat from Heat p 307b 174.489	ump = (98) x 0 0 103.6968	50 x 1.00 54.7204	x 1.15 11.6330	1.3485	0.0000	0.0000	0.0000	0.0000	13.6196	88.0924	183.2366	
Space heating requirem 348.977	ent 9 207.3936	109,4408	23,2660	2,6969	0.0000	0.0000	0.0000	0.0000	27.2393	176.1848	366,4732	(307)
Efficiency of secondar Space heating fuel for	y/supplementar	y heating	system in %	(from Tabl	e 4a or App	endix E)					0.0000	(308)
0.000	0 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 r 124.287	equirement 8 109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
Water heat from Boiler 310a 71.465	s = (64) x 0.5 5 63.0892	0 x 1.00 x 67.4924	1.15 61.3164	60,6072	55,9657	56.5768	58.2952	58.2840	63.3111	65.1566	71.0146	
Water heat from Heat p	$ump = (64) \times 0$	.50 x 1.00	x 1.15	60 6072	55 9657	56 5768	58 2952	58 2840	63 3111	65 1566	71 01/6	
Water heating fuel	0 126 1792	124 0840	122 6220	121 2145	111 0212	112 1526	116 5004	116 5690	126 6222	120 2121	142 0201	(210)
Cooling System Energy	Efficiency Rat	134.9849	122.0329	121.2145	20,0525	113.1330	110.5904	110.3080	120.0223	150.5151	2.6000	(314)
Space coolin 0.000 Pumps and Fa 24.033	0 0.0000 6 21.7078	0.0000 24.0336	0.0000 23.2584	0.0000 24.0336	38.8525 23.2584	47.2722 24.0336	42.0480 24.0336	0.0000 23.2584	0.0000 24.0336	0.0000 23.2584	0.0000 24.0336	(315) (331)
Lighting 26.758	9 21.4670 by PVs (Append	19.3286	14.1610	10.9383	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
(333a)m 0.000 Electricity generated	0 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
(334a)m 0.000	0 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
(335a)m 0.000	0 0.0000	0.0000	0.0000	0.0000	ative quant 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated (333b)m 0.000	by PVs (Append 0 0.0000	lix M) (nega 0.0000	ative quant: 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated (334b)m 0.000	by wind turbin 0      0.0000	es (Append: 0.0000	ix M) (negat 0.0000	tive quanti 0.0000	ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated (335b)m 0.000	by hydro-elect 0 0.0000	ric generat 0.0000	tors (Append 0.0000	dix M) (neg 0.0000	ative quant 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Annual totals kWh/year Space heating fuel - c	ommunity heati	ng									1261 6724	(307)
Space heating fuel - s	econdary										0.0000	(309)
Efficiency of water he	ommunity heati ater	.ng									0.0000	(310)
Electricity used for h Space cooling fuel	eat distributi	.on									12.6167 128.1727	(313) (321)
Electricity for numer	and fance											(- )
(BalancedWithHeatR	ecovery, Datab	ase: in-us	e factor = 1	1.1000, SFP	= 0.6820)							· \
Total electricity for	the above, kWh	= 0.0 I/year	6820)								282.9768	(330a) (331)
Electricity for lighti	ng (calculated	l in Append:	ix L)								215.9594	(332)
Energy saving/generati	on technologie	es (Appendio	ces M ,N and	d Q)							0 0000	(333)
Wind generation											0.0000	(334)
Hydro-electric generat Electricity generated	ion (Appendix - Micro CHP (A	N) Appendix N)									0.0000 0.0000	(335a) (335)
Appendix Q - special f Energy saved or genera	eatures ted										-0.0000	(336)
Energy used	for all uses										0.0000	(337)
iotar derivered energy	ioi att neep										7272,0411	رەددى

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):	0.3	600 (356)
Energy cost factor (ECF)	$[(255) \times (256)] / [(4) + 45.0] = 1.0$	467 (357)
SAP value	83.0	336
SAP rating (Section 12)		83 (358)
SAP band		В

12b. Carbon dioxide emissions - Community heating scheme			
	Energy	Emission factor	Emissions
	kWh/year	kg CO2/kWh	kg CO2/year
Efficiency of heat source Boilers		0	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			А


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SAP	10	WORKS	SHEE	T FO	R New	Build	(As	Desig	gned)	(Version	10.2,	February	2022)		
CALC	ULA	TION	0F	EPC	COSTS	, EMISS	SIONS	5 AND	PRIMARY	ENERGY					

1. Overall dwelling characteristics	
	Area
	(m2)
Ground floor	61.0000

		Area	Stor	ey height	
		(m2)		(m)	
Ground floor		61.0000 (1b)	х	2.9000 (2b)	=
First floor		51.0000 (1c)	х	3.2000 (2c)	=
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)(1n)	112.0000				
Dwelling volume		(3a)+(3b	)+(3c)	+(3d)+(3e)(3n	) =

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)

Volume (m3) 176.9000 (1b) -163.2000 (1c) -

(4) 340.1000 (5)



Infiltration du Pressure test Pressure Test M Measured/design Infiltration ra Number of sides	e to chimne ethod AP50 te sheltered	eys, flues	and fans	= (6a)+(6b)	)+(6c)+(6d)+(	6e)+(6f)+(	(6g)+(7a)+(	7b)+(7c) =		0.0000	Air chang / (5) =	es per hour 0.0000 Yes Blower Door 3.0000 0.1500	<ul> <li>(8)</li> <li>(17)</li> <li>(18)</li> <li>(19)</li> </ul>
Shelter factor Infiltration ra	te adjusted	d to includ	e shelter f	actor				(	20) = 1 (2	- [0.075 x 21) = (18) x	(19)] = (20) =	1.0000 0.1500	(20) (21)
Wind speed Wind factor Adj infilt rate	Jan 4.2000 1.0500	Feb 4.0000 1.0000	Mar 4.0000 1.0000	Apr 3.7000 0.9250	May 3.7000 0.9250	Jun 3.3000 0.8250	Jul 3.4000 0.8500	Aug 3.2000 0.8000	Sep 3.3000 0.8250	Oct 3.5000 0.8750	Nov 3.5000 0.8750	Dec 3.8000 0.9500	(22) (22a)
Balanced mechan If mechanical vo If exhaust air l If balanced with	0.1575 nical venti entilation heat pump u h heat reco	0.1500 ilation wit using Appen overy: effi	0.1500 h heat reco dix N, (23b ciency in %	0.1388 overy ) = (23a) > & allowing f	0.1388 < Fmv (equati For in-use fa	0.1237 .on (N5)), actor (from	0.1275 otherwise n Table 4h)	0.1200 (23b) = (23a =	0.1237	0.1313	0.1313	0.1425 0.5000 0.5000 84.6000	(22b) (23a) (23b) (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)
3. Heat losses	and heat lo	oss paramet	er										
Element Front Door Window (Uw = 1.: Opening Floor to unheat External Wall U LGF Roof Total net area Fabric heat los	20) GF GF GF s, W/K = Su	L elements um (A x U)	Aum(A, m2)	Gross m2 31.6000 36.8000 7.1700	Openings m2 15.4100 10.4400 2.1300	Net 2. 23. 2. 61. 16. 26. 5. 136.	Area m2 .0000 8500 .1300 .0000 .1900 .3660 .0400 .5700 .(26)(	U-value W/m2K 1.0000 1.1450 0.1000 0.1500 0.1500 0.1500 0.1000 30) + (32) =	A x W 2.000 27.309 2.433 6.100 2.422 3.954 0.504 44.734	U K- K k 90 92 99 99 90 90 85 10 10	value J/m2K	A x K kJ/K	(26) (27a) (28a) (29a) (29a) (29a) (30) (31) (33)
Thermal mass par Thermal bridges Point Thermal br Total fabric her	rameter (TM (User defi ridges at loss	MP = Cm / T ined value	FA) in kJ/m 0.040 * tot	12K al exposed	area)				(3	33) + (36) +	(36a) = · (36a) =	250.0000 5.4628 0.0000 50.1974	(35) (36) (37)
Ventilation head (38)m	t loss calc Jan 26.3186	ulated mon Feb 25.4769	thly (38)m Mar 25.4769	= 0.33 x (2 Apr 24.2143	25)m x (5) May 24.2143	Jun 22.5308	Jul 22.9516	Aug 22.1099	Sep 22.5308	Oct 23.3725	Nov 23.3725	Dec 24.6351	(38)
Average = Sum(3)	76.5160 9)m / 12 =	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325 74.1311	(39)
HLP HLP (average) Days in mont	Jan 0.6832 31	Feb 0.6757 28	Mar 0.6757 31	Apr 0.6644 30	May 0.6644 31	Jun 0.6494 30	Jul 0.6531 31	Aug 0.6456 31	Sep 0.6494 30	Oct 0.6569 31	Nov 0.6569 30	Dec 0.6681 0.6619 31	(40)
4. Water heating	g energy re	equirements	(kWh/year)										
Assumed occupand Hot water usage Hot water usage	cy for mixer 0.0000 for baths	showers 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.8263 0.0000	(42) (42a)
Hot water usage	0.0000 for other	0.0000 uses	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Average daily h	ot water us	se (litres/	day)	30.8207	57.2502	55.0517	55.0517	57.2502	38.8207	40.4032	41.9097	39.6130	(420)
Daily hot water	Jan use	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(44)
Energy conte Energy content Distribution los	69.0110 (annual) ss (46)m =	59.7928 = 0.15 x (4	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295 Total = Su	59.8221 1m(45)m =	68.2268 657.9858	(44) (45)
Water storage lo	10.3516 oss:	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
b) If manufact Hot water stor Volume factor Temperature fi Enter (49) or (1	turer decla rage loss f from Table actor from 54) in (55) oss	ared loss f Factor from 2a Table 2b	actor is no 1 Table 2 (k	ot known : Wh∕litre/da	ay)							0.0152 1.0294 0.6000 1.0327	(47) (51) (52) (53) (55)
If cylinder con	32.0144 tains dedic	28.9162 ated solar	32.0144 storage	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
Primary loss Combi loss Total heat requ	32.0144 23.2624 0.0000 ired for wa	28.9162 21.0112 0.0000 ater heatin	32.0144 23.2624 0.0000 g calculate	30.9817 22.5120 0.0000 ed for each	32.0144 23.2624 0.0000 month	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	(57) (59) (61)



	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	ı/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 pe	er year (kWl	h/year) = Si	um(64)m =	1308.8255	(64)
Electric show	ver(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)
				Tota	al Energy us	ed by insta	intaneous el	lectric show	ver(s) (kWh	/year) = Su	n(64a)m =	838.1104	(64a)
Heat gains fr	om water hea	ating, 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	0ct	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	(calculate	d in Append	lix L, equa	tion 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 gai	ns (calcula	ted in Appe	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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 Appendi	x L, equat	ion 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. ev	aporation (	negative va	alues) (Tab	le 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 (Tabl	e 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./399	6//.5182	643.4626	593.4386	517.1329	381./3/0	259.4024	1/9.604/ (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 inte	rnal tempera	ture (heati	ng season)										
Temperature (	during heati	ng periods	in the livi	ng area fro	m Table 9,	Th1 (C)						21.0000 (8	85)
ULIIISALION -	ractor tor g	ains for in	ving area,	nii,m (see	Table 9a)	-			~	<u> </u>			
	Jan	Feb	Mar	Apr	мау	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 a	area												
0	0.9766	0.9455	0.8616	0.6849	0.4902	0.2965	0.1931	0.2056	0.3954	0.7039	0.9243	0.9821 (8	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 (8	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 (8	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 (8	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	a / (4) =	0.1696 (9	91)
міт	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369 (9	92)
Temperature a	adiustment											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 (9	<del>9</del> 3)

8 Snace heating requirement

8. Space heating requirement

	_					_						_
	Jan	Feb	Mar	Apr	Мау	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	e 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	requiremen	t - total pe	er year (kW	h/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	contributi	on - total p	ber year (kl	Wh/year)								0.0000



Space heating kW 2 Space heating re Space heating pe	lh 19.2980 1 quirement a r m2	24.9721 fter solar	53.6732 contribu	7.4509 tion - total	0.4527 per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	7.0958 (98c)	82.5999 / (4) =	231.1554 726.6980 6.4884	(98c) (99)
8c. Space coolin	g requireme	nt											
Calculated for J	une. Julv a	nd August.	See Tabl	 e 10b									
Ext. temp.	Jan 5.1000	Feb 5.6000	Mar 7.4000	Apr 9.9000	May 13.0000	Jun 16.0000	Jul 17.9000	Aug 17.8000	Sep 15.2000	Oct 11.6000	Nov 8.0000	Dec 5.1000	
Utilisation Useful loss Total gains Space cooling kW	0.0000 0.0000 0.0000 0.0000 Ih	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	581.8253 0.9993 581.4113 1321.3284	446.2091 0.9999 446.1459 1264.5960	448.3052 0.9998 448.2205 1209.6840	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	(100) (101) (102) (103)
Cooled fraction	0.0000	0.0000	0.0000	0.0000	0.0000	532.7403	608.9269	566.5288	0.0000 fC =	0.0000 cooled area	0.0000 a / (4) =	0.0000 0.9821	(104) (105)
Space cooling kW	0.2500	10b) 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 re	0.0000 quirement	0.0000	0.0000	0.0000	0.0000	130.8068	149.5133	139.1031	0.0000	0.0000	0.0000	0.0000 419.4231	(107) (107)
9b. Energy requi	rements 	secondary	 /suppleme	ntarv system	 (Table 11							0.0000	(301)
Fraction of spac Fraction of heat Fraction of heat Factor for contr Factor for chang Distribution los Efficiency of se Space heating:	e heat from from commu- ol and char ing method s factor (T condary/sup	community nity Boiler nity Heat   ging method (Table 4c(: able 12c) - plementary	system rs-Space pump-Spac d (Table 3)) for w for commu heating	and Water e and Water 4c(3)) for s ater heating nity heating system, %	pace heati system	ing						1.0000 0.5000 1.0000 1.0000 1.1500 0.0000	(302) (303a) (303b) (305) (305a) (306) (208)
Space heat from	$19.2980 \qquad 1$	24.9721 98) x 0 50	53.6732	7.4509 1 15	0.4527	0.0000	0.0000	0.0000	0.0000	7.0958	82.5999	231.1554	(98)
307a 1 Space heat from	.26.0964 Heat nump =	71.8589	30.8621	4.2843	0.2603	0.0000	0.0000	0.0000	0.0000	4.0801	47.4949	132.9143	
307b 1	.26.0964	71.8589	30.8621	4.2843	0.2603	0.0000	0.0000	0.0000	0.0000	4.0801	47.4949	132.9143	
Efficiency of se	52.1927 1 condary/sup	43.7179 plementary	61.7242 heating	8.5685 system in %	0.5207 (from Tab]	0.0000 Le 4a or App	0.0000 endix E)	0.0000	0.0000	8.1601	94.9899	265.8287 0.0000	(307) (308)
Space neating tu	0.0000	ndary/supp. 0.0000	0.0000	system 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)
Water heating	ting poquin	omont											
Annual water nea 1	24.2878 1	09.7203 3	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
310a Water heat from	71.4655	63.0892	67.4924	61.3164	60.6072	55.9657	56.5768	58.2952	58.2840	63.3111	65.1566	71.0146	
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	
Cooling System F	42.9310 1	26.1783	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310) (314)
Space coolin Pumps and Fa Lighting	0.0000 24.0336 26.7589	0.0000 21.7078 21.4670	0.0000 24.0336 19.3286	0.0000 23.2584 14.1610	0.0000 24.0336 10.9383	50.3103 23.2584 8.9367	57.5051 24.0336 9.9783	53.5012 24.0336 12.9702	0.0000 23.2584 16.8470	0.0000 24.0336 22.1042	0.0000 23.2584 24.9666	0.0000 24.0336 27.5026	(315) (331) (332)
Electricity gene (333a)m	rated by PV 0.0000	s (Appendi: 0.0000	x M) (neg 0.0000	ative quanti 0.0000	ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity gene (334a)m	rated by wi 0.0000	nd turbine: 0.0000	s (Append 0.0000	ix M) (negat 0.0000	ive quanti 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity gene (335a)m	rated by hy 0.0000	dro-electr: 0.0000	ic genera 0.0000	tors (Append 0.0000	ix M) (neg 0.0000	gative quant 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity gene (333b)m	rated by PV 0.0000	s (Appendi: 0.0000	x M) (neg 0.0000	ative quanti 0.0000	ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity gene (334b)m	rated by wi 0.0000	nd turbine: 0.0000	s (Append 0.0000	ix M) (negat 0.0000	ive quanti 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity gene (335b)m	rated by hy 0.0000	dro-electr: 0.0000	ic genera 0.0000	tors (Append 0.0000	ix M) (neg 0.0000	gative quant 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Annual totals kw Space heating fu Space heating fu Water heating fu Efficiency of wa Electricity used Space cooling fu	h/year el - commun el - second el - commun ter heater   for heat d el	ity heatin ary ity heatin istribution	g n									835.7027 0.0000 1505.1494 0.0000 8.3570 161.3166	(307) (309) (310) (311) (313) (321)
Electricity for (BalancedWit mechanical ve Total electricit Electricity for	pumps and f hHeatRecove ntilation f y for the a lighting (c	ans: ry, Databas ans (SFP = bove, kWh/j alculated s	se: in-us 0. year in Append	e factor = 1 6820) ix L)	.1000, SFF	9 = 0.6820)						282.9768 282.9768 215.9594	(330a) (331) (332)
Energy saving/ge PV generation Wind generation	neration te	chnologies	(Appendi	ces M ,N and	Q)							0.0000	(333) (334)



0.0000 (335a) 0.0000 (335)

-0.0000 (336) 0.0000 (337) 3839.2152 (338)

Hydro-electric generation (Appendix N) Electricity generated - Micro CHP (Appendix N) Appendix Q - special features Energy saved or generated Energy used Total delivered energy for all uses

10b. Fuel costs - using BEDF prices (511)			
	Fuel	Fuel price	Fuel cost
	kWh/year	p/kWh	£/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	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	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 Prima	ry energy factor	Primary energy	
	kWh/year	kg CO2/kWh	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)

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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

SAP change Cost change Recommended measures: (none)

CO2 change

Energy Environmental



Recommended meas	ures		Typical an	nual savings		efficiency	impact								
(none)		Total Saving	s £0	0.00	kg/m²										
Potential energy Potential enviro	efficiency nmental imp	rating: act rating:				B 83	96								
Fuel prices for Recommendation t	cost data o exts revisi	n this page on number 6.	from database 1 (11 Jun 201	revision nu 9)	mber !	511 TEST (31	Jan 2023)								
Typical heating	and lightin	g costs of t	his home (per	year, Thame	s Vali	ley):									
Electricity Community sche	me		£276 £176	£276 £176	£0 £0	Saving									
Space heating Space cooling Water heating Lighting			£175 £30 £207 £40	£175 £30 £207 £40	£0 £0 £0 £0										
Total cost of Total cost of Delivered ener Carbon dioxide CO2 emissions Primary energy	fuels uses gy emissions per m²		£452 £452 34 kWh/m <sup>2</sup> 0.4 tonnes 4 kg/m <sup>2</sup> 42 kWh/m <sup>2</sup>	£452 £452 34 kWh/m² 0.4 tonne: 4 kg/m² 42 kWh/m²	s	f0 f0 0 kWh/m <sup>2</sup> 0.0 tonnes 0 kg/m <sup>2</sup> 0 kWh/m <sup>2</sup>									
SAP 10 WORKSHEET CALCULATION OF E	FOR New Bu NERGY RATIN	ild (As Desi G FOR IMPROV	gned) (Vers ED DWELLING	ion 10.2, Fel	bruar	y 2022)									
1. Overall dwell Ground floor First floor Total floor area Dwelling volume	ing charact TFA = (1a)	 eristics 	1d)+(1e)(1	n)	1:	12.0000		Area (m2) 61.0000 51.0000 (	(1b) (1c) 3a)+(3b)+	Storey x x (3c)+(:	height (m) 2.9000 3.2000 3d)+(3e)	(2b) (2c) )(3r	= = )) =	Volume (m3) 176.9000 163.2000 340.1000	(1b) - (1c) - (4) (5)
2. Ventilation r	ate												m3	per hour	
Number of open c Number of open f Number of chimme Number of flues Number of flues Number of interm Number of passiv Number of fluele	himneys lues ys / flues attached to attached to d chimneys ittent extr e vents ss gas fire	attached to solid fuel other heate act fans s	closed fire boiler r									0 * 8 0 * 2 0 * 1 0 * 2 0 * 3 0 * 2 0 * 1 0 * 1 0 * 4	30       =         20       =         20       =         20       =         25       =         20       =	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration due Pressure test Pressure Test Me Measured/design Infiltration rat Number of sides	to chimney thod AP50 e sheltered	s, flues and	fans = (6a	)+(6b)+(6c)+	(6d)+	(6e)+(6f)+(6	g)+(7a)+(7b	o)+(7c) =			0.0000	Air (	hanges = Bl	per hour 0.0000 Yes ower Door 3.0000 0.1500 0	<ul> <li>(8)</li> <li>(17)</li> <li>(18)</li> <li>(19)</li> </ul>
Shelter factor Infiltration rat	e adjusted	to include s	helter factor						(20) =	1 - (21)	[0.075 > = (18)	(19)] ×(20)	=	1.0000 0.1500	(20) (21)
Wind speed Wind factor Adj infilt rate	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar Ap 4.9000 4. 1.2250 1.	r May 4000 4.30 1000 1.0	000 750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.00 1.00	90 90	Oct 4.3000 1.0750	No 4. 1.	ov 5000 1250	Dec 4.7000 1.1750	(22) (22a)
Balanced mechan If mechanical ve If exhaust air h	0.1912 ical ventil ntilation eat pump us	0.1875 ation with h ing Appendix	0.1837 0. eat recovery N, (23b) = (	1650 0.10 23a) x Fmv (6	612 equat:	0.1425 ion (N5)), o	0.1425 therwise (2	0.1388 23b) = (2	0.15 3a)	90	0.1612	0.	1687	0.1762 0.5000 0.5000	(22b) (23a) (23b) (23c)
Effective ac	0.2682	0.2645	0.2607 0.	2420 0.2	382	0.2195	0.2195	0.2157	0.22	70	0.2382	0.	2457	0.2532	(25)



3. Heat losses	and heat I	oss paramet	ter										
Element				Gross	Openings	Net	tArea	U-value	Ах	U K	-value	АхК	
				m2	m2		m2	W/m2K	W/	′κ I	kJ/m2K	kJ/K	
Front Door						2.	.0000	1.0000	2.000	90			(26)
Window (Uw = 1	.20)					23.	.8500	1.1450	27.309	92			(27)
Opening						2.	.1300	1.1450	2.438	39			(27a)
Floor to unhea	ted					61.	.0000	0.1000	6.100	90			(28a)
External Wall	LGF			31.6000	15.4100	16.	.1900	0.1500	2.428	35			(29a)
External Wall	UGF			36.8000	10.4400	26.	.3600	0.1500	3.954	10			(29a)
LGF Roof				7.1700	2.1300	5.	.0400	0.1000	0.504	10			(30)
Total net area	of externa	l elements	Aum(A, m2)			136.	.5700						(31)
Fabric heat lo	ss, W/K = S	um (A x U)					(26)(	30) + (32) =	44.734	16			(33)
Thermal mass p	arameter (T	MP = Cm / 1	[FA) in kJ/m	12K								250.0000	(35)
Thermal bridge	s (User def	ined value	0.040 * tot	al exposed	area)							5.4628	(36)
Point Thermal	bridges										(36a) =	0.0000	
Total fabric h	eat loss								(3	33) + (36) ·	+ (36a) =	50.1974	(37)
Ventilation he	at loss cal	culated mor	1+hlv (38)m	= 0.33 x ()	25)m x (5)								
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	0ct	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	Eob	Man	۸۵۵	May	Jun	11	Δυσ	Son	Oct	Nov	Doc	
нр	0 7170	0 7132	0 7095	A 6907	0 6869	0 6681	0 6681	Aug 0 6611	0 6757	0 6869	0 6945	0 7020	(10)
HIP (average)	0.7170	0.7152	0.7035	0.0907	0.0809	0.0081	0.0081	0.0044	0.0757	0.0809	0.0945	0.7020	(40)
Davs in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heati	ng energy r	equirements	s (kWh/year)										
Assumed occupation	ncy											2.8263	(42)
Hot water usage		a aaaa	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	(122)
Hot water usag	e for haths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
not water usag		a aaaa	a aaaa	a aaaa	0 0000	a aaaa	a aaaa	0 0000	a aaaa	0 0000	a aaaa	0 0000	(42h)
Hot water usag	e for other		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(420)
not water usug	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 u	se (litres/	/day)									39.6130	(43)
	7.00	<b>Fab</b>	Max	A 10 10	Maxi	7	71	A	Com	Oct	Neur	Dee	
Daily hat water	Jan	Feb	MgL.	Apr.	may	Jun	JUT	Aug	Sep	υςτ	NOV	Dec	
Daily not wate	1. USE 13 E213	41 0907	40 4052	20 0207	27 2262	25 6517	25 6517	27 2262	20 0207	40 4052	41 0007	42 5742	(11)
Enongy conto	43.3/43	41.909/	40.405Z	52 1/26	57.202	JJ.0JI/	12 1176	3/.2302	17 9600	40.403Z	41.909/	43.3/43	(44)
Energy content	(Jenual)	39.1928	02.1013	33.1430	20.12/1	42.03/9	43.11/6	40.1002	47.0050	74.0295 Total - Si	59.0221 m(45)m -	657 9859	(45)
Distribution 1		- 0 15 v ()	15 ) m							10Lai - 31	um(45)m =	001.0000	
DISCIDUCION IN	10 3516	8 9689	9 3152	7 9715	7 5191	6 5757	6 4676	6 9159	7 1805	8 2244	8 9733	10 23/0	(46)
Water storage	loss:	0.000	2.2122	,.,,15	,.,,,,,	0.5757	0.4070	0.7177	,.1005	0.2244	0.2,35	10.2040	()

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 Temperature factor from Table 2b 1.0294 (52) 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 32.0144 30.9817 32.0144 30.9817 32.0144 (56) 32.0144 30.9817 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) 23.2624 0.0000 23.2624 0.0000 23.2624 (59) 0.0000 (61) Primary loss 21.0112 23,2624 22.5120 23,2624 22.5120 23,2624 22,5120 23,2624 22,5120 0.0000 0.0000 0.0000 0.0000 Combi loss 0.0000 0.0000 0.0000 0.0000 0.0000 Total heat required for water heating calculated for each month 117.3781 123.5036 (62) 0.0000 (63a) 0.0000 (63b) 124.2878 109.7203 106.6373 105.4039 97.3316 98.3944 101.3830 101.3635 110.1063 113.3158 WWHRS 0.0000 PV diverter 0.0000 0.0000 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) 838.1104 (64a) Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =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 Feb Mar Мау Jun Jul Aug Sep 0ct Nov Jan Apr 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)



Appliance	es gains (calcul	ated in App	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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 g	gains (calculate	d in Append	ix L, equat	ion 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, fa	ans 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 v	alues) (Tab	le 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 hea	ating gains (Tab	ole 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 int	ernal 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											

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[Jan]			Δ	m2	Solar flux Table 6a W/m2	a Speci 2 or	g fic data Table 6b	Specific or Tab	FF data ble 6c	Acce fact Table	ss or 6d	Gains W	
North South North			8.5 15.2 2.1	700 800 300	10.6334 46.7521 26.0000	L )	0.4000 0.4000 0.4000	6 6 6	0.8000 0.8000 0.7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (82)
Solar gains Total gains	192.5834 859.0526	327.0542 992.7637	447.6459 1095.4089	559.4518 1175.5045	634.2937 1214.8707	633.9533 1183.0422	609.3668 1140.2600	552.3024 1084.0343	485.8676 1035.2160	361.2385 941.4828	230.4236 847.1262	165.0075 813.9055	(83) (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) May Jan Feb Mar Apr Jun Jul Aug 104.5236 Sep 102.7797 0ct Nov Dec 96.8543 97.8803 100.5429 101.0929 103.9358 99.9989 98,9282 tau 97.3646 103.9358 101.0929 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) мтт 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 20.0454 19.7170 (90) 19,9486 20.1581 20.3129 20.3485 20.3689 20.3690 20.3724 20.3616 20.3115 Living area fraction fLA Living area (4) = 0.1696 (91) мтт 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

Aug 0.2800 Jan Feb Mar Apr May Jun Jul Sep 0ct Nov Dec Utilisation 0.9801 0.9502 0.8823 0.7344 0.5521 0.3716 0.2544 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 0.0000 0.0000 0.0000 0.0000 318.6723 (98a) 95.1659 20.2313 2.3451 23.6863 153.2042 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 0.0000 0.0000 0.0000 180.3422 95.1659 20.2313 0.0000 23.6863 153.2042 318.6723 (98c) 2.3451 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 Feb Mar May Jun Jul Aug 0ct Jan Apr Sep 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) 700.5422 553,2038 564.5982 0.0000 Useful loss 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000(102)Total gains 0.0000 0.0000 0.0000 0.0000 0.0000 1271.9489 1163.0526 0.0000 0.0000 0.0000 0.0000 (103) 1226.0126 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 0.9821 (105) fC = cooled area (4) =Intermittency factor (Table 10b) 0.2500 0.2500 (106) 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 Space cooling kWh



Space cooling re	0.0000 equirement	0.0000	0.0000	0.0000	0.0000	101.0165	122.9077	109.3248	0.0000	0.0000	0.0000	0.0000 333.2491	(107) (107)
9b. Energy requi	irements												
Fraction of spac Fraction of spac Fraction of heat Fraction of heat Factor for contr Factor for charg Distribution los Efficiency of se Space heating:	te heat fro te heat fro t from comm t from comm t from comm tol and cha ging method ss factor ( econdary/su	m secondary m community unity Boile unity Heat rging metho (Table 4c( Table 12c) pplementary	//supplemer / system ers-Space a pump-Space od (Table 4 (3)) for wa for commur / heating s	itary system and Water and Water (3)) for s iter heating ity heating ystem, %	n (Table 11 space heati g g system	) ng						0.0000 1.0000 0.5000 1.0000 1.0000 1.1500 0.0000	(301) (302) (303a) (303b) (305) (305a) (306) (208)
Space heating re	equirement 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 307a 1	Boilers = L74.4890	(98) x 0.50 103.6968	0 x 1.00 x 54.7204	1.15 11.6330	1.3485	0.0000	0.0000	0.0000	0.0000	13.6196	88.0924	183.2366	
Space heat from 307b 1	Heat pump L74.4890	= (98) x 0. 103.6968	50 x 1.00 54.7204	x 1.15 11.6330	1.3485	0.0000	0.0000	0.0000	0.0000	13.6196	88.0924	183.2366	
Space heating re	equirement 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)
Space heating fu	lel for sec	ondary/supp	lementary	system in %	(TROM TADE	e 4a or App		0 0000	0 0000	0 0000	0 0000	0.0000	(308)
Water besting	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)
Annual water heating	ating requi L24.2878	rement 109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
310a	Boilers = 71.4655	(64) X 0.56 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 310b	Heat pump 71.4655	= (64) x 0. 63.0892	.50 x 1.00 67.4924	x 1.15 61.3164	60.6072	55.9657	56.5768	58.2952	58.2840	63.3111	65.1566	71.0146	
Water neating fill	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)
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	(314)
Pumps and Fa Lighting	24.0336 26.7589	21.7078 21.4670	24.0336 19.3286	23.2584 14.1610	24.0336 10.9383	23.2584 8.9367	24.0336 9.9783	24.0336 12.9702	23.2584 16.8470	24.0336 22.1042	23.2584 24.9666	24.0336 27.5026	(331) (332)
Electricity gene (333a)m	erated by P 0.0000	Vs (Appendi 0.0000	ix M) (nega 0.0000	tive quanti 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity gene (334a)m	0.0000	0.0000	es (Appendi 0.0000	.x M) (negat 0.0000	0.0000	ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity gene (335a)m	0.0000	ydro-electr 0.0000	nic generat	ors (Append 0.0000	11x M) (neg 0.0000	ative quant 0.0000	1ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity gene (333b)m	erated by P 0.0000	Vs (Appendi 0.0000	ix M) (nega 0.0000	tive quanti 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity gene (334b)m	0.0000	0.0000	es (Appendi 0.0000	.x M) (negat 0.0000	0.0000	ty) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity gene (335b)m	erated by h 0.0000	ydro-electr 0.0000	ric generat 0.0000	ors (Append 0.0000	lix M) (neg 0.0000	ative quant 0.0000	ity) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Annual totals kk Space heating fu Space heating fu Water heating fu Efficiency of wa Electricity used Space cooling fu	Wh/year Jel - commu Jel - secon Jel - commu Jer heater J for heat Jel	nity heatir dary nity heatir distributic	ng on									1261.6724 0.0000 1505.1494 0.0000 12.6167 128.1727	(307) (309) (310) (311) (313) (321)
Electricity for (BalancedWit mechanical ve Total electricit Electricity for	pumps and thHeatRecov entilation ty for the lighting (	fans: ery, Databa fans (SFP = above, kWh/ calculated	ase: in-use = 0.6 /year in Appendi	e factor = 1 820) x L)	L.1000, SFP	= 0.6820)						282.9768 282.9768 215.9594	(330a) (331) (332)
Energy saving/ge PV generation Wind generation Hydro-electric g Electricity gene	eneration t generation erated - Mi	echnologies (Appendix M cro CHP (Ap	5 (Appendic N) opendix N)	es M ,N and	i Q)							0.0000 0.0000 0.0000 0.0000	(333) (334) (335a) (335)
Appendix Q - spe Energy saved or Energy used Total delivered	ecial featu generated energy for	res all uses										-0.0000 0.0000 4232.0411	(336) (337) (338)
10b. Fuel costs	 - using Ta	ble 12 pric											

	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)


0.3600 (356)

1.0467 (357)

В

83 (358)

(367)

(368)

(386) (373)

(264a)

(376)

(377)

(379)

(383)

96 (385)

Δ

(m3)

0.0000 (6a)

0.0000 (6b)

(6c)

(6d)

(6e)

(6f)

(7a)

(7b)

0.0000

0.0000

0.0000

0.0000

0.0000

0.0000 (7c)

0.0000 (8)

3.0000 (17)

0.1500 (18)

1.0000 (20) 0.1500 (21)

 $(21) = (18) \times (20)$ 

=

0 (19)

Yes

\_

(4)

Pumps, fans and electric keep-hot 282.9768 16,4900 46.6629 (349) Energy for lighting Additional standing charges 215,9594 16,4900 35,6117 (350) 92.0000 (351) Total energy cost 456.4615 (355) 11b. SAP rating - Community heating scheme Energy cost deflator (Table 12): Energy cost factor (ECF) [(255) x (256)] / [(4) + 45.0] = SAP value 83.0336 SAP rating (Section 12) SAP band 12b. Carbon dioxide emissions - Community heating scheme Energy Emission factor Emissions kg CO2/kWh kg CO2/year kWh/year Efficiency of heat source Boilers 100.0000 Space and Water heating from Boilers Efficiency of heat source Heat pump 1383,4109 0.1589 100.2687 (367) 310.0000 (367) Space and Water heating from Heat pump 446.2616 0.1589 32.3447 Electrical energy for heat distribution (space & water) Overall CO2 factor for heat network 12.6167 0.0000 4.1153 (372) 0.0998 Total CO2 associated with community systems 276.2582 Energy for instantaneous electric shower(s) Space and water heating 838,1104 0.1391 116.5997 276.2582 Space cooling 128.1727 0.1141 14.6189 Pumps, fans and electric keep-hot Energy for lighting 282,9768 0.1387 39.2524 (378) 215,9594 31.1696 0.1443 Total CO2, kg/year 477.8987 CO2 emissions per m2 4.2700 (384) 95.9211 (384a) EI value EI rating EI band 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 Volume Area Storey height (m2) (m) Ground floor 61.0000 (1b) 2.9000 (2b) 176.9000 (1b) First floor 51.0000 (1c) х 3.2000 (2c) = 163.2000 (1c) Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)112.0000 Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 340.1000 (5) 2. Ventilation rate m3 per hour Number of open chimneys Number of open flues 0 \* 80 0 \* 20 = Number of chimneys / flues attached to closed fire 0 \* 10 0 \* 20 Number of flues attached to solid fuel boiler Number of flues attached to other heater = 0 \* 35 0.0000 = Number of blocked chimneys 0 \* 20 = 0 \* 10 Number of intermittent extract fans = 0 \* 10 = Number of passive vents Number of flueless gas fires 0 \* 40 Air changes per hour 0.0000 / (5) = Pressure test Pressure Test Method Blower Door Measured/design AP50 Infiltration rate Number of sides sheltered (20) = 1 [0.075 x (19)]

Shelter factor Infiltration rate adjusted to include shelter factor



Wind speed Wind factor Adj infilt rate	Jan 4.2000 1.0500	Feb 4.0000 1.0000	Mar 4.0000 1.0000	Apr 3.7000 0.9250	May 3.7000 0.9250	Jun 3.3000 0.8250	Jul 3.4000 0.8500	Aug 3.2000 0.8000	Sep 3.3000 0.8250	Oct 3.5000 0.8750	Nov 3.5000 0.8750	Dec 3.8000 0.9500	(22) (22a)
Balanced mechar	0.1575 nical ven	0.1500 tilation wit	0.1500 th heat rec	0.1388 overy	0.1388	0.1237	0.1275	0.1200	0.1237	0.1313	0.1313	0.1425	(22b)
If mechanical ve If exhaust air h If balanced with	ntilation neat pump n heat re	n using Apper covery: effi	ndix N, (23 iciency in 1	b) = (23a) : % allowing :	x Fmv (equati for in-use fa	.on (N5)), ictor (from	otherwise n Table 4h)	(23b) = (23a =	)			0.5000 0.5000 84.6000	(23a) (23b) (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)
3. Heat losses a	and heat	loss paramet	ter										
Element Front Door Window (Uw = 1.2	20)			Gross m2	Openings m2	Net 2. 23. 2	tArea m2 .0000 .8500 1300	U-value W/m2K 1.0000 1.1450	A x W/ 2.000 27.309 2.438	U K K I 10 2	-value kJ/m2K	A x K kJ/K	(26) (27) (27a)
Floor to unheate External Wall LC External Wall UC LGF Roof Total net area c Fabric heat loss	ed GF GF of externa	al elements Sum (A x U)	Aum(A, m2)	31.6000 36.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5. 136.	.0000 .1900 .3600 .0400 .5700 (26)(	0.1000 0.1500 0.1500 0.1000 30) + (32) =	6.100 2.428 3.954 0.504	0 5 0 0			(29a) (29a) (29a) (29a) (30) (31) (33)
Thermal mass par	rameter (	TMP = Cm / T	[FA] in kJ/	m2K			(					250.0000	(35)
Thermal bridges Point Thermal br Total fabric hea	(User de ridges at loss	fined value	0.040 * to	tal exposed	area)				(3	3) + (36) -	(36a) = + (36a) =	5.4628 0.0000 50.1974	(36) (37)
Ventilation heat (38)m	t loss ca Jan 26.3186	lculated mor Feb 25.4769	nthly (38)m Mar 25.4769	= 0.33 x (2 Apr 24.2143	25)m x (5) May 24.2143	Jun 22.5308	Jul 22.9516	Aug 22.1099	Sep 22.5308	Oct 23.3725	Nov 23.3725	Dec 24.6351	(38)
Average = Sum(39	76.5160 9)m / 12 :	75.6743 =	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325 74.1311	(39)
HLP HLP (average)	Jan 0.6832	Feb 0.6757	Mar 0.6757	Apr 0.6644	May 0.6644	Jun 0.6494	Jul 0.6531	Aug 0.6456	Sep 0.6494	Oct 0.6569	Nov 0.6569	Dec 0.6681 0.6619	(40)
<ol> <li>Water heating</li> </ol>	g energy i	requirements	s (kWh/year	)									
Assumed occupance	y for mixed			, 								2.8263	(42)
Hot water usage	0.0000 for bath	0.0000 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage	0.0000 for othe	0.0000 r uses	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Average daily ho	43.5743 ot water (	41.9897 use (litres/	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (43)
Daily hot water	Jan use	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Energy conte Energy content (	43.5743 69.0110 (annual)	41.9897 59.7928	40.4052 62.1013	38.8207 53.1436	37.2362 50.1271	35.6517 43.8379	35.6517 43.1176	37.2362 46.1062	38.8207 47.8698	40.4052 54.8295 Total = Su	41.9897 59.8221 um(45)m =	43.5743 68.2268 657.9858	(44) (45)
Water storage lo	10.3516	= 0.15 x (4 8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
b) If manufact	turer deci	lared loss f	factor is n	ot known :	214)							110.0000	(47)
Volume factor Temperature fa Enter (49) or (5	from Tab from Tab from from from from factor from	le 2a n Table 2b 5)	I TADIE Z (	KWII/ II LI'E/ U	ay)							0.0132 1.0294 0.6000 1.0327	(52) (53) (55)
Total storage lo	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)
Primary loss Combi loss	32.0144 23.2624 0.0000	28.9162 21.0112 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	(57) (59) (61)
Total heat requi 1 WWHRS PV diverter Solar input FGHRS	ired for 1 124.2878 0.0000 0.0000 0.0000 0.0000	water heatin 109.7203 0.0000 0.0000 0.0000 0.0000 0.0000	ng calculat 117.3781 0.0000 0.0000 0.0000 0.0000	ed for each 106.6373 0.0000 0.0000 0.0000 0.0000	month 105.4039 0.0000 0.0000 0.0000 0.0000	97.3316 0.0000 0.0000 0.0000 0.0000	98.3944 0.0000 0.0000 0.0000 0.0000	101.3830 0.0000 0.0000 0.0000 0.0000	101.3635 0.0000 0.0000 0.0000 0.0000	110.1063 0.0000 0.0000 0.0000 0.0000	113.3158 0.0000 0.0000 0.0000 0.0000	123.5036 0.0000 0.0000 0.0000 0.0000	(62) (63a) (63b) (63c) (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)
Electric shower(	(s) 73.6804	65.6499	71.6871	68.4101 Tota	69.6938 al Energy use	66.4812 d by insta	68.6972 antaneous e	IOTAL Pe 69.6938 lectric show	r year (kWh 68.4101 wer(s) (kWh/	/year) = Su 71.6871 year) = Sur	um(64)m = 70.3391 n(64a)m =	73.6804 838.1104	(64) (64a) (64a)



Heat gains fro	om water hea 85.5877	nting, kWh/ 76.2355	month 82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(65)
5. Internal ga	ains (see Ta	able 5 and	 5a)										
Metabolic gair													
Metabolit gai	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
(66)m Lighting gains	169.5788	169.5788 d in Annen	169.5788 dix L equa	169.5788	169.5788 9a) also	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	169.5788	(66)
Lighting gains	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 gai	ins (calcula 409 5503	ted in App 413 8002	endix L, eq 403 0907	uation L13 ( 380 2914	or L13a), a 351 5115	also see Tab 324 4624	ole 5 306 3920	302 1421	312 8516	335 6509	364 4308	391 4799	(68)
Cooking gains	(calculated	in Append	ix L, equat	ion L15 or I	_15a), also	see Table	5	50212.22	51210510	55510505	50111500	5521	(00)
Pumps, fans	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	(69) (70)
Losses e.g. ev	vaporation (	negative v	alues) (Tab	le 5)	112 0525	112 0525	112 0525	112 0525	112 0525	112 0525	112 0525	112 0525	(71)
Water heating	gains (Tabl	-113.0525 le 5)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Total internal	115.0372 gains	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
	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]			А	m2	Solar flux	( 	g	Sportfi	FF	Acces	55	Gains	
				mz	W/m2	2 or	Table 6b	or Tab	ole 6c	Table 6	5d	W	
North			8.5	700	11.9814	1	0.4000	e	.8000	0.77	90	22.7705	(74)
South North			15.2 2.1	.800 .300	50.9848 30.000	3 9	0.4000 0.4000	e	0.8000 0.7000	0.770 1.000	30 30	172.7617 16.1028	(78) (82)
Solar gains Total gains	211.6350 878.1043	323.4846 989.1941	438.5844 1086.3474	568.4742 1184.5269	631.7399 1212.3169	677.5182 1226.6071	643.4626 1174.3557	593.4386 1125.1706	517.1329 1066.4813	381.7370 961.9814	259.4024 876.1050	179.6047 828.5027	(83) (84)
7. Mean intern	al temperat	ure (heati	ng season)										
						Th1 (C)						21 0000	(05)
Utilisation fa	actor for ga	ig periods ains for li	in the livi ving area,	ng area from ni1,m (see 1	rable 9,	INI (C)						21.0000	(85)
+	Jan	Feb	 Mar	Apr 104 F226	May 104 F226	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
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 an	rea 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)
													(00)
MIT Th 2 util rest of H	20.6244 20.3557 Nouse	20.7589 20.3624	20.9024 20.3624	20.9845 20.3724	20.9989 20.3724	21.0000 20.3858	21.0000 20.3824	21.0000 20.3891	20.9999 20.3858	20.9849 20.3791	20.8458 20.3791	20.6053 20.3691	(87) (88)
MTT 2	0.9705	0.9332	0.8369	0.6497 20 3593	0.4521	0.2600	0.1546	0.1664	0.3536	0.6622	0.9059	0.9772	(89) (90)
Living area fr	raction	20.1015	20.2055	20.3393	20.3/1/	20.3838	20.3824	20.3891	fLA =	Living area	a / (4) =	0.1696	(90)
MIT Temperature a	20.0501	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369 0 0000	(92)
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 heat	ing requirem												
	J	-											
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Utilisation	0.9670 849 1664	0.9299	0.8373	0.6550	0.4585	0.2662	0.1612	0.1730	0.3607	0.6686	0.9042	0.9741 807 0712	(94) (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	9 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	124 0721	52 (722	7 4500	0 4507	0.0000	0.0000	0.0000	0.0000	7 0050	00 5000	221 1554	(00-)
Space heating	219.2980 requirement kWh	124.9721 : - total p	53.6732 er year (kW	7.4509 h/year)	0.4527	0.0000	0.0000	0.0000	0.0000	1.0328	82.5999	726.6980	(989)
Solar heating	0.0000 contributio	0.0000 on - total	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
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 Space heating	requirement per m2	after sol	ar contribu	tion - total	l per year	(kWh/year)				(98c)	) / (4) =	726.6980 6.4884	(99)
90 Case 7	ing month												
or. shace coor	ung require	ment											

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	1											
	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 kw	lh											
	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 fa	ctor (Tabl	e 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 kw	lh											
	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 re	quirement											419.4231 (107)

9b. Energy requirements												
Fraction of space heat Fraction of space heat Fraction of heat from c	from secondar from communit	y/suppleme y system ers-Space	ntary system and Water	n (Table 11	)						0.0000 1.0000 0.5000	(301) (302) (303a)
Fraction of heat from of	ommunity Heat	pump-Spac	e and Water								0.5000	(303b)
Factor for control and	charging meth	od (Table 4	4c(3)) for s	space heati ~	ng						1.0000	(305)
Distribution loss facto	or (Table 12c)	for commu	nity heating	s g system							1.1500	(306)
Efficiency of secondary	/supplementar	y heating	system, %								0.0000	(208)
Space heating:												
Space neating requireme 219.2980	ent 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 0.5	0 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	
307h 126.0964	Imp = (98) X 0 1.8589	.50 X 1.00 30.8621	X 1.15 4.2843	0.2603	0.0000	0.0000	0.0000	0.0000	4,0801	47,4949	132,9143	
Space heating requireme	ent	5010022		012005	010000	010000	010000	010000			10110110	
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)
Snace heating fuel for	secondary/sup	y neating : nlementary	system in %	(Trom Tabl	e 4a or App	pendix E)					0.0000	(308)
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)
Waton boating												
Annual water heating re	auirement											
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	$= (64) \times 0.50$	0 x 1.00 x	1.15	60 6070			F8 20F2	F0 2040	C2 2111	CF 15CC	71 0146	
Water heat from Heat pu	$mp = (64) \times 0$	.50 x 1.00	x 1.15	60.6072	700.2027	50.5768	58.2952	58.2840	03.3111	05.1200	/1.0146	
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	106 1700	124 0840	122 (220	101 0145	111 0212	112 1526	116 5004	116 5690	126 6222	120 2121	142 0201	(210)
Cooling System Energy E	fficiency Rat	134.9849 io	122.6329	121.2145	111.9313	113.1536	110.5904	110.5080	120.0223	130.3131	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)
Electricity generated b	v PVs (Append:	ix M) (neg	ative quant:	10.9383 itv)	8.9307	9.9783	12.9702	16.8470	22.1042	24.9000	27.5020	(332)
(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 b	y wind turbin	es (Append	ix M) (negat	tive quanti	ty)	0,0000	0 0000	0 0000	0 0000	0,0000	0 0000	(224-)
Electricity generated b	v hvdro-elect	v.0000 ric genera	tors (Append	0.0000 dix M) (neg	ative quant	0.0000 titv)	0.0000	0.0000	0.0000	0.0000	0.0000	(334a
(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 b	y PVs (Append	ix M) (neg	ative quant:	ity)	0 0000	0,0000	0 0000	0 0000	0 0000	0,0000	0 0000	(2226)
Electricity generated b	v wind turbin	es (Append	0.0000 ix M) (nega	0.0000 tive quanti	0.0000 tv)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(3330
(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 b	y hydro-elect	ric genera	tors (Append	dix M) (neg	ative quant	tity)	0.0000	0.0000	0 0000	0 0000	0.0000	(2256
(3350)m 0.0000 Annual totals kWh/year	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(3350
Space heating fuel - co	mmunity heati	ng									835.7027	(307)
Space heating fuel - se	condary										0.0000	(309)
Water neating fuel - co Efficiency of water hea	ommunity neati	ng									1505.1494	(310)
Electricity used for he	at distributi	on									8.3570	(313)
Space cooling fuel											161.3166	(321)
51												
(BalancedWithHeatRe mechanical ventilati	covery, Datab on fans (SEP	ase: in-us	e factor = : 6820)	1.1000, SFP	= 0.6820)						282.9768	(330a)
Total electricity for t	he above, kWh	/year	,								282.9768	(331)
Electricity for lightir	ng (calculated	in Append	ix L)								215.9594	(332)
Energy saving/generation	on technologie	s (Appendi	ces M .N and	d 0)								
PV generation			, ,								0.0000	(333)
Wind generation	<i>/</i> •										0.0000	(334)
Hydro-electric generation	on (Appendix I	N) nnondiv N)									0.0000	(335a)
Appendix Q - special fe	atures	Phenaty M)									0.0000	(222)
Energy saved or generat	ed										-0.0000	(336)
Energy used	fon all use-										0.0000	(337)
iocar derivered energy	ion all uses										2023.2122	(338)

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

\_\_\_\_\_



	Fuel	Fuel price	Fuel cost
	kWh/year	p/kWh	£/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	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	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 Prima	ry energy factor	Primary energy
	kWh/year	kg CO2/kWh	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)



Property Reference		A-GF-02_Copy						Issued on Date				20/02/2023		
Assessment Reference	ce	A-G	F-02 BeLean_Copy				Prop	o Type Ref	01					
Property														
SAP Rating				8	33 B	DER		8.04		TER		10.	.63	
Environmental				9	93 A	% DEF	R < TER					24.	.37	
CO <sub>2</sub> Emissions (t/year	r)			C	0.76	DFEE		31.00		TFEE		34.	.81	
Compliance Check				5	See BREL	% DFE	E < TFEE					10.	.92	
% DPER < TPER				4	1.78	DPER		53.52		TPER		56.	.21	
Assessor Details		Mr. Andrew	Jones							Assessor II	כ	N9	55-0001	
Client														
SAP 10 WORKSHEET CALCULATION OF D	T FOR New Buil DWELLING EMISS	d (As E IONS FC	Designed) ( DR REGULATION	Version 1 IS COMPLIA	0.2, February NCE	2022)								
1. Overall dwell	ling character	istics												
Ground floor First floor Total floor area Dwelling volume	a TFA = (1a)+(	1b)+(1c	:)+(1d)+(1e).	(1n)	11	2.0000		Area (m2) 61.0000 51.0000	Store (1b) x (1c) x 3a)+(3b)+(3c)+	y height (m) 2.9000 3.2000 (3d)+(3e)	(2b) (2c) )(3n)	= =	Volume (m3) 176.9000 163.2000 340.1000	(1b) - (1c) - (4) (5)
2. Ventilation r	rate											m3	3 per hour	
Number of open of Number of open of Number of chimme Number of flues Number of flues Number of intern Number of passiv Number of flues	chimneys flues eys / flues at attached to s attached to d chimneys mittent extrac ve vents ess gas fires	tached olid fu ther he t fans	to closed fi el boiler eater	ire							0 * 80 0 * 20 0 * 10 0 * 20 0 * 35 0 * 20 0 * 10 0 * 10 0 * 40		0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration due Pressure test Pressure Test Me Measured/design Infiltration rat Number of sides	e to chimneys, ethod AP50 te sheltered	flues	and fans =	= (6a)+(6b)	)+(6c)+(6d)+(4	6e)+(6f)+(6	g)+(7a)+(	7b)+(7c) =		0.000	Air ch 0 / (5)	anges = Bl	5 per hour 0.0000 Yes Lower Door 3.0000 0.1500 0	<ul> <li>(8)</li> <li>(17)</li> <li>(18)</li> <li>(19)</li> </ul>
Shelter factor Infiltration rat	te adjusted to	includ	le shelter fa	actor					(20) = 1 - (21	[0.075 ) ) = (18)	x (19)] x (20)	= =	1.0000 0.1500	(20) (21)
Wind speed Wind factor Adj infilt rate	Jan F 5.1000 5 1.2750 1	eb .0000 .2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5 1.1	000 250	Dec 4.7000 1.1750	(22) (22a)
	0.1912 0	.1875	0.1837	0.1650	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1	687	0.1762	(22b)
Balanced mechan If mechanical ve If exhaust air h If balanced with	nicai ventilat entilation neat pump usin n heat recover	uon wit g Apper y: effi	n neat recov ndix N, (23b) Lciency in %	very ) = (23a) : allowing ·	x Fmv (equation for in-use factor	on (N5)), o ctor (from	therwise Table 4h)	(23b) = (23 =	Ba)				0.5000 0.5000 84.6000	(23a) (23b) (23c)
Effective ac	0.2682 0	.2645	0.2607	0.2420	0.2382	0.2195	0.2195	0.2157	0.2270	0.2382	0.2	457	0.2532	(25)
3. Heat losses a	and heat loss	paramet	er											
Element				Gross	Openings	NetA	rea	U-value	ΑxU	ŀ	<-value		A x K	
Front Door Window (Uw = 1.2	20)			m2	m2	2.0 23.8	m2 000 500	W/m2K 1.0000 1.1450	W/K 2.0000 27.3092		kJ∕m2K		kJ/K	(26) (27)



Opening Floor to unheat External Wall L External Wall L LGF Roof Total net area Fabric heat los	ed GF JGF of externa ss, W/K = S	l elements um (A x U)	Aum(A, m2)	31.6000 36.8000 7.1700	15.4100 10.4400 2.1300	2. 61. 16. 26. 5. 136.	1300 0000 1900 3600 0400 5700 (26)(	1.1450 0.1000 0.1500 0.1500 0.1000 30) + (32)	2.43 6.10 2.42 3.95 0.50 = 44.73	89 00 85 40 40			(27a) (28a) (29a) (29a) (30) (31) (33)
Thermal mass pa Thermal bridges Point Thermal b Total fabric he	arameter (T ; (User def pridges eat loss	MP = Cm / T ined value	[FA) in kJ/n 0.040 * to	m2K tal exposed	d area)				(	33) + (36)	(36a) = + (36a) =	250.0000 5.4628 0.0000 50.1974	(35) (36) (37)
Ventilation hea	at loss cal	culated mor	nthly (38)m Mar	= 0.33 x	(25)m x (5) Mav	Jup	101	Διισ	Sen	Oct	Nov	Dec	
(38)m Heat transfer o	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)
Average = Sum(3	80.3039 89)m / 12 =	79.8830	79.4621	77.3578	76.9369	74.8325	74.8325	74.4117	75.6743	76.9369	77.7787	78.6204 77.2526	(39)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
HLP HLP (average)	0.7170	0.7132	0.7095	0.6907	0.6869	0.6681	0.6681	0.6644	0.6757	0.6869	0.6945	0.7020 0.6898	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heatir	ng energy r	equirements	6 (kWh/year	)									
Assumed occupar Hot water usage	cy for mixer	showers										2.8263	(42)
Hot water usage	0.0000 for baths	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	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)
Average daily h	43.5743 not water u	41.9897 se (litres/	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (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 content Distribution lo	(annual) oss (46)m	= 0.15 x (4	15)m	55.1450	50.1271	45.6575	43.1170	40.1002	47.8098	Total = S	um(45)m =	657.9858	(45)
Water storage l	10.3516 .oss:	8.9689	9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
Store volume b) If manufac	turer decl:	ared loss f	Factor is n	ot known :								110.0000	(47)
Hot water sto Volume factor	orage loss from Tabl	factor from e 2a	n Table 2 (	kWh/litre/o	day)							0.0152 1.0294	(51) (52)
Temperature f Enter (49) or (	actor from 54) in (55	Table 2b )										0.6000 1.0327	(53) (55)
Total storage l	.oss 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 cor	itains dedi 32.0144	cated solar 28.9162	r storage 32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss Combi loss	23.2624 0.0000	21.0112 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	(59) (61)
Total heat requ	ired for w	ater heatin	ng calculat	ed for each	1 month 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 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	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) (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)
	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) (64)
12Total per yea	ar (kWh/yea	r)						iocar p	er year (kw	nyyear) = 5	um(04)m =	1309	(64)
Electric shower	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)
Heat gains from	water hea	ting, kWh/m	nonth	77 5677	Lai Energy us	72 0012	75 7222	76 9752	75 9142	year) = Su	80 2706	858.1104	(644)
	1,001,00	70.2355	82.7919	//.50//	78.3122	75.5515	/3./325	70.9752	75.8142	80.3740	80.2700	85.5205	(05)
5. Internal gai	ns (see Ta	ble 5 and 5	5a)										
Metabolic gains	G (Table 5) Jan	, Watts Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m Lighting gains	141.3156 (calculate	141.3156 d in Append	141.3156 dix L, equa	141.3156 tion L9 or	141.3156 L9a), also s	141.3156 ee Table 5	141.3156	141.3156	141.3156	141.3156	141.3156	141.3156	(66)
Appliances gair	138.4026 ns (calcula	153.2315 ted in Appe	138.4026 endix L, eq	143.0161 uation L13	138.4026 or L13a), al	143.0161 so see Tabl	138.4026 Le 5	138.4026	143.0161	138.4026	143.0161	138.4026	(67)
Cooking gains (	274.3987 calculated	277.2461 in Appendi	270.0707 ix L, equat	254.7953 ion L15 or	235.5127 L15a), also	217.3898 see Table 5	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Pumps, fans	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	(69) (70)

-113.0525

102.7657

-113.0525

105.2583

-113.0525

101.7908

-113.0525

103.4613

-113.0525

105.2975

-113.0525

111.4869

-113.0525

108.0296

Losses e.g. evaporation (negative values) (Table 5) -113.0525 -113.0525 -113.0525 -113.0525 Water heating gains (Table 5) 115.0372 113.4457 111.2795 107.7330

-113.0525 (71)

114.6868 (72)



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]			A	rea m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab	FF data le 6c	Acce fact Table	ss or 6d	Gains W	
North South North			8.5 15.2 2.1	700 800 300	10.6334 46.7521 26.0000		0.4000 0.4000 0.4000	0 0 0	. 8000 . 8000 . 7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (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)

192.5834327.0542447.6459559.4518634.2937633.9533609.3668552.3024485.8676361.2385230.4236165.0075(83)785.8166936.37231032.79341130.39081178.86201162.51961120.23761061.99621009.1864897.9515794.4898745.7831(84) Solar gains Total gains

7. Mean internal temperature (heating season)	

Temperature during heating periods in the living area from Table 9, Th1 (C) 21												21.0000 (85)
Utilisation	factor for ga	ins for liv	ing 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 o	f 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	a / (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 MI	T 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	0ct	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	s 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 ra	ate 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	ng 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	ng requiremen	t - total p	er year (kWl	n/year)								1265.7052	
Solar heating	ng 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	ng contributi	on - total	per year (kl	wh/year)								0.0000	
Space heating	ng 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	ng requiremen	t after sol	ar contribut	tion - total	l per year	(kWh/year)						1265.7052	
Space heating	ng per m2									(98c	) / (4) =	11.3009	(99)

\_\_\_\_\_ 8c. Space cooling requirement

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

curcuracea .o.	sancy sary	and magabe		100								
	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 k	<wh< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></wh<>											
	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	า								fC =	cooled area	/ (4) =	0.9821 (105)
Intermittency f	factor (Tabl	le 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 k	<wh< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></wh<>											
	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 r	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 Fraction of heat from community Boilers-Space and Water Factor for control and charging method (Table 4c(3)) for space heatin Factor for charging method (Table 4c(3)) for water heating Distribution loss factor (Table 12c) for community heating system Efficiency of secondary/supplementary heating system, % Space heating:	ng						1.0000 1.0000 1.0000 1.0000 1.1500 0.0000	(302) (303a) (305) (305a) (306) (208)
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 Efficiency of secondary/supplementary heating system in % (from Table	0.0000 e 4a or App	0.0000 endix E)	0.0000	0.0000	34.3540	205.1988	414.6031 0.0000	(307) (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	0.0000	(309)
Water heating Annual water heating requirement								
124.2878 109.7203 117.3781 106.6373 105.4039 Water heat from Boilers = (64) x 1.00 x 1.00 x 1.15	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
310a 142.9310 126.1783 134.9849 122.6329 121.2145 Water heating fuel	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	
142.9310 126.1783 134.9849 122.6329 121.2145 Cooling System Energy Efficiency Ratio	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291 2.6000	(310) (314)
Space coolin         0.0000         0.0000         0.0000         0.0000         0.0000           Pumps and Fa         24.0336         21.7078         24.0336         23.2584         24.0336	38.8525 23.2584	47.2722 24.0336	42.0480 24.0336	0.0000 23.2584	0.0000 24.0336	0.0000 23.2584	0.0000 24.0336	(315) (331)
Lighting 26.7589 21.4670 19.3286 14.1610 10.9383 Electricity generated by PVs (Appendix M) (negative quantity)	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
(333a)m 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by wind turbines (Appendix M) (negative quantit	0.0000 ty)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
(334a)m 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by hydro-electric generators (Appendix M) (nega	0.0000 ative quant	0.0000 ity)	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
(335a)m         0.0000         0.0000         0.0000         0.0000           Electricity generated by PVs (Appendix M) (negative quantity)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
(333b)m 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by wind turbines (Appendix M) (negative quantit	0.0000 ty)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
(334b)m 0.0000 0.0000 0.0000 0.0000 0.0000 Electricity generated by hydro-electric generators (Appendix M) (nega	0.0000 ative quant	0.0000 ity)	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
(335b)m 0.0000 0.0000 0.0000 0.0000 0.0000 Annual totals kWh/year	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Space heating fuel - community heating Space heating fuel - secondary Water heating fuel - community heating Efficiency of water heater Electricity used for heat distribution Space cooling fuel							1455.5610 0.0000 1505.1494 0.0000 14.5556 128.1727	(307) (309) (310) (311) (313) (321)
<pre>Electricity for pumps and fans: (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP mechanical ventilation fans (SFP = 0.6820) Total electricity for the above, kWh/year Electricity for lighting (calculated in Appendix L)</pre>	= 0.6820)						282.9768 282.9768 215.9594	(330a) (331) (332)
Energy saving/generation technologies (Appendices M ,N and Q) PV generation Wind generation Hydro-electric generation (Appendix N) Electricity generated - Micro CHP (Appendix N)							0.0000 0.0000 0.0000 0.0000	(333) (334) (335a) (335)
Energy saved or generated Energy used Total delivered energy for all uses							-0.0000 0.0000 4425.9296	(336) (337) (338)
12b. Carbon dioxide emissions - Community heating scheme								
			Energy kWh/year	Emiss: 	ion factor ‹g CO2/kWh	k	Emissions g CO2/year	/a
Efficiency of heat source Boilers Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Overall CO2 factor for heat network			3308.0563 14.5556		0.2100 0.0000		89.5000 341.5283 4.4214 0.2361	(367) (367) (372) (386)
Total CO2 associated with community systems Energy for instantaneous electric shower(s)			838.1104		0.1391		699.1133 116.5997	(373) (264a)
Space and water heating Space cooling			128.1727		0.1141		699.1133 14.6189	(376) (377)
Pumps, fans and electric keep-hot Energy for lighting Total CO2, kg/year EPC Dwelling Carbon Dioxide Emission Rate (DER)			282.9768 215.9594		0.1387 0.1443		39.2524 31.1696 900.7538 8.0400	(378) (379) (383) (384)
13b. Primary energy - Community heating scheme								
			Energy kWh/year	Primary ener	rgy factor kg CO2/kWh	Prim	ary energy kWh/year	
Efficiency of heat source Boilers Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Overall CO2 factor for heat network			3308.0563 14.5556		1.1300 0.0000		89.5000 1837.7474 45.9642 1.2781	(467a) (467) (472) (486)

Efficiency of heat source Boilers			89.5000
Space and Water heating from Boilers	3308.0563	1.1300	1837.7474
Electrical energy for heat distribution (space & water)	14.5556	0.0000	45.9642
Overall CO2 factor for heat network			1.2781



Total CO2 as Energy for i Space and wa Space coolir Pumps, fans Energy for 1 Total Primar Dwelling Pri	ssocia Instan Iter l and o ight: y eno mary	ated with ntaneous e neating electric k ing ergy kWh/y energy Ra	community s lectric sho eep-hot ear te (DPER)	ystems wer(s)			838.1104 128.1727 282.9768 215.9594		1.5143 1.4204 1.5128 1.5338		3784.0678 1269.1792 3784.0678 182.0541 428.0873 331.2457 5994.6341 53.5200	(473) (278a) (476) (477) (478) (479) (483) (484)		
SAP 10 WORKS CALCULATION	HEET OF T/	FOR New B ARGET EMIS	uild (As De SIONS	signed)	(Version 10.	2, February	2022)							
1. Overall d	IWell:	ing charac	teristics 						Area	Store	/ height		Volume	
Ground floor First floor Total floor Dwelling vol	area ume	TFA = (1a	)+(1b)+(1c)	+(1d)+(1e	)(1n)	11	2.0000		(m2) 61.0000 ( 51.0000 (	1b) x 1c) x 1)+(3b)+(3c)+(	(m) 2.9000 3.2000 (3d)+(3e)	(2b) = (2c) = )(3n) =	(m3) 176.9000 163.2000 340.1000	(1b) - (1c) - (4) (5)
2. Ventilati	.on ra	ate												
												ma	9 per hour	
Number of op Number of op Number of ch Number of fl Number of fl Number of in Number of pa Number of fl	en cl en f. umney ues a .ues a .ockeo term: ssivo .uele:	nimneys lues ys / flues attached t attached t d chimneys ittent ext e vents ss gas fire	attached t o solid fue o other hea ract fans es	o closed <sup>-</sup> l boiler ter	fire							$\begin{array}{ccccc} 0 & * & 80 & = \\ 0 & * & 20 & = \\ 0 & * & 10 & = \\ 0 & * & 20 & = \\ 0 & * & 35 & = \\ 0 & * & 20 & = \\ 4 & * & 10 & = \\ 0 & * & 10 & = \\ 0 & * & 40 & = \end{array}$	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 40.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration Pressure tes Pressure Tes Measured/des Infiltration Number of si	i due st st Met sign / i rate des s	to chimne thod AP50 e sheltered	ys, flues a	nd fans	= (6a)+(6b)+	+(6c)+(6d)+(4	6e)+(6f)+(	6g)+(7a)+(7	7b)+(7c) =		40.0000	Air changes ð / (5) = B]	5 per hour 0.1176 Yes .ower Doon 5.0000 0.3676 0	(8) (17) (18) (19)
Shelter fact Infiltration	or rate	e adjusted	to include	shelter ·	factor				(	20) = 1 - (21)	[0.075 ) ) = (18)	x (19)] = x (20) =	1.0000 0.3676	(20) (21)
Wind speed Wind factor		Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (22a)
Adj infilt r	ate	0.4687 0.6098	0.4595 0.6056	0.4503 0.6014	0.4044 0.5818	0.3952 0.5781	0.3492 0.5610	0.3492 0.5610	0.3400 0.5578	0.3676 0.5676	0.3952 0.5781	0.4136 0.5855	0.4319 0.5933	(22b) (25)
3. Heat loss	es a	nd heat lo	 ss paramete											
Element					Gross	Openings	Net	Area	U-value	Α×υ	ŀ	<-value	АхК	
TER Opaque d TER Opening Opening Floor to unf External Wal LGF Roof Total net ar Fabric heat	loor Type leated l LGI .1 UGI rea o loss	(Uw = 1.2 F F F f external , W/K = Su	0) elements A m (A x U)	.um(A, m2)	m2 31.6000 36.8000 7.1700	m2 15.4100 10.4400 2.1300	2. 23. 2. 16. 26. 5. 136.	m2 0000 8500 1300 0000 1900 3600 0400 5700 (26)(3	W/m2K 1.0000 1.1450 2.0221 0.1300 0.1800 0.1800 0.1100 30) + (32) =	W/K 2.0000 27.3092 4.3070 7.9300 2.9142 4.7448 0.5544 49.7595		kJ/m2K	kJ/K	(26) (27) (27a) (28a) (29a) (29a) (30) (31) (33)
Thermal mass	para mal	ameter (TM Bridøes	P = Cm / TF	A) in kJ/r	m2K								250.0000	(35)
K1 E E5 G E1 S E3 S E4 J	ilemen iround iteel ill amb	nt d floor (n lintel wi	ormal) th perforat	ed steel I	base plate				Le 22. 11. 10. 36.	ength Ps: 4000 7600 7600 9600	i-value 0.1600 0.0500 0.0500 0.0500	Tota 3.584 0.588 0.538 1.848	al 10 30 30 30	



E5 Gr E6 In E18 P R11 U Thermal bridg	E5 Ground floor (normal) E6 Intermediate floor within a dwelling E18 Party wall between dwellings R11 Upstands or kerbs of rooflights Thermal bridges (Sum(L x Psi) calculated using Appendix K)									10.90000.16001.744011.50000.00000.000024.40000.06001.46407.86000.08000.6288			(36)
Point Thermal Total fabric	bridges heat loss	isiy cuicu		Appendix	()				(	33) + (36)	(36a) = + (36a) =	0.0000 60.1543	(37)
Ventilation h (38)m	eat loss ca Jan 68.4445	lculated mo Feb 67.9658	nthly (38)m Mar 67.4965	= 0.33 x Apr 65.2926	(25)m x (5) May 64.8802	Jun 62.9606	Jul 62.9606	Aug 62.6052	Sep 63.7000	Oct 64.8802	Nov 65.7144	Dec 66.5865	(38)
Heat transfer Average = Sum	coeff 128.5988 (39)m / 12 =	128.1201	127.6509	125.4469	125.0346	123.1150	123.1150	122.7595	123.8544	125.0346	125.8687	126.7408 125.4449	(39)
HLP	Jan 1.1482	Feb 1.1439	Mar 1.1397	Apr 1.1201	May 1.1164	Jun 1.0992	Jul 1.0992	Aug 1.0961	Sep 1.1058	Oct 1.1164	Nov 1.1238	Dec 1.1316	(40)
HLP (average) Days in mont	31	28	31	30	31	30	31	31	30	31	30	1.1200 31	
4. Water heat	ing energy i	requirement	s (kWh/vear	)									
												2 8263	(42)
Hot water usa	ge for mixer 92.0047	r showers 90.6220	88.6072	84.7523	81.9074	78.7349	76.9316	78.9311	81.1230	84.5294	88.4671	91.6522	(42) (42a)
HOL Water USa	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 usa Average daily	ge for other 43.5743 hot water u	r uses 41.9897 use (litres	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 124.4382	(42c) (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Daily hot wat Energy conte	er use 135.5789 214.7239	132.6118 188.8374	129.0125 198.2874	123.5730 169.1653	119.1436 160.3902	114.3866 140.6516	112.5833 136.1597	116.1673 143.8394	119.9437 147.9026	124.9346 169.5351	130.4569 185.8597	135.2264 211.7319	(44) (45)
Energy conten Distribution	t (annual) loss (46)m 32.2086	= 0.15 x (+ 28.3256	45)m 29.7431	25.3748	24.0585	21.0977	20.4240	21.5759	22.1854	Total = S 25.4303	um(45)m = 27.8790	2067.0843 31.7598	(46)
Water storage Store volume	1055:											150.0000	(47)
a) If manufa Temperature Enter (49) or	cturer decla factor from (54) in (59	ared loss f m Table 2b 5)	actor is kn	own (kWh/d	day):							1.3938 0.5400 0.7527	(48) (49) (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 c	ontains ded: 23.3325	icated sola 21.0745	r storage 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 Total heat re	0.0000 quired for	0.0000 water heati	0.0000 ng calculat	0.0000 ed for eacl	0.0000 h month	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
	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 PV diverter	-42.0607 -0.0000	-37.1988 -0.0000	-38.9525 -0.0000	-32.2542	-30.0597 -0.0000	-25.7223	-24.1106 -0.0000	-25.6392	-26.6133	-31.3742	-35.5431 -0.0000	-41.2818	(63a) (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)
Output from w	/h	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(630)
12Total per y	219.2581 ear (kWh/yea	193.7243 ar)	205.9298	182.0029	176.9254	160.0211	158.6440	164.7951 Total p	166.3811 er year (kw	184.7558 lh/year) = S	195.4085 um(64)m =	217.0450 2224.8913 2225	(64) (64) (64)
Electric show	er(s) 0.0000	0.0000	0.0000	0.0000 Tot	0.0000 tal Energy ι	0.0000 used by inst	0.0000 antaneous e	0.0000 electric sho	0.0000 wer(s) (kWh	0.0000 n/year) = Su	0.0000 m(64a)m =	0.0000 0.0000	(64a) (64a)
Heat gains fr	om water hea 108.6716	ating, kWh/n 96.4570	month 103.2065	92.3209	90.6057	82.8401	82.5490	85.1025	85.2511	93.6463	97.8718	107.6768	(65)
5. Internal g	ains (see Ta	able 5 and	5a)										
Metabolic gai	ns (Table 5	), Watts							-			_	
(66)m	Jan 141.3156	Feb 141.3156	Mar 141.3156	Apr 141.3156	May 141.3156	Jun 141.3156	Jul 141.3156	Aug 141.3156	Sep 141.3156	Oct 141.3156	Nov 141.3156	Dec 141.3156	(66)
LIGHTING Galn	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 ga	ins (calcula 274.3987	ated in App 277.2461	endix L, eq 270.0707	uation L13 254.7953	or L13a), a 235.5127	1150 see Tab 217.3898	205.2826	202.4352	209.6106	224.8861	244.1686	262.2915	(68)
Cooking gains Pumps, fans	(calculated) 37.1316 3.0000	d in Append 37.1316 3.0000	ix L, equat 37.1316 3.0000	ion L15 or 37.1316 3.0000	L15a), also 37.1316 3.0000	see Table 37.1316 0.0000	5 37.1316 0.0000	37.1316 0.0000	37.1316 0.0000	37.1316 3.0000	37.1316 3.0000	37.1316 3.0000	(69) (70)
Losses e.g. e	vaporation	(negative v	alues) (Tab	le 5)	-113 0525	-113 0525	-113 0525	-113 0525	-113 0525	-113 0525	-113 0525	-113 0525	(71)
Water heating	gains (Tab. 146.0640	le 5) 143.5372	138.7184	128.2235	121.7818	115.0557	110.9530	114.3851	118.4043	125.8687	135.9331	144.7269	(72)
Total interna	l gains	1-2.2212	1001/104	120.2255	121./010	110.000	110.000	114.3031	110.4045	123.0007	100.001	177.7209	(, 2)

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]	Jan]		Area m2		rea m2	Solar flux Table 6a W/m2	Speci or	g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		
North			8.5	700	10.6334		0.6300	е	0.7000	0.77	00	27.8500	(74)	
South			15.2	800	46.7521		0.6300	е	0.7000	0.77	00	218.3212	(78)	
North			2.1	300	26.0000		0.6300	е	0.7000	1.00	00	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)	

000 (85) 576 912 946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 198 (92) 300 198 (93)
000 (85) 676 912 946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
676 912 946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
676 912 946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 198 (93)
676 912 946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
946 (86) 508 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 900 498 (93)
946 (86) 608 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 200 498 (93)
608 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 200 498 (93)
608 (87) 751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
751 (88) 928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
928 (89) 432 (90) 596 (91) 498 (92) 300 498 (93)
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432 (90) 696 (91) 498 (92) 300 498 (93)
696 (91) 498 (92) 200 498 (93)
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000 498 (93)
498 (93)
898 (94)
320 (95)
<i>3</i> 00 (96)
509 (97)
588 (98a)
252
000 (98b)
900
F00 (00-)
588 (98C)
202 083 (00)
(22)
20 98 20 98 20 98 12 98 12 98 12 90 90 98 12 90 90 98 12 90 98 12 98 98 12 98 98 12 98 98 12 98 98 12 98 98 12 98 12 98 12 98 12 10 19 10 10 10 10 10 10 10 10 10 10 10 10 10

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

Jan         Feb         Mar         Apr         May         Jun         Jul         Aug         Sep         Oct         Nov         Dec           Space         heating         requirement         728.349         508.4585         372.6235         159.9852         46.1121         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         0.0000         0.0000         0.0000         0.0000         0.0000         92.3000         92.3000         (10)           Space         heating         fuel (main heating system 2)         0.0000	Fraction of space heat from secondary/supplementary system (Table 11) Fraction of space heat from main system(s) Efficiency of main space heating system 1 (in %) Efficiency of main space heating system 2 (in %) Efficiency of secondary/supplementary heating system, %												0.0000 (201) 1.0000 (202) 92.3000 (206) 0.0000 (207) 0.0000 (208)
Space heating requirement       728.3449       508.4585       372.6235       159.9852       46.1121       0.0000       0.0000       0.0000       172.6046       465.1375       750.8588       (98)         Space heating efficiency (main heating system 1)       92.3000       92.3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec
728.3449       508.4585       372.623       159.9852       46.1121       0.0000       0.0000       0.0000       172.6046       465.1375       750.8588       (98)         Space heating efficiency (main heating system)       92.3000       92	Space heating	requirement	:										
Space heating efficiency (main heating system 1)       92.3000		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)
92.3000 92.3000 92.3000 92.3000 92.3000 92.3000 92.3000 0.0000 0.0000 0.0000 0.0000 92.3000 90.0000 92.3000 9	Space heating	efficiency	(main heat	ing system	1)								
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		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)
789.1061       558.8760       403.7091       173.3318       49.9590       0.0000       0.0000       0.0000       187.0039       503.9410       813.4982 (211)         Space heating efficiency (main heating system 2)       0.0000       <	Space heating	fuel (main	heating sy	stem)									
Space heating efficiency (main heating system 2)         0.0000		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)
0.0000       0.0000	Space heating	etticiency	(main heat	ing system	2)								
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 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 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 (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 0.0000 (221) Pumps and Fa 7.3041 6.5973 7.3041 7.0685 7.3041 7.0685 7.3041 7.3041 7.3041 7.0685 7.3041 7.0685 7.3041 (231)	Course hashing	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)
0.0000       0.00000       0.0000       0.0000	Space neating	tuel (main	neating sy	stem 2)	0 0000	0,0000	0,0000	0 0000	0,0000	0 0000	0 0000	0,0000	0 0000 (212)
Space heating full (secondary)       0.0000	Cuese beeting	6.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (213)
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       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       217.0653       200.5277       198.8020       206.5102       208.4977       220.1899       227.3965       250.6016       (219)         Space cooling fuel requirement       (221)m       0.00000       0.0000       0.00000	space nearing		nuary)	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 (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 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 2.0000 0.0		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 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       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       0.0000	Water heating												
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       79.8000       79.8000       79.8000       79.8000       79.8000       83.9075       85.9329       86.6096       (217)         Space cooling fuel requirement       221.2123       217.2601       217.0653       200.5277       198.8020       206.5102       208.4977       220.1899       227.3965       250.6016       (219)         Space cooling fuel requirement       0.00000       0.0000       0.0000	Water heating	requirement	:										
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       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<	-	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)
(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	Efficiency of	water heate	er										79.8000 (216)
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       0.0000 </td <td>(217)m</td> <td>86.5416</td> <td>86.1203</td> <td>85.3728</td> <td>83.7719</td> <td>81.5079</td> <td>79.8000</td> <td>79.8000</td> <td>79.8000</td> <td>79.8000</td> <td>83.9075</td> <td>85.9329</td> <td>86.6096 (217)</td>	(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)
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       0.00000       0.0000       0.000	Fuel for wate	r heating, k	Wh/month										
Space cooling fuel requirement           (221)m         0.0000		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)
(221)m         0.0000<	Space cooling	fuel requir	rement										
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)	(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 26.83	312 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 -27.29	943 -20.7435 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	
(234a)m 0.00000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000000	0.0000 (234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)	
(235a)m 0.000000	000 0.0000 (235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)	
(235c)m 0.00000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.000000	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 -11.59	53 -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 0.000	0.0000 (234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)	
(235b)m 0.00000 0.00000 0.0000 0.00000 0.000000	900 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 0.000	900 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)
France environmentation to the large (Amendian H, H, and A)	
Energy saving/generation technologies (Appendices M ,N and Q)	1107 17(1 (222)
PV generation	-110/.1/61 (233)
Wind generation	0.0000 (234)
Hydro-Electric generation (Appendix N)	0.0000 (235d)
Electricity generated - micro chr (Appendix N)	0.0000 (235)
Appendix Q - Special reactives	-0 0000 (235)
Licity save of generated	
Licity used	5249 7021 (227)
Incat nettine en energy initiate ases	JJ40./021 (230)

#### 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

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	Energy kWh/vear	Emission factor	Emissions kg CO2/year
Space heating - main system 1 Total CO2 associated with community systems	3471.4250	0.2100	728.9992 (261) 0.0000 (373)
Water heating (other fuel) Space and water heating	2666.3651	0.2100	559.9367 (264) 1288.9359 (265)
Pumps, fans and electric keep-hot Energy for lighting	86.0000 232.0882	0.1387 0.1443	11.9293 (267) 33.4975 (268)
Energy saving/generation technologies PV Unit electricity used in dwelling PV Unit electricity exported Total Total CO2, kg/year EPC Target Carbon Dioxide Emission Rate (TER)	-597.2204 -509.9557	0.1335 0.1253	-79.7287 -63.8843 -143.6129 (269) 1190.7498 (272) 10.6300 (273)

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

	Energy	Primary energy factor	Primary energy
	kwn/year	kg CO2/kWh	kwn/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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(4)

(6c)

(6d)

(7a)

(18)

(26)

(27) (27a)

(28a)

(29a)

(29a)

(30)

(31)

(33)

 Overall dwelling characteristics Storey height Volume Area (m2) (m) (m3) 2.9000 176.9000 (1b) -Ground floor 61.0000 (1b) (2b) First floor Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)51.0000 (1c) 3.2000 (2c) = 163.2000 (1c) 112,0000 340.1000 (5) Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 2. Ventilation rate m3 per hour 0.0000 (6a) Number of open chimneys 0 \* 80 = 0 \* 20 = Number of open flues Number of chimneys / flues attached to closed fire 0.0000 (6b) 0 \* 10 = 0.0000 0 \* 20 Number of flues attached to solid fuel boiler = 0.0000 0 \* 35 = Number of flues attached to other heater 0.0000 (6e) 0.0000 (6f) 0 \* 20 Number of blocked chimneys = Number of intermittent extract fans 4 \* 10 = 40.0000 0 \* 10 = Number of passive vents Number of flueless gas fires 0.0000 (7b) 0 \* 40 = 0.0000 (7c) Air changes per hour 40.0000 / (5) = Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =0.1176 (8) Pressure test Yes Pressure Test Method Blower Door Measured/design AP50 3.0000 (17) Infiltration rate 0.2676 Number of sides sheltered 0 (19) 1.0000 (20) Shelter factor (20) = 1[0.075 x (19)] Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.2676 (21) lan Feb Mar Apr May 4.3000 Jun 7u1 Aug 3.7000 Sep 0ct Nov Dec 4.7000 (22) 5.1000 5.0000 4.9000 4.4000 3.8000 3.8000 4.0000 4.3000 4.5000 Wind speed 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 If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) Effective ac 0.5582 0.5560 0.5537 0.5433 0.5414 0.5323 0.5323 = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b) 0.0000 (23c) 0.5306 0.5358 0.5414 0.5453 0.5494 (25) 3. Heat losses and heat loss parameter Flement Gross **Openings** NetArea U-value ΑxU K\_v2]up АхК m2 m2 m2 W/m2K W/K kJ/m2K kJ/K Front Door 2.0000 1.0000 2.0000 Window (Uw = 1.20) 23.8500 1.1450 27.3092 Opening Floor to unheated 1.1450 2.1300 2.4389 61.0000 0.1000 6.1000 External Wall LGF 31,6000 15.4100 16.1900 0.1500 2.4285 External Wall UGF 36.8000 10.4400 26.3600 0.1500 3.9540 LGF Roof 7.1700 2.1300 5.0400 0.1000 0.5040 Total net area of external elements Aum(A, m2) 136.5700 (26)...(30) + (32) =44.7346 Fabric heat loss,  $W/K = Sum (A \times U)$ Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 250.0000 (35) Thermal bridges (User defined value 0.040 \* total exposed area) Point Thermal bridges 5.4628 (36) 0.0000 (36a) =Total fabric heat loss 50.1974 (37) (33) + (36) + (36a) Ventilation heat loss calculated monthly  $(38)m = 0.33 \times (25)m \times (5)$ Мау Jan Feb Mar Apr Jun Jul Aug Sep 0ct 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 112.3447 110.9582 112.5934 111.1767 109.9409 109.9409 109.7525 110.3328 110.9582 111.4003 111.8624 (39) Average = Sum(39)m / 12 = 111.1757 Feb Mar Мау Jun Jul 0ct Nov Jan Apr Aug Sep Dec 1.0053 1.0076 1.0031 0.9926 0.9907 0.9816 0.9816 0.9799 0.9851 0.9907 0.9946 0.9988 (40) HI P HLP (average) 0.9926 Days in mont 31 28 31 30 31 30 31 31 30 31 30 31

4. Water	heatin	g energy re	quirements	(kWh/year)									
Assumed of	occupan	cy for mixer	showers										2.8263 (42)
Hot water	usage	0.0000 for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (42a)
	asaBe	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 usa	ge for other	r 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 u	use (litres	/day)									68.2778	(43)
	7	E.L				7	21	<b>A</b>	6	0+	N	<b>D</b>	
	Jan	Feb	Mar	Apr	may	Jun	JUI	Aug	Sep	Οςτ	NOV	Dec	
Daily not wat	er use			<b>67 1 1 1 1</b>		<b>60 000</b>	<i></i>			co 0070			
	74.4912	/2.44/5	/0.2164	67.4397	64.9624	62.3881	61.8534	64.0800	66.3636	69.00/3	/1.8086	/4.386/	(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 conten	t (annual)									Total = Su	um(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 c	ontains ded:	icated sola	r 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 re	quired for w	water heati	ng calculate	d 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 pe	r vear (kW	h/vear) = Su	um(64)m =	963.8565	(64)
12Total per v	ear (kWh/vea	ar)										964	(64)
Electric show	er(s)	,											(- )
2200010 20 5000	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)
	57.5455	52.0557	55.7545	5512440 Tota	al Energy us	sed by insta	antaneous el	ectric show	er(s) (kWh	/vear) = Sur	n(64a)m =	652,3063	(64a)
Heat gains fr	om water he:	ating kWh/	month	1002	in Linergy us	sea by inste	incuncous er			, <b>y</b> car	(040)m =	052.5005	(0-40)
near Barns II	39 /063	3/ 6963	36 8816	32 9293	32 1//3	29 2373	29 2632	30 1215	30 7005	33 8476	35 1260	39 0867	(65)
	55.4005	J-10905	20.0010	52.5255	72.1445	27.25/5	20.2052	50.4215	50.7005	55.0470	55.4200	55.0007	(0)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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	(calculate	d in Append	dix L, equa <sup>.</sup>	tion 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 gai	ns (calcula	ted in App	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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 Append:	ix L, equat	ion 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. ev	aporation (	negative va	alues) (Tab	le 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 (Tabl	e 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			a Speci 2 or	g fic data Table 6b	Specific or Tab	FF data le 6c	Acce fact Table	ss or 6d	Gains W	
North			8.5700		10.6334		0.4000	0	.8000	0.77	00	20.2086	(74)
South			15.2	15.2800		L	0.4000	0	.8000	0.77	00	158.4190	(78)
North			2.1	300	26.0000	)	0.4000 0.7000		.7000	1.00	00	13.9558	(82)
Solar gains Total gains	192.5834 723.7449	327.0542 874.5580	447.6459 971.0860	559.4518 1068.3930	634.2937 1116.8085	633.9533 1100.3612	609.3668 1057.7790	552.3024 999.4240	485.8676 946.5285	361.2385 835.4160	230.4236 732.2058	165.0075 683.6321	(83) (84)

7. Mean internal temperature (heating season)

Temperature	during heatin	g periods i	n the livin.	ig area from	Table 9, T	h1 (C)						21.0000 (85)
Utilisation	factor for ga	ins for liv	ing area, n	i1,m (see T	able 9a)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 o	f 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

Ful	I SA		Calc	ut	elmhurst energy								
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 heati	ing requirem	ient											
	Jan	Fab	Man	400	May	Jun	11	Aug	Son	Oct	Nov	Doc	
Utilisation Useful gains Ext temp. Heat loss rate	0.9948 720.0118 4.3000	0.9857 862.0324 4.9000	0.9653 937.4087 6.5000	0.9027 964.4461 8.9000	0.7677 857.3372 11.7000	0.5541 609.7182 14.6000	0.3785 400.3554 16.6000	0.4211 420.8573 16.4000	0.6798 643.4252 14.1000	0.9257 773.3293 10.6000	0.9869 722.6132 7.1000	0.9962 681.0071 4.2000	(94) (95) (96)
	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 Space heating Solar heating	KWh 713.2183 requirement kWh	516.9180 : - total p	401.3956 er year (kW	190.8797 h/year)	60.5887	0.0000	0.0000	0.0000	0.0000	197.2188	475.4519	737.1193 3292.7903	(98a)
Solar heating	0.0000 contributio	0.0000 on - total	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
Space heating Space heating	kWh 713.2183 requirement	516.9180 after sol	401.3956 ar contribu	190.8797 tion - total	60.5887 L per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	197.2188	475.4519	737.1193 3292.7903	(98c)
Space heating	per m2									(98c	) / (4) =	29.3999	(99)
8c. Space cool	ling require	ement											
Calculated for	r June, July Jan	and Augus <sup>.</sup> Feb	t. See Tabl Mar	e 10b Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Ext. temp. Heat loss rate	4.3000 e W	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Utilisation Useful loss Total gains	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	1033.4446 0.9097 940.1094 1211.3498	813.5628 0.9575 778.9705 1165.2390	834.1192 0.9418 785.5839 1102.6705	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	(100) (101) (102) (103)
Space cooling Cooled fractic	kWh 0.0000 on	0.0000	0.0000	0.0000	0.0000	195.2931	287.3838	235.9125	0.0000 fC =	0.0000 cooled are	0.0000 a / (4) =	0.0000	(104) (105)
Intermittency	factor (Tab 0.2500	ole 10b) 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 Energy for spa Energy for spa Total Fabric Energy	requirement ace heating ace cooling Efficiency	(DFEE)						5015702				179.6473 29.3999 1.6040 31.0039 31.0	(107) (99) (108) (109) (109)
SAP 10 WORKSHE	EET FOR New	Build (As	Designed)	(Version 10	).2, Febru	ary 2022)							
	+ IAKGEI FAB	RIC ENERGY	EFFICIENCY										
1. Overall dwe	elling chara	cteristics											
Ground floor First floor								Area (m2) 61.0000 51.0000	Stc (1b) x (1c) x	rey height (m) 2.9000 3.2000	(2b) = (2c) =	Volume (m3) 176.9000 163.2000	(1b) - (1c) -
Total floor ar Dwelling volun	rea TFA = (1 me	.a)+(1b)+(1	c)+(1d)+(1e	)(1n)		112.0000		(3	3a)+(3b)+(3c	)+(3d)+(3e)	(3n) =	340.1000	(4) (5)
2. Ventilatior	n rate										'n	13 per hour	
Number of oror	n chimnous										0 * 80 -	0 0000 ·	(62)
Number of oper Number of chin Number of flue Number of flue	n flues mneys / flue es attached es attached	es attached to solid f to other h	to closed uel boiler eater	fire							0 * 20 = 0 * 10 = 0 * 20 = 0 * 20 = 0 * 35 = 0	0.0000 0.0000 0.0000 0.0000	(6b) (6c) (6d) (6e)
Number of bloc Number of inte Number of pass	cked chimney ermittent ex sive vents	rs tract fans									0 * 20 = 4 * 10 = 0 * 10 =	0.0000 40.0000 0.0000	(6f) (7a) (7b)
NUMBER OF ITHE	cacaa gas Ti										5 40 =	0.0000	(, )

Number of flues attached to solid fuel boiler Number of flues attached to other heater Number of blocked chimneys Number of intermittent extract fans Number of passive vents Number of flueless gas fires 0 \* 20 = 0 \* 20 = 0 \* 35 = 0 \* 20 = 4 \* 10 = 0 \* 10 = 0 \* 40 =

Air changes per hour 40.0000 / (5) = 0.1176 (8)



Pressure test Pressure Test Mu Measured/design Infiltration ra Number of sides	ethod AP50 te sheltered											Yes Blower Door 5.0000 0.3676 0	(17) (18) (19)
Shelter factor Infiltration ra	te adiusted	i to include	shelter fa	ctor				(2	0) = 1 - (21)	[0.075 x]	(19)] = (20) =	1.0000 0.3676	(20) (21)
1			. Sheree Tu						()	(10) /	(20)	015070	()
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 Adj infilt rate	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)
5	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 u	using Append	lix N, (23b)	= (23a) >	<pre>K Fmv (equation)</pre>	on (N5)),	otherwise (	(23b) = (23a)				0.0000	(23b)
If balanced with	h heat reco	overv: effic	iency in %	allowing f	for in-use fa	ctor (from	Table 4h)	=				0.0000	(23c)
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 lo	oss paramete	er										
Element				Gross	Openings	Net	Area	U-value	ΑxU	K	value	АхК	
				m2	m2		m2	W/m2K	W/K	k	J/m2K	kJ/K	
TER Opaque door						2.	0000	1.0000	2.0000				(26)
TER Opening Type	e (Uw = 1.2	20)				23.	8500	1.1450	27.3092				(27)
Opening						2.	1300	2.0221	4.3070				(27=)
Floor to unheat	ed						1300						(2/4)
External Wall LO						61.	0000	0.1300	7.9300				(28a)
	GF		3	1.6000	15.4100	61. 16.	0000 1900	0.1300 0.1800	7.9300 2.9142				(28a) (29a)
External Wall U	GF GF		3	1.6000 5.8000	15.4100 10.4400	61. 16. 26.	0000 1900 3600	0.1300 0.1800 0.1800	7.9300 2.9142 4.7448				(28a) (29a) (29a)
External Wall U LGF Roof	GF GF		3:	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5.	0000 1900 3600 0400	0.1300 0.1800 0.1800 0.1100	7.9300 2.9142 4.7448 0.5544				(28a) (29a) (29a) (30)
External Wall U LGF Roof Total net area	GF GF of external	l elements A	3 3 Aum(A, m2)	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5. 136.	0000 1900 3600 0400 5700	0.1300 0.1800 0.1800 0.1100	7.9300 2.9142 4.7448 0.5544				(29a) (29a) (29a) (30) (31)
External Wall U LGF Roof Total net area Fabric heat los	GF GF of external s, W/K = Su	L elements A um (A x U)	3 3 Aum(A, m2)	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5. 136.	0000 1900 3600 0400 5700 (26)(3	0.1300 0.1800 0.1800 0.1100 30) + (32) =	7.9300 2.9142 4.7448 0.5544 49.7595				(27a) (28a) (29a) (29a) (30) (31) (33)
External Wall U LGF Roof Total net area Fabric heat loss Thermal mass pa	GF GF s, W/K = Su rameter (TM	L elements A um (A x U) 1P = Cm / TF	3 3 Aum(A, m2) FA) in kJ/m2	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61.) 16. 26. 5.) 136.	0000 1900 3600 0400 5700 (26)(3	0.1300 0.1800 0.1800 0.1100 30) + (32) =	7.9300 2.9142 4.7448 0.5544 49.7595			250.0000	(27a) (28a) (29a) (29a) (30) (31) (33) (35)
External Wall U LGF Roof Total net area Fabric heat loss Thermal mass pai List of Thermal	GF GF s, W/K = Su rameter (TM Bridges	L elements A um (A x U) 1P = Cm / TF	3 3 Aum(A, m2) A) in kJ/m2	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61.) 16. 26. 5.) 136.	0000 1900 3600 0400 5700 (26)(3	0.1300 0.1800 0.1800 0.1100 300) + (32) =	7.9300 2.9142 4.7448 0.5544 49.7595		_	250.0000	(27a) (28a) (29a) (29a) (30) (31) (33) (35)
External Wall U LGF Roof Total net area o Fabric heat los: Thermal mass pai List of Thermal K1 Elemi	GF GF s, W/K = Su rameter (TM Bridges ent	L elements A um (A x U) MP = Cm / TF	3 3 Aum(A, m2) A) in kJ/m2	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5. 136.	0000 1900 3600 0400 5700 (26)(3	0.1300 0.1800 0.1800 0.1100 300) + (32) =	7.9300 2.9142 4.7448 0.5544 49.7595 gth Psi	-value	То	250.0000 tal	(27a) (28a) (29a) (29a) (30) (31) (33) (35)
xternal Wall U GF Roof otal net area abric heat los hermal mass pa ist of Thermal K1 Elem E5 Grou	GF GF s, W/K = Su rameter (TM Bridges ent nd floor (r	L elements A um (A x U) 1P = Cm / TF normal)	3 3 Aum(A, m2)	1.6000 5.8000 7.1700	15.4100 10.4400 2.1300	61. 16. 26. 5. 136.	2000 1900 3600 2400 5700 (26)(3	0.1300 0.1800 0.1800 0.1100 30) + (32) =	7.9300 2.9142 4.7448 0.5544 49.7595 gth Psi	-value 0.1600	To 3.5	250.0000 tal 840	(27a) (28a) (29a) (30) (31) (33) (35)

E5 Gr	ound tioor	(normal)				22	.4000	0.1600	3.584	40		
E1 St	eel lintel	with perfor	ated steel	base plate		11	.7600	0.0500	0.58	80		
E3 Si	.11							10	.7600	0.0500	0.53	80
E4 Ja	imb							36	.9600	0.0500	1.84	80
E5 Gr	ound floor	(normal)						10	.9000	0.1600	1.74	40
E6 In	termediate	floor withi	n a dwellin	g				11	.5000	0.0000	0.00	90
E18 P	arty wall b	etween dwel	lings					24	.4000	0.0600	1.464	40
R11 U	lpstands or	kerbs of ro	oflights					7	.8600	0.0800	0.62	88
Thermal bridg	es (Sum(L x	Psi) calcu	lated using	Appendix K						10.3948 (36)		
Point Thermal	bridges		0		•						(36a) =	0.0000
Total fabric	heat loss									(33) + (36)	+ (36a) =	60.1543 (37)
Ventilation h	eat loss ca	lculated mo	nthly (38)m	= 0.33 x (	25)m x (5)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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	1(39)m / 12	-										125.4449
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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													
4. water neati	ng energy r	requirements	s (kwn/year)										
Assumed occupa	ncy											2.8263 (42)	)
Hot water usag	e for mixer	r 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	a)
Hot water usag	e for baths	5											
	30.9169	30.4578	29.8112	28.6190	27.7263	26.7364	26.2017	26.8438	27.5429	28.6021	29.8188	30.8124 (42t	b)
Hot water usag	e for other	r 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 (420	c)
Average daily	hot water ι	use (litres,	/day)									68.2778 (43)	)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
Daily hot wate	r 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 = S	um(45)m =	1133.9488	
Distribution 1	oss (46)m	= 0.15 x (4	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 co	ntains dedi	icated sola	r 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 req	uired for w	vater heatin	ng calculate	d 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 pe	r year (kWh	/year) = Su	m(64)m =	963.8565	(64)
12Total per y	ear (kWh/yea	ır)										964	(64)
Electric show	er(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)
				Tota	l Energy us	sed by insta	antaneous el	ectric show	er(s) (kWh/	'year) = Sum	(64a)m =	652.3063	(64a)
Heat gains fr	om water hea	iting, kWh/m	nonth										
	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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Metabolic gain	is (labie 5)	, Walls										
	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	(calculate	ed in Append	dix L, equa	tion 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 gai	.ns (calcula	ated in App	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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 Append:	ix L, equat	ion 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. ev	aporation (	negative v	alues) (Tab	le 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 (Tabl	le 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	gai	ns								


[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	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 inte	rnal temperat	ure (heatir	ng season)									
Temperature ( Utilisation	during heatin factor for ga	ng periods i nins for liv	in the livin ving area, n	ng area from 11.m (see T	Table 9, T able 9a)	Th1 (C)						21.0000 (85)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 <sup>.</sup>	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)

9 Space beating pequiperment

8. Space heating requirement

	lan	Feb	Mar	Δnr	May	Jun	1.1	Διισ	Sen	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 rat	e 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	requiremen	t - total p	er year (kW	h/year)								3626.9847
Solar heating	k Wh											
	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	contributi	on - total	per year (k	Wh/year)								0.0000



Space heating k Space heating r Space heating p	Wh 811.4817 ! equirement a er m2	572.8089 after solar	426.9621 contributi	188.2354 .on - total	56.2242 per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	207.0454 (98c)	529.3799 ) / (4) =	834.8469 3626.9847 32.3838	(98c) (99)
8c. Space cooli	ng requireme	ent											
Calculated for		and August	Soo Tablo	10b									
Ext. temp.	Jan 4.3000	Feb 4.9000	Mar 6.5000	Apr 8.9000	May 11.7000	Jun 14.6000	Jul 16.6000	Aug 16.4000	Sep 14.1000	Oct 10.6000	Nov 7.1000	Dec 4.2000	
Heat loss rate Utilisation Useful loss Total gains Space cooling k	W 0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	1157.2808 0.9271 1072.9094 1505.8162	911.0508 0.9649 879.0573 1448.0536	932.9722 0.9512 887.4822 1357.9795	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	0.0000 0.0000 0.0000 0.0000	(100) (101) (102) (103)
Cooled fraction	0.0000	0.0000	0.0000	0.0000	0.0000	311.6929	423.3332	350.0500	0.0000 fC =	0.0000 cooled area	0.0000 a / (4) =	0.0000 1.0000	(104) (105)
Intermittency f	actor (Table 0.2500 Wh	e 10b) 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 r Space cooling r Energy for spac Energy for spac Total Fabric Energy E	0.0000 equirement e heating e cooling fficiency (	0.0000 (fee)	0.0000	0.0000	0.0000	77.9232	105.8333	87.5125	0.0000	0.0000	0.0000	0.0000 271.2690 32.3838 2.4220 34.8058 34.8	(107) (107) (99) (108) (109) (109)
SAP 10 WORKSHEE CALCULATION OF	T FOR New BI ENERGY RATI	uild (As De NG	esigned) (	Version 10	.2, Februa	ary 2022)							
1. Overall dwel	ling charact	teristics											
Ground floor First floor Total floor are Dwelling volume	a TFA = (1a	)+(1b)+(1c)	9+(1d)+(1e).	(1n)		112.0000		Area (m2) 61.0000 51.0000	Stor (1b) x (1c) x 3a)+(3b)+(3c)	rey height (m) 2.9000 3.2000 )+(3d)+(3e)	(2b) = (2c) = (3n) =	Volume (m3) 176.9000 163.2000 340.1000	(1b) - (1c) - (4) (5)
2. Ventilation	rate												
											m3	per hour	
Number of open Number of open Number of chimm Number of flues Number of flues Number of block Number of passi Number of fluel	chimneys flues eys / flues attached to attached to ed chimneys mittent extu ve vents ess gas fire	attached t o solid fue o other hea ract fans es	co closed fi el boiler ater	re							$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration du Pressure test Pressure Test M Measured/design Infiltration ra Number of sides	e to chimney ethod AP50 te sheltered	ys, flues a	and fans =	• (6a)+(6b)•	+(6c)+(6d)	)+(6e)+(6f)+	(6g)+(7a)+(	7b)+(7c) =		0.0000	Air changes / (5) = Bl	per hour 0.0000 Yes ower Door 3.0000 0.1500 0	<ul> <li>(8)</li> <li>(17)</li> <li>(18)</li> <li>(19)</li> </ul>
Shelter factor Infiltration ra	te adjusted	to include	e shelter fa	ictor					(20) = 1 (2	- [0.075 x 21) = (18) x	(19)] = x (20) =	1.0000 0.1500	(20) (21)
Wind speed Wind factor	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (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 mecha If mechanical v If exhaust air If balanced wit	nical venti entilation heat pump us h heat recov	iation with sing Appenc very: effic	i neat recov dix N, (23b) ciency in %	very = (23a) x allowing f	Fmv (equa or in-use	ation (N5)), factor (fro	otherwise m Table 4h)	(23b) = (23 =	3a)			0.5000 0.5000 84.6000	(23a) (23b) (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 parame	ter 										
Element				Gross m2	Openings m2	Ne	tArea m2	U-value W/m2K	A x W/	U К ′К	-value kJ/m2K	A x K kJ/K	
Front Door	20)					2	.0000	1.0000	2.000	0	- ,	- ,	(26)
Opening	. 20)					23	.1300	1.1450	2,438	9 19			(27) (27a)
Floor to unheat External Wall L	.GF			31,6000	15,4100	61 16	.0000 .1900	0.1000 0.1500	6.100 2.428	90 15			(28a) (29a)
External Wall L	JGF			36.8000	10.4400	26	.3600	0.1500	3.954	0			(29a)
Total net area	of extern	al elements	Aum(A, m2)	7.1700	2.1300	136	.0400 .5700	0.1000	0.504	10			(30)
Fabric heat los	s, W/K = 1	Sum (A x U)					(26)(	30) + (32)	= 44.734	6			(33)
Thermal mass pa	arameter (	TMP = Cm /	TFA) in kJ/	m2K tal oxnosod	2002)							250.0000	(35)
Point Thermal b Total fabric he	oridges eat loss	Tined Value	0.040 10	tai exposed					(3	3) + (36)	(36a) = + (36a) =	0.0000 50.1974	(37)
Ventilation hea	at loss ca	lculated mo	nthly (38)m	= 0.33 x (	25)m x (5)	7	71	A	6	0+	New	Dee	
(38)m	Jan 30.1065	Feb 29.6856	Mar 29.2648	Apr 27.1604	мау 26.7395	Jun 24.6351	Jul 24.6351	Aug 24.2143	Sep 25.4769	0ct 26.7395	NOV 27.5813	Dec 28.4230	(38)
Heat transfer o	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(3	39)m / 12	=										77.2526	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(40)
HLP (average)	0.7170	0.7152	0.7095	0.0907	0.0009	0.0001	0.0001	0.0044	0.0757	0.0009	0.0945	0.6898	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heatir	ng energy	requirement	s (kWh/year	)									
Assumed occupar	ncy for mixe	r showers										2.8263	(42)
list water usuge	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)
HOL WALEP USAge	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	e for othe 43.5743	r uses 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 h	not water	use (litres	/day)									39.6130	(43)
Dailv hot water	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	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 Energy content	(annual)	59./928	62.1013	53.1436	50.12/1	43.8379	43.1176	46.1062	47.8698	54.8295 Total = S	59.8221 um(45)m =	657.9858	(45)
Distribution lo	oss (46)m 10.3516	= 0.15 x (	45)m 9.3152	7,9715	7,5191	6.5757	6.4676	6.9159	7,1805	8,2244	8,9733	10,2340	(46)
Water storage 1	loss:											110 0000	(47)
b) If manufac	turer dec	lared loss	factor is n	ot known :								110.0000	(47)
Hot water sto Volume factor	orage loss r from Tab	factor fro le 2a	m Table 2 (	kWh/litre/d	ay)							0.0152 1.0294	(51) (52)
Temperature f	Factor fro	m Table 2b										0.6000	(53)
Total storage 1	loss	5)										1.0327	(55)
If cvlinder cor	32.0144 htains ded	28.9162 icated sola	32.0144 r storage	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
	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 Combi loss	23.2624 0.0000	21.0112 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120	23.2624 0.0000	(59) (61)
Total heat requ	ired for	water heati	ng calculat	ed for each	month								
WWHRS	0.0000	109.7203	0.0000	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	0.0000	0.0000	123.5036	(62) (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 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 0.0000	0.0000	0.0000 0.0000	0.0000	0.0000 0.0000	0.0000	(63c) (63d)
Output from w/h	1	100 7000	117 2701	106 6373	105 4020	07 2216	00.0044	101 2020	101 2025	110 1000	112 2150	122 5026	()
	124.2878	109.7203	11/.3/81	106.6373	105.4039	97.3316	98.3944	101.3830 Total p	101.3635 er year (kWh	110.1063 I/year) = S	113.3158 um(64)m =	123.5036	(64) (64)
Electric shower	r(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)
Heat gains from	n water he	ating. kWh/	month	Tot	al Energy us	ed by inst	antaneous e	lectric sho	wer(s) (kWh/	'year) = Su	m(64a)m =	838.1104	(64a)
	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 gai	ins (see T	able 5 and	5a)										
Metabolic gains	5 (Table 5	), Watts							<i>.</i>	<b>a</b> :			
(66)m	Jan 169.5788	reb 169.5788	mar 169.5788	арг 169.5788	™ay 169.5788	Jun 169.5788	JUI 169.5788	Aug 169.5788	Sep 169.5788	UCT 169.5788	NOV 169.5788	рес 169.5788	(66)



Lighting gains	s (calculate	d in Appen	dix L, equa	tion 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 ga:	ins (calcula	ted in App	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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 Append	ix L, equat	ion 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. e	vaporation (	negative v	alues) (Tab	le 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 (Tabl	e 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 interna	l 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)

5.	Solar	gains				

[Jan]		Α	m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab	FF data ble 6c	Acce fact Table	ss or 6d	Gains W		
North South North			8.5 15.2 2.1	700 1800 1300	10.6334 46.7521 26.0000	)	0.4000 0.4000 0.4000	e e e	0.8000 0.8000 0.7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (82)
Solar gains Total gains	192.5834 859.0526	327.0542	447.6459	559.4518 1175.5045	634.2937 1214.8707	633.9533 1183.0422	609.3668 1140.2600	552.3024 1084.0343	485.8676 1035.2160	361.2385 941.4828	230.4236 847.1262	165.0075 813.9055	(83) (84)

#### 7. Mean internal temperature (heating season)

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

ULILISACION T	actor for ga	TUR FOL TIN	ing area,	nii,m (see	Table 9a)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 a	irea											
Ū	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 f	raction								fLA =	Living area	a / (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 a	adjustment											0.0000
adjusted MIT	<sup>19.8635</sup>	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 0.7344 May 0.5521 Jun Jul Aug 0.2800 Sep 0.4650 0ct Nov Dec 0.9849 (94) 801.5840 (95) Utilisation 0.9801 0.9502 0.8823 0.3716 0.2544 0.7687 0.9479 Useful gains 841.9312 943.3598 966.4632 863.2718 670.6746 439.6041 290.0530 303.5055 481.3854 723.7079 803.0237 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 290.0572 482.0234 755.5443 1015.8073 1229.9070 (97) 439.7120 303.5141 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 318.6723 (98c) 1097.1065 303.4591 180.3422 95.1659 20.2313 2.3451 0.0000 0.0000 0.0000 0.0000 23.6863 153.2042 Space heating requirement after solar contribution - total per year (kWh/year) (98c) / (4) = 9.7956 (99) Space heating per m2

8c. Space cooling requirement

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

		0										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 fractio	n								fC =	cooled area	/ (4) =	0.9821 (105)
Intermittency	factor (Tab	le 10b)										

21.0000 (85)



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)
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	n secondary	/suppleme	ntary system	n (Table 11)							0.0000	(301)
Fraction of space heat from Fraction of heat from comm	n community unity Boile	y system ers-Space	and Water								1.0000 1.0000	(302) (303a)
Factor for control and chan Eactor for changing method	rging metho	od (Table	4c(3)) for s	space heatin	g						1.0000	(305)
Distribution loss factor (	Table 12c)	for commu	nity heating	g system							1.1500	(306)
Space heating:	ppiementary	y neating	system, %								0.0000	(208)
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 = 307a 348.9779	(98) x 1.00 207.3936	0 x 1.00 x 109.4408	1.15 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/su	pplementary	/ heating	system in %	(from Table	4a or App	endix E)					0.0000	(308)
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 require 124.2878	rement 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 = 310a 142.9310	(64) x 1.00 126.1783	0 x 1.00 x 134.9849	1.15 122.6329	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 Space coolin 0.0000	ciency Rati 0.0000	io 0.0000	0.0000	0.0000	38.8525	47.2722	42.0480	0.0000	0.0000	0.0000	2.6000	(314) (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)
Electricity generated by P	Vs (Appendi	ix M) (neg	ative quanti	ity)	0.9507	0.0000	0.0000	10.8470	22.1042	24.9000	27.3020	(332)
Electricity generated by w	ind turbine	es (Append	lix M) (negat	tive quantit	y)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(224-)
Electricity generated by h	0.0000 ydro-electr	0.0000 ric genera	tors (Append	0.0000 dix M) (nega	0.0000 tive quant	0.0000 ity)	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
(335a)m 0.0000 Electricity generated by P	0.0000 Vs (Appendi	0.0000 ix M) (neg	0.0000 ative quanti	0.0000 ity)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
(333b)m 0.0000 Electricity generated by w	0.0000 ind turbine	0.0000 es (Append	0.0000 lix M) (negat	0.0000 tive quantit	0.0000 y)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
(334b)m 0.0000 Electricity generated by h	0.0000 vdro-electr	0.0000 ric genera	0.0000 tors (Append	0.0000 dix M) (nega	0.0000 tive quant	0.0000 (ity)	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
(335b)m 0.0000 Annual totals kWb/year	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Space heating fuel - commun	nity heatir	ng									1261.6724	(307)
Water heating fuel - commu	nity heatir	ng									1505.1494	(310)
Electricity used for heat of	distributio	on									0.0000 12.6167	(311) (313)
Space cooling fuel											128.1727	(321)
Electricity for pumps and (BalancedWithHeatRecove	fans: erv, Databa	ase: in-us	e factor = 1	L.1000, SFP	= 0.6820)							
mechanical ventilation	fans (SFP =	= 0.	6820)	, .	,						282.9768	(330a) (331)
Electricity for lighting (	calculated	in Append	ix L)								215.9594	(332)
Energy saving/generation to	echnologies	s (Appendi	.ces M ,N and	d Q)								
PV generation Wind generation											0.0000 0.0000	(333) (334)
Hydro-electric generation Electricity generated - Mi	(Appendix N cro CHP (Ap	N) opendix N)									0.0000 0.0000	(335a) (335)
Appendix Q - special feature Energy saved or generated	res										-0.0000	(336)
Energy used Total delivered energy for	all uses										0.0000 4232.0411	(337)
	411 4505											(550)
10b. Fuel costs - using Tal	ble 12 pric	ces										
							Fuel		Fuel price		Fuel cost	
Space heating from Boilers							1261.6724		4.4400		£/year 56.0183	(340a)
Space heating total Total CO2 associated with	community s	systems									56.0183 0.0000	(340) (473)
Space heating - secondary Water heating from Boilers							0.0000 1505.1494		0.0000 4.4400		0.0000 66.8286	(341) (342a)
Water heating total Energy for instantaneous e	lectric sho	ower(s)					838.1104		16.4900		66.8286 138.2044	(342) (347a)
Space cooling Pumps, fans and electric be	en-hot	x - 7					128.1727		16.4900		21.1357	(348)
Energy for lighting							215.9594		16.4900		35.6117	(350)
Total energy cost	2										456.4615	(355)



11b. SAP rating	- Community	heating s	cheme												
Energy cost defla	ator (Table	12):								(256)]	( [(4) ]	45 01		0.360	0 (356)
SAP value	or (ECF)							L	(255) X	(256)]	/ [(4) +	45.0]	=	83.033	7 (357) 5
SAP rating (Sect SAP band	ion 12)													8	3 (358) B
12b. Carbon diox	ide emissio	ns - Commu	nitv heati	ng scheme											
								Energy	v Ei	nission	factor			Emission	5
Efficiency of he	at source B	oilers						kWh/year	•	kg	CO2/kWh		kg	g CO2/yea 89.500	r ð (367)
Space and Water Electrical energy	heating fro y for heat	m Boilers distributi	on (space a	& water)			3	3091.4210 12.6167	)		0.2100 0.0000			296.034 4.115	9 (367) 3 (372)
Overall CO2 facto Total CO2 associa	or for heat ated with c	network ommunity s	ystems											0.236 653.313	1 (386) 7 (373)
Energy for instan Space and water	ntaneous el heating	ectric sho	wer(s)					838.1104	Ļ		0.1391			116.599 653.313	7 (264a) 7 (376)
Space cooling Pumps, fans and	electric ke	ep-hot						128.1727	, }		0.1141 0.1387			14.618 39.252	9 (377) 4 (378)
Energy for light	ing ar							215.9594	Ļ		0.1443			31.169	5 (379) 3 (383)
CO2 emissions per	r m2													7.630	3 (384) 3 (384a)
EI rating EI hand														9	3 (385)
															-
SAP 10 WORKSHEET CALCULATION OF E	FOR New Bu PC COSTS, E	ild (As De MISSIONS A	signed) ND PRIMARY	(Version 10 ENERGY	.2, Februa	ary 2022)									
1. Overall dwell	ing charact	eristics													
								Area	I	Storey	height			Volum	e
Ground floor								(m2) 61.0000	) (1b)	x	(m) 2.9000	(2b)	=	(m3) 176,900	) Ə (1b) -
First floor Total floor area	TFA = (1a)	+(1b)+(1c)	+(1d)+(1e)	(1n)		112,0000		51.0000	(1c)	x	3.2000	(2c)	=	163.200	0 (1c) - (4)
Dwelling volume	()		(					(	3a)+(3b)	+(3c)+(	3d)+(3e)	(3n)	=	340.100	9 (5)
2. Ventilation r	ate														
													m3	8 per hou	r
Number of open c	himneys											0 * 80	=	0.000	0 (6a)
Number of open f Number of chimne	lues ys / flues	attached t	o closed f	ire								0 * 20 0 * 10	=	0.000 0.000	0 (6b) 0 (6c)
Number of flues Number of flues	attached to attached to	solid fue other hea	l boiler ter									0 * 20 0 * 35	=	0.000 0.000	ð (6d) ð (6e)
Number of blocker Number of interm	d chimneys ittent extr	act fans										0 * 20 0 * 10	=	0.000 0.000	0 (6f) 0 (7a)
Number of passive Number of fluele	e vents ss gas fire	s										0 * 10 0 * 40	=	0.000 0.000	ð (7b) ð (7c)
												Air ch	anges	s per hou	r
Infiltration due Pressure test	to chimney	s, flues a	nd fans	= (6a)+(6b)	+(6c)+(6d)	)+(6e)+(6f)+(	6g)+(7a)+(7b	o)+(7c) =	:		0.0000	) / (5)	-	0.000 Ye	ð (8) s
Pressure Test Me Measured/design	thod AP50												B1	ower Doo. 3.000	r ð (17)
Infiltration rate Number of sides	e sheltered													0.150	0 (18) 0 (19)
Shelter factor									(20) =	1 -	[0.075 ×	(19)]	=	1.000	0 (20)
Infiltration rate	e adjusted	to include	shelter f	actor						(21)	= (18)	x (20)	=	0.150	0 (21)
Wind snood	Jan	Feb	Mar 4 0000	Apr	May	Jun	Jul	Aug	Sep	200	Oct	Nov	000	Dec	2 (22)
Wind factor	1.0500	1.0000	1.0000	0.9250	0.9250	0.8250	0.8500	0.8000	0.8	250	0.8750	0.8	750	0.950	ð (22) ð (22a)
Balanced mechan	0.1575 ical ventil	0.1500 ation with	0.1500 heat reco	0.1388 very	0.1388	0.1237	0.1275	0.1200	0.1	237	0.1313	0.1	313	0.142	5 (22b)

SAP 10 Online 2.3.6

Full	SA	<b>NP (</b>	Calc	ula <sup>-</sup>	tion	Pri	nto	ut			elm ene	nurst rgy	
If mechanical v If exhaust air If balanced wi	ventilation heat pump th heat rec	using Appen overy: eff:	ndix N, (23 iciency in	b) = (23a) % allowing	x Fmv (equat: for in-use fa	ion (N5)), actor (fro	otherwise m Table 4h)	(23b) = (23a =	a)			0.5000 0.5000 84.6000	(23a (23b (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)
3. Heat losses	and heat l	.oss parame	ter										
Element Front Door Window (Uw = 1 Opening Floor to unhear External Wall ( External Wall ( LGF Roof Total net area Fabric heat los	.20) ted LGF JGF of externa ss, W/K = S	l elements um (A x U)	Aum(A, m2)	Gross m2 31.6000 36.8000 7.1700	Openings m2 15.4100 10.4400 2.1300	Ne <sup>-</sup> 2 23 2 61 16 26 5 136	tArea m2 .0000 .8500 .1300 .0000 .1900 .3600 .0400 .5700 (26)(	U-value W/m2K 1.0000 1.1450 0.1000 0.1500 0.1500 0.1000 30) + (32) =	A x W/ 2.006 27.309 2.438 6.100 2.428 3.954 0.504	U K (K 12) (2) (2) (2) (2) (2) (2) (2) (2) (2) (	-value kJ/m2K	A x K kJ/K	(26) (27) (27a (28a (29a (29a (30) (31) (33)
Thermal mass pa Thermal bridges Point Thermal I Total fabric he	arameter (T s (User def bridges eat loss	MP = Cm / <sup>·</sup> ined value	TFA) in kJ/ 0.040 * to	m2K tal exposed	area)				(3	33) + (36)	(36a) = + (36a) =	250.0000 5.4628 0.0000 50.1974	(35) (36) (37)
Ventilation hea	at loss cal Jan 26 3186	culated mon Feb	nthly (38)m Mar 25 4769	$I = 0.33 \times ($ Apr 24 2143	25)m x (5) May 24 2143	Jun 22 5308	Jul 22 9516	Aug	Sep	Oct	Nov	Dec	(38)
Heat transfer ( Average = Sum()	coeff 76.5160 39)m / 12 =	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325 74.1311	(39)
HLP HLP (average)	Jan 0.6832	Feb 0.6757	Mar 0.6757	Apr 0.6644	May 0.6644	Jun 0.6494	Jul 0.6531	Aug 0.6456	Sep 0.6494	Oct 0.6569	Nov 0.6569	Dec 0.6681 0.6619	(40)
4 Water boati		oquinament											
Assumed occupation	ng energy r  ncy e for mixer	showers		·) 								2.8263	(42)
Hot water usage	0.0000 e for baths	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	0.0000 e for other 43.5743	0.0000 uses 41.9897	0.0000 40.4052	0.0000 38.8207	0.0000 37.2362	0.0000 35.6517	0.0000 35.6517	0.0000 37.2362	0.0000 38.8207	0.0000 40.4052	0.0000 41.9897	0.0000 43.5743	(42b (42c
Average daily I	lan	Feb	/day) Mar	Apr	May	Jun	101	Διισ	Sen	Oct	Nov	39.6130 Dec	(43)
Daily hot water	r use 43.5743 69.0110	41.9897	40.4052	38.8207 53.1436	37.2362 50.1271	35.6517 43.8379	35.6517 43.1176	37.2362 46.1062	38.8207 47.8698	40.4052	41.9897	43.5743	(44) (45)
Energy content Distribution lo	(annual) oss (46)m 10.3516	= 0.15 x (4 8.9689	45)m 9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	Total = S 8.2244	um(45)m = 8.9733	657.9858 10.2340	(46)
Water storage : Store volume	loss:											110.0000	(47)
b) If manufacture Hot water store Volume factor Temperature Enter (49) or Total storage	cturer decl orage loss r from Tabl factor from (54) in (55	ared loss factor from e 2a n Table 2b 5)	factor is n m Table 2 (	ot known : kWh/litre/d	ay)							0.0152 1.0294 0.6000 1.0327	(51) (52) (53) (55)
If cylinder co	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)
Primary loss Combi loss	32.0144 23.2624 0.0000	28.9162 21.0112 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	(57) (59) (61)
WWHRS PV diverter Solar input FGHRS	124.2878 0.0000 0.0000 0.0000 0.0000 0.0000	109.7203 0.0000 0.0000 0.0000 0.0000 0.0000	117.3781 0.0000 0.0000 0.0000 0.0000	106.6373 0.0000 0.0000 0.0000 0.0000	105.4039 0.0000 0.0000 0.0000 0.0000	97.3316 0.0000 0.0000 0.0000 0.0000	98.3944 0.0000 0.0000 0.0000 0.0000	101.3830 0.0000 0.0000 0.0000 0.0000	101.3635 0.0000 0.0000 0.0000 0.0000	110.1063 0.0000 0.0000 0.0000 0.0000	113.3158 0.0000 0.0000 0.0000 0.0000	123.5036 0.0000 0.0000 0.0000 0.0000	(62) (63a (63b (63c (63d
Output from w/l	h 124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830 Total pe	101.3635 er year (kWł	110.1063 n/year) = S	113.3158 um(64)m =	123.5036 1308.8255	(64) (64)
Electric showe	r(s) 73.6804	65.6499	71.6871	68.4101 Tot	69.6938 al Energy us	66.4812 ed by insta	68.6972 antaneous e	69.6938 lectric show	68.4101 ver(s) (kWh/	71.6871 ′year) = Su	70.3391 n(64a)m =	73.6804 838.1104	(64a (64a
Heat gains from	m water hea 85.5877	ting, kWh/ı 76.2355	month 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 ga:	ins (Table 5)	), Watts											
-	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 gain	ns (calculate	ed in Appen	dix L, equa	tion 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 ga	ains (calcula	ated in App	endix L, eq	uation L13	or L13a), a	lso see Tab	le 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	s (calculated	d in Append	ix L, equat	ion 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 v	alues) (Tab	le 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	g gains (Tabl	le 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 interna	al 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 heati	ng periods	in the livi	ng area fro	m Table 9,	Th1 (C)						21.0000 (	85)
Utilisation	tactor tor g	ains tor liv	ving area, I	nil,m (see	Table 9a)								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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	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	F 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	a / (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	r 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 rat	e 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	requiremen	t - total pe	er year (kWh	n/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	contributi	on - total p	per year (kk	wh/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	requiremen	t after sola	ar contribut	tion - total	per year	(kWh/year)						726.6980
Space heating	per m2									(98c	) / (4) =	6.4884 (99)

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8c. Space cooli	ng require	ment										
Calculated for	June, July	and August.	See Table	10b								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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	522 7402	608 0260	566 5299	0 0000	0 0000	0 0000	0 0000	(104)
Cooled fraction	0.0000	0.0000	0.0000	0.0000	552.7405	008.9209	500.5288	fC =	cooled area	/ (4) =	0.9821	(104) $(105)$
Intermittency factor (Table 0.2500	10b) 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 kwn 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 Fraction of space heat from Fraction of heat from commu Factor for control and char Factor for charging method Distribution loss factor (T Efficiency of secondary/sup Space heating:	secondary/ community nity Boiler ging method (Table 4c(3 able 12c) f plementary	/supplemen system rs-Space a d (Table 4 3)) for wa for commun heating s	tary system nd Water c(3)) for s ter heating ity heating ystem, %	(Table 11) pace heatin system	) ng						0.0000 1.0000 1.0000 1.0000 1.0000 1.1500 0.0000	(301) (302) (303a) (305) (305a) (306) (208)
Space heating requirement 219.2980 1	24.9721	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 = ( 307a 252.1927 1	98) x 1.00 43.7179	x 1.00 x 61.7242	1.15 8.5685	0.5207	0.0000	0.0000	0.0000	0.0000	8.1601	94.9899	265.8287	. ,
Space heating requirement 252.1927 1	43.7179	61,7242	8,5685	0.5207	0.0000	0.0000	0.0000	0.0000	8,1601	94,9899	265.8287	(307)
Efficiency of secondary/sup Space heating fuel for seco	plementary ndary/suppl	heating s Lementary	ystem in %	(from Table	e 4a or App	endix E)					0.0000	(308)
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 requir 124.2878 1	ement 09.7203 1	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
310a 142.9310 1	64) x 1.00 26.1783 1	x 1.00 x 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 1	26.1783 1	134.9849	122.6329	121.2145	111.9313	113.1536	116.5904	116.5680	126.6223	130.3131	142.0291	(310)
Cooling System Energy Effic Space coolin 0.0000	iency Ratic 0.0000	0.0000	0.0000	0.0000	50.3103	57,5051	53,5012	0.0000	0.0000	0.0000	2.6000	(314) (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 Electricity generated by PV	21.4670 s (Appendix	19.3286 ( M) (nega	14.1610 tive quanti	10.9383 tv)	8.9367	9.9783	12.9702	16.8470	22.1042	24.9666	27.5026	(332)
(333a)m 0.0000 Electricity generated by wi	0.0000 nd turbines	0.0000 s (Appendi	0.0000 x M) (negat	0.0000 ive quantit	0.0000 tv)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
(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)
(335a)m 0.0000	0.0000	0.0000	ors (Append 0.0000	1x M) (nega 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
(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)
(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)
(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 - commun Space heating fuel - second Water heating fuel - commun Efficiency of water heater Electricity used for heat d Space cooling fuel	ity heating ary ity heating istributior	3 3 1									835.7027 0.0000 1505.1494 0.0000 8.3570 161.3166	(307) (309) (310) (311) (313) (321)
Electricity for pumps and f (BalancedWithHeatRecove	ans: ry, Databas	se: in-use	factor = 1	.1000, SFP	= 0.6820)							
mechanical ventilation f Total electricity for the a Electricity for lighting (c	ans (SFP = bove, kWh/y alculated i	0.6 year in Appendi	820) x L)								282.9768 282.9768 215.9594	(330a) (331) (332)
Energy saving/generation te PV generation	chnologies	(Appendic	es M ,N and	Q)							0.0000	(333)
Wind generation Hydro-electric generation ( Electricity generated - Mic	Appendix N) ro CHP (App	) pendix N)									0.0000 0.0000 0.0000	(334) (335a) (335)
Energy saved or generated Energy used Total delivered energy for	es all uses										-0.0000 0.0000 3839.2152	(336) (337) (338)

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

		- 1 .		
	Fuel	Fuel price	Fuel cost	
	kWh/year	p/kWh	£/year	
Space heating from Boilers	835.7027	3.5000	29.2496 (340	∂a)
Space heating total			29.2496 (340	))
Total CO2 associated with community systems			0.0000 (473	3)
Space heating - secondary	0.0000	0.0000	0.0000 (341	L)
Water heating from Boilers	1505.1494	3.5000	52.6802 (342	2a)
Water heating total			52.6802 (342	2)
Energy for instantaneous electric shower(s)	838.1104	18.3900	154.1285 (347	7a)
Space cooling	161.3166	18.3900	29.6661 (348	3)
Pumps, fans and electric keep-hot	282.9768	18.3900	52.0394 (349	)



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

12b. Carbon dioxide emissions - Community heating scheme

	Energy	Emission factor	Emissions	
	kWh/year	kg CO2/kWh	kg CO2/year	
Efficiency of heat source Boilers	2	Ū.	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 (264)	a)
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 Prima	ry energy factor	Primary energy	
	kWh/year	kg CO2/kWh	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 U Solar photovoltaic panels V2 Wind turbine			Not applicable Not applicable Not applicable
Recommended measures: (none)	SAP change	Cost change	CO2 change

Recommended measures		Typical	annual savings	Energy efficier	Environmental cy impact
(none)	Total Savings	£0	0.00 kg/m²		
Potential energy effic Potential environmenta	iency rating: l impact rating:			B 83	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 Electricity Community scheme	this home (per Current £276 £176	year, Thames V Potential £276 £ £176 £	Valley): Saving 50
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 m <sup>2</sup>	7 kg/m²	7 kg/m²	0 kg/m²
Primary energy	47 kWh/m²	47 kWh/m²	0 kWh/m²

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SAP 10 WORKSHEE	T FOR New I	 Build (As D	esigned)	(Version 10	.2, February	/ 2022)							
CALCULATION OF	ENERGY RAT	ING FOR IMP	ROVED DWELL	ING									
1. Overall dwel	ling chara	cteristics											
								Area	Store	v height		Volume	
Ground floor First floor	/.		· · · · · · · ·	<i>(</i> , )				(m2) 61.0000 51.0000	(1b) x (1c) x	(m) 2.9000 3.2000	(2b) = (2c) =	(m3) 176.9000 163.2000	(1b) - (1c) -
Dwelling volume	ea IFA = (1)	a)+(1b)+(1c	)+(1d)+(1e)	(1n)	11	12.0000		(3	a)+(3b)+(3c)+	(3d)+(3e)	(3n) =	340.1000	(4) (5)
2. Ventilation	rate										m	3 per hour	
Number of open	chimnevs										0 * 80 =	0.0000	(6a)
Number of open Number of chimn Number of flues Number of flues Number of block Number of inter Number of passi Number of fluel	flues heys / flues attached at	s attached to solid fu to other he s tract fans res	to closed f el boiler ater	ire							0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 0 * 20 = 0 * 10 = 0 * 10 = 0 * 40 =	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration du	ue to chimno	eys, flues	and fans	= (6a)+(6b)	+(6c)+(6d)+(	(6e)+(6f)+(	6g)+(7a)+(7	7b)+(7c) =		0.0000	Air changes	5 per hour 0.0000	(8)
Pressure test Pressure Test M	lethod										B	Yes Lower Door	(17)
Infiltration ra Number of sides	i APS0 ite s sheltered											3.0000 0.1500 0	(17) (18) (19)
Shelter factor Infiltration ra	ate adjuste	d to includ	e shelter f	actor					(20) = 1 - (21)	[0.075 x ) = (18)	x (19)] = x (20) =	1.0000 0.1500	(20) (21)
Wind speed Wind factor	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (22a)
Balanced mecha	0.1912 anical vent:	0.1875 ilation wit	0.1837 h heat reco	0.1650 very	0.1612	0.1425	0.1425	0.1388	0.1500	0.1612	0.1687	0.1762	(22b)
If exhaust air If balanced wit	heat pump i h heat reco	using Appen overy: effi	dix N, (23b ciency in %	) = (23a) x allowing f	Fmv (equati or in-use fa	ion (N5)), actor (from	otherwise ( 1 Table 4h)	(23b) = (23 =	a)			0.5000 84.6000	(23b) (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 lo	oss paramet	er										
Element				Gross	Openings	Net	Area	U-value	A x U	к	-value	A x K	
Front Door Window (Uw = 1.	20)			m2	m2	2. 23.	m2 0000 8500	W/m2K 1.0000 1.1450	2.0000 27.3092		KJ/MZK	KJ/K	(26) (27)
Floor to unheat External Wall L	ed .GF			31.6000	15.4100	2. 61. 16.	1300 0000 1900	0.1000 0.1500	2.4389 6.1000 2.4285				(27a) (28a) (29a)
External Wall U LGF Roof Total net area	JGF of externa	l elements	Aum(A, m2)	36.8000 7.1700	10.4400 2.1300	26. 5. 136.	3600 0400 5700	0.1500 0.1000	3.9540 0.5040				(29a) (30) (31)
Fabric heat los	s, W/K = S	um (A x U)					(26)(3	30) + (32)	= 44.7346				(33)
Thermal mass pa Thermal bridges Point Thermal b Total fabric he	arameter (TI 5 (User def: pridges 2at loss	MP = Cm / T ined value	FA) in kJ/m 0.040 * tot	2K al exposed	area)				(33)	) + (36)	(36a) = + (36a) =	250.0000 5.4628 0.0000 50.1974	(35) (36) (37)
Ventilation hea	at loss cal Jan	culated mon Feb	thly (38)m Mar	= 0.33 x (2 Apr	5)m x (5) May	Jun	Jul	Aug	Sep	0ct	Nov	Dec	
(38)m Heat transfer c	30.1065 coeff 80.3039	29.6856 79.8830	29.2648 79.4621	27.1604 77.3578	26.7395 76.9369	24.6351 74.8325	24.6351 74.8325	24.2143 74.4117	25.4769 75.6743	26.7395 76.9369	27.5813 77.7787	28.4230 78.6204	(38) (39)
Average = Sum(3	39)m / 12 =											77.2526	. /



HLP HLP (average)	Jan 0.7170	Feb 0.7132	Mar 0.7095	Apr 0.6907	May 0.6869	Jun 0.6681	Jul 0.6681	Aug 0.6644	Sep 0.6757	Oct 0.6869	Nov 0.6945	Dec 0.7020 0.6898	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heatir	ig energy r	requirements	s (kWh/year	)									
Assumed occupar	icy											2.8263	(42)
Hot water usage	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	e 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 Average daily h	e for other 43.5743 Not water ι	vuses 41.9897 Jse (litres/	40.4052 (day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 Energy content	69.0110 (annual)	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295 Total = S	59.8221 um(45)m =	68.2268 657.9858	(45)
	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)
Store volume	.055:											110.0000	(47)
b) It manutation Hot water stor Volume factor Temperature factor	turer decl rage loss from Tabl actor from	lared loss f factor from le 2a n Table 2b	Factor is no n Table 2 (	ot known : kWh/litre/d	ay)							0.0152 1.0294 0.6000	(51) (52) (53)
Total storage ]	.055 .055	)										1.0327	(55)
If cylinder cor	32.0144 Itains dedi	28.9162 icated solar	32.0144 storage	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
Primary loss Combi loss	32.0144 23.2624 0.0000	28.9162 21.0112 0 0000	32.0144 23.2624 0.000	30.9817 22.5120 0 0000	32.0144 23.2624 0.0000	30.9817 22.5120 0.0000	32.0144 23.2624 0.0000	32.0144 23.2624 0.000	30.9817 22.5120 0 0000	32.0144 23.2624 0.0000	30.9817 22.5120 0 0000	32.0144 23.2624 0.000	(57) (59) (61)
Total heat requ	ired for w	vater heatir	ng calculat	ed for each	month	07 2216	08.2044	101 2820	101 2025	110 1000	112 2150	122 5026	(01)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	98.3944 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(62) (63a)
PV diverter 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	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) (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)
	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)
Electric shower	(s)							iotai p	er year (kw	n/year) = S	um(64)m =	1308.8255	(64)
	73.6804	65.6499	71.6871	68.4101 Tot	69.6938 al Energy u	66.4812 sed by inst	68.6972 antaneous e	69.6938 lectric show	68.4101 ver(s) (kWh	71.6871 /year) = Su	70.3391 m(64a)m =	73.6804 838.1104	(64a) (64a)
Heat gains from	1 water hea 85.5877	ating, kWh/n 76.2355	nonth 82.7919	77.5677	78.3122	73.9913	75.7323	76.9752	75.8142	80.3740	80.2706	85.3269	(65)
5. Internal gai	.ns (see Ta	able 5 and 5	 5a)										
Metabolic gains	(Table 5)	). Watts	· · · · · · · · · · · · · · · · · · ·										
(66)m	Jan	Feb	Mar 169 5788	Apr 169 5788	May	Jun 169 5788	Jul 169 5788	Aug	Sep	0ct 169 5788	Nov	Dec	(66)
Lighting gains	(calculate	ed in Append	dix L, equa	tion L9 or	L9a), also	see Table 5	11 4000	14 0101	10 0000	25 2524	20 4745	21 4210	(67)
Appliances gair	s (calcula	ated in Appe	endix L, eq	uation L13	or L13a), a	also see Tab	le 5	14.0101	19.0000	25.2554	29.4745	51.4210	(87)
Cooking gains (	409.5503 calculated	413.8002 d in Appendi	403.0907 ix L, equat	380.2914 ion L15 or	351.5115 L15a), also	324.4624 see Table	306.3920 5	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Pumps, fans	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	54.7842 0.0000	(69) (70)
Losses e.g. eva	poration ( 113.0525	(negative va -113.0525	alues) (Tab -113.0525	le 5) -113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(71)
Water heating g	ains (Tabl 115.0372	le 5) 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

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[Jan]			]			mea m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab	FF data le 6c	Acce fact Table	ss or 6d	Gains W	
North South North			8.5 15.2 2.1	700 800 300	10.6334 46.7521 26.0000		0.4000 0.4000 0.4000	e e e	.8000 .8000 .7000	0.77 0.77 1.00	00 00 00	20.2086 158.4190 13.9558	(74) (78) (82)		
Solar gains Total gains	192.5834 859.0526	327.0542 992.7637	447.6459 1095.4089	559.4518 1175.5045	634.2937 1214.8707	633.9533 1183.0422	609.3668 1140.2600	552.3024 1084.0343	485.8676 1035.2160	361.2385 941.4828	230.4236 847.1262	165.0075 813.9055	(83) (84)		



#### ..... 7. Mean internal temperature (heating season)

			0									
Temperature d	during heatin	g periods i	n the livi	ng area fro	n Table 9, '	Th1 (C)						21.0000 (85)
Utilisation f	Factor for ga	ins for liv	ing area,	ni1,m (see	Table 9a)							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 a	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 f	Fraction								fLA =	Living area	a / (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 a	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

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 ra	te 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 heatin	g 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 heatin	g requiremen	t - total p	er year (kW	h/year)								1097.1065
Solar heatin	g 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 heatin	g contributi	on - total	per year (kl	Wh/year)								0.0000
Space heatin	g 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 heatin	g requiremen	t after sol	ar contribu	tion - tota	l per year	(kWh/year)						1097.1065
Space heatin	g per m2									(980	) / (4) =	9.7956 (99)

#### \_\_\_\_\_ 8c. Space cooling requirement

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	n								fC =	cooled area	/ (4) =	0.9821 (105
Intermittency ·	factor (Tabl	le 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 o	f space heat fi	rom seconda	ry/suppleme	ntary system	n (Table 11)							0.0000	(301)
Fraction o	f space heat fi	rom communi	ty system									1.0000	(302)
Fraction o	f heat from cor	nmunity Boi	lers-Space	and Water								1.0000	(303a
Factor for	control and ch	harging met	hod (Table 4	4c(3)) for :	space heatin	ng						1.0000	(305)
Factor for	charging metho	od (Table 4	c(3)) for w	ater heating	B							1.0000	(305a
Distributi	on loss factor	(Table 12c	) for commu	nity heating	g system							1.1500	(306)
Efficiency	of secondary/s	supplementa	ry heating	system, %								0.0000	(208)
Space heat	ing:												
Space heat	ing requirement	t											
	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 heat	ing requirement	t											
	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/s	supplementa	ry heating	system in %	(from Table	e 4a or Appe	ndix E)					0.0000	(308)
Space heat	ing fuel for se	econdary/su	pplementary	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 heat	ing												
Annual wat	er heating requ	uirement											
	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)



310a 142.9310 126.1783 134.9849 122.6329 121.2145 111.9313 113.1536 Water heating fuel	116.5904	116.5680	126.6223	130.3131	142.0291	
142.9310 126.1783 134.9849 122.6329 121.2145 111.9313 113.1536 Cooling System Energy Efficiency Ratio	116.5904	116.5680	126.6223	130.3131	142.0291 2.6000	(310) (314)
Space coolin         0.0000         0.0000         0.0000         0.0000         0.0000         38.8525         47.2722           Pumps and Fa         24.0336         21.7078         24.0336         23.2584         24.0336 <td< td=""><td>42.0480</td><td>0.0000 23.2584</td><td>24.0336</td><td>23.2584</td><td>24.0336</td><td>(315) (331) (332)</td></td<>	42.0480	0.0000 23.2584	24.0336	23.2584	24.0336	(315) (331) (332)
Electricity generated by PVs (Appendix M) (negative quantity) (333a) 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	(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	(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 kWN/year Space heating fuel - community heating Space heating fuel - secondary Water heating fuel - community heating Efficiency of water heater Electricity used for heat distribution Space cooling fuel					1261.6724 0.0000 1505.1494 0.0000 12.6167 128.1727	(307) (309) (310) (311) (313) (321)
<pre>Electricity for pumps and fans: (BalancedWithHeatRecovery, Database: in-use factor = 1.1000, SFP = 0.6820) mechanical ventilation fans (SFP = 0.6820) Total electricity for the above, kWh/year Electricity for lighting (calculated in Appendix L)</pre>					282.9768 282.9768 215.9594	(330a) (331) (332)
Energy saving/generation technologies (Appendices M ,N and Q) PV generation Wind generation Hydro-electric generation (Appendix N) Electricity generated - Micro CHP (Appendix N)					0.0000 0.0000 0.0000 0.0000	(333) (334) (335a) (335)
Appendix Q - Special Features Energy saved or Energy used Total delivered energy for all uses					-0.0000 0.0000 4232.0411	(336) (337) (338)
10b. Fuel costs - using Table 12 prices						
Space heating from Boilers Space heating total	Fuel kWh/year 1261.6724	Fu	el price p/kWh 4.4400		Fuel cost £/year 56.0183	(340a) (340)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Joilers	Fuel kWh/year 1261.6724 0.0000 1505.1494	Fu	el price p/kWh 4.4400 0.0000 4.4400		Fuel cost f/year 56.0183 0.0000 66.8286 66.8286	(340a) (340) (473) (341) (342a) (342)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727	Fu	el price p/kWh 4.4400 0.0000 4.4400 16.4900 16.4900		Fuel cost £/year 56.0183 0.0000 66.8286 66.8286 138.2044 21.1357	(340a) (340) (473) (341) (342a) (342) (347a) (348)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594	Fu	el price p/kWh 4.4400 0.0000 4.4400 16.4900 16.4900 16.4900 16.4900		Fuel cost f/year 56.0183 0.0000 66.8286 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615	(340a) (340) (473) (341) (342a) (342a) (342a) (347a) (348) (349) (350) (355)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594	Fu	el price p/kWh 4.4400 0.0000 4.4400 16.4900 16.4900 16.4900 16.4900		Fuel cost f/year 56.0183 0.0000 66.8286 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615	(340a) (340) (473) (341) (342a) (342) (347a) (348) (349) (351) (355)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Boilers Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594	Fu (255) x (256)]	<pre>lel price</pre>	45.0] =	Fuel cost f/year 56.0183 50.0183 0.0000 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 0 1.0467 83.0336 83 B	(340a) (340) (473) (341) (342a) (347a) (347a) (347a) (356) (355) (355) (355) (356) (357) (358)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Bo	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594 [	Fu (255) × (256)]	<pre>lel price</pre>	45.0] =	Fuel cost f/year 56.0183 0.0000 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 0 1.0467 83.0336 B	(340a) (340) (473) (342a) (342a) (347a) (347a) (347a) (356) (355) (355) (355) (356) (357) (358)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost 11b. SAP rating - Community heating scheme Energy cost deflator (Table 12): Energy cost deflator (Table 12): Energy cost factor (ECF) SAP value SAP rating (Section 12) SAP band 12b. Carbon dioxide emissions - Community heating scheme	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594 [ [ [ Energy kwh/year	Fu (255) × (256)] Emissio kg	<pre>el price</pre>	45.0] =	Fuel cost f/year 56.0183 50.0183 0.0000 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 83.0336 83 B Emissions cg CO2/year	(340a) (340) (473) (341) (342a) (347a) (347a) (347a) (357) (355) (355) (355) (355) (357) (358)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating - secondary Water heating from Boilers Water heating from Boilers Water heating from Boilers Water heating from Boilers Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost Total energy cost Total energy cost Energy cost deflator (Table 12): Energy cost factor (ECF) SAP value SAP rating (Section 12) SAP band Efficiency of heat source Boilers Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Correl CO2 for the total total total constructions Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Correl CO2 for the total total total constructions Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Correl CO2 for the total for the total total total total constructions Electrical energy for heat distribution (space & water) Correl CO2 for the total total total total constructions Space and Water heating from Boilers	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594 [ [ [ Energy kWh/year 3091.4210 12.6167	Fu (255) × (256)] Emissio kg	<pre>lel price</pre>	45.0] = k	Fuel cost f/year 56.0183 0.0000 66.8286 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 83.0306 83.0336 83 83 83 83 83 83 83 83 83 83 83 83 83	(340a) (340) (342) (341) (342a) (348) (348) (350) (351) (355) (355) (355) (355) (357) (358) (357) (358)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space conting Water heating from Boilers Water heating total Energy for instantaneous electric shower(s) Space cooling Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost 11b. SAP rating - Community heating scheme Energy cost deflator (Table 12): Energy cost factor (ECF) SAP value SAP rating (Section 12) SAP band Efficiency of heat source Boilers Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Overall CO2 associated with community systems Energy for instantaneous electric shower(s)	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594 [ [ Energy kwh/year 3091.4210 12.6167 838.1104	Fu (255) × (256)] Emissio kg	<pre>lel price</pre>	45.0] = k	Fuel cost f/year 56.0183 0.0000 66.8286 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 83.0306 83.0336 83 83 83 83 83 83 83 83 83 83 83 83 83	(340a) (340) (341) (342a) (347a) (348) (347a) (348) (355) (355) (355) (355) (355) (357) (358) (358) (367) (373) (373) (264a)
Space heating from Boilers Space heating total Total CO2 associated with community systems Space heating from Boilers Water heating from Boilers Water heating from Boilers Water heating from Boilers Pumps, fans and electric keep-hot Energy for lighting Additional standing charges Total energy cost Total energy cost Hob SAP rating - Community heating scheme Energy cost deflator (Table 12): Energy cost factor (ECF) SAP value SAP rating (Section 12) SAP band Efficiency of heat source Boilers Space and Water heating from Boilers Electrical energy for heat distribution (space & water) Overall CO2 factor for heat network Total CO2 associated with community systems Energy for instantaneous electric shower(s) Space and water heating Space cooling	Fuel kwh/year 1261.6724 0.0000 1505.1494 838.1104 128.1727 282.9768 215.9594 	Fu (255) × (256)] Emissio kg	<pre>lel price</pre>	45.0] = k	Fuel cost f/year 56.0183 56.0183 0.0000 66.8286 138.2044 21.1357 46.6629 35.6117 92.0000 456.4615 83.0306 83 83 83 83 83 83 83 83 83 83 83 83 83	(340a) (340) (473) (341) (342a) (342a) (347a) (347a) (350) (355) (355) (355) (355) (357) (358) (358) (367) (367) (372) (386) (372) (376) (377) (376) (377)



92.7029 (384a) 93 (385) A

EI value EI rating EI band

SAP 10 WORKSHEE	T FOR New B	uild (As De	esigned) (	Version 10	.2, February	2022)							
1. Overall dwel	ling charac	teristics											
								Area	Storey	height		Volume	•
Ground floor First floor								(m2) 61.0000 51.0000	(1b) x (1c) x	(m) 2.9000 3.2000	(2b) = (2c) =	(m3) 176.9000 163.2000	(1b) -
Total floor are Dwelling volume	ea TFA = (1a	)+(1b)+(1c)	)+(1d)+(1e).	(1n)	11	2.0000		(3	(12) A Ba)+(3b)+(3c)+(	(3d)+(3e)	()(3n) =	340.1000	(4) (5)
2. Ventilation	rate												
											m	13 per hour	
Number of open Number of open	chimneys flues										0 * 80 = 0 * 20 =	0.0000 0.0000	(6a) (6b)
Number of chimn Number of flues	eys / flues attached t	attached t o solid fue	to closed fi el boiler aton	re							0 * 10 = 0 * 20 = 0 * 25 =	0.0000	) (6c) ) (6d)
Number of block Number of inter	ed chimneys	ract fans									0 * 20 = 0 * 10 =	0.0000	) (6f) ) (7a)
Number of passi Number of fluel	ve vents ess gas fir	es									0 * 10 = 0 * 40 =	0.0000 0.0000	) (7b) ) (7c)
Infiltration du	e to chimne	evs. flues a	and fans =	(6a)+(6b)	+(6c)+(6d)+(	6e)+(6f)+	(6g)+(7a)+(	7b)+(7c) =		0.000	Air change	s per hour 0.0000	
Pressure test Pressure Test M	lethod	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		(00) (00)			(08) () 0) ()				B	Yes lower Door	
Measured/design Infiltration ra Number of sides	n AP50 nte s sheltered											3.0000 0.1500 0	) (17) ) (18) ) (19)
Shelter factor Infiltration ra	ate adjusted	l to include	e shelter fa	ctor					(20) = 1 - (21)	[0.075 ) = (18)	x (19)] = x (20) =	1.0000 0.1500	(20) (21)
Used encod	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(22)
Wind speed Wind factor Adi infilt rate	4.2000	4.0000 1.0000	1.0000	3.7000 0.9250	3.7000 0.9250	3.3000 0.8250	3.4000 0.8500	3.2000 0.8000	0.8250	3.5000 0.8750	0.8750	3.8000 0.9500	(22) (22a)
Balanced mecha	0.1575 0inical venti	0.1500 lation with	0.1500 heat recov	0.1388 ery	0.1388	0.1237	0.1275	0.1200	0.1237	0.1313	0.1313	0.1425	(22b)
If mechanical v If exhaust air	ventilation heat pump u	sing Append	dix N, (23b)	= (23a) x	Fmv (equati	on (N5)), ctor (fro	otherwise	(23b) = (23	a)			0.5000 0.5000 84 6000	(23a) (23b)
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	(250)
	and heat le												
Element				Gross	Openings	Net	tArea	U-value	Α×υ	ŀ	<-value	АхК	I
Front Door				m2	m2	2	m2 .0000	W/m2K 1.0000	W/K 2.0000		kJ/m2K	kJ/K	(26)
Window (Uw = 1. Opening	20)					23	.8500 .1300	1.1450	27.3092 2.4389				(27) (27a)
External Wall L	.GF IGF		3	1.6000	15.4100 10.4400	16	.1900 .3600	0.1500	2.4285				(20a) (29a) (29a)
LGF Roof Total net area	of external	. elements A	Aum(A, m2)	7.1700	2.1300	5 136	.0400 .5700	0.1000	0.5040				(30) (31)
Fabric heat los	s, W/K = Su	m (AxU)		W.			(26)(	30) + (32)	= 44.7346			250 0000	(33)
Thermal mass pa Thermal bridges	arameter (TM 5 (User defi pridges	⊪ = Cm / TF .ned value 0	-я) in кJ/m2 0.040 * tota	l exposed	area)						(36a) =	250.0000 5.4628 0.0000	(35) (36)
Total fabric he	at loss								(33)	+ (36)	+ (36a) =	50.1974	(37)
Ventilation hea	at loss calc Jan	ulated mont Feb	thly (38)m = Mar	0.33 x (2 Apr	5)m x (5) May	Jun	Jul	Aug	Sep	0ct	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)
Average = Sum(3	76.5160 39)m / 12 =	75.6743	75.6743	74.4117	74.4117	72.7282	73.1490	72.3073	72.7282	73.5699	73.5699	74.8325 74.1311	(39)
HI P	Jan 0.6832	Feb 0.6757	Mar 0.6757	Apr 0.6644	May 0.6644	Jun 0.6494	Jul 0.6531	Aug 0.6456	Sep 0.6494	0ct 0.6569	Nov 0.6569	Dec 0.6681	(40)
HLP (average)	31	28	31	30	31	30	31	31	30	31	30	0.6619	()
	51	20	51	50	51	50	51	51	50	51	50	51	
4. Water heatir	ng energy r	requirements	s (kWh/year	·)									
Assumed occupar	ncy											2.8263	(42)
Hot water usage	0.0000 for hath	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	0.0000 e for other	, 0.0000 uses	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Average daily h	43.5743 not water u	41.9897 use (litres,	40.4052 /day)	38.8207	37.2362	35.6517	35.6517	37.2362	38.8207	40.4052	41.9897	43.5743 39.6130	(42c) (43)
Deily hat water	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily not water	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 Energy content	69.0110 (annual)	59.7928	62.1013	53.1436	50.1271	43.8379	43.1176	46.1062	47.8698	54.8295 Total = S	59.8221 um(45)m =	68.2268 657.9858	(45)
Distribution lo	oss (46)m 10.3516	= 0.15 x (4 8.9689	45)m 9.3152	7.9715	7.5191	6.5757	6.4676	6.9159	7.1805	8.2244	8.9733	10.2340	(46)
Water storage l Store volume	loss:											110.0000	(47)
b) If manufac Hot water sto	turer decl brage loss	lared loss f factor from	factor is n m Table 2 (	ot known : kWh/litre/d	ay)							0.0152	(51)
Volume factor Temperature f Enter (49) or (	from Tabl Factor from (54) in (55	le 2a 1 Table 2b 5)	·									1.0294 0.6000 1.0327	(52) (53) (55)
Total storage I	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 cor	itains dedi 32.0144	cated solar 28.9162	r storage 32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss Combi loss	23.2624	21.0112 0.0000	23.2624 0.0000	22.5120	23.2624	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	(59) (61)
lotal neat requ	11red for V 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 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	(63a)
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 Output from w/h	0.0000 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
	124.2878	109.7203	117.3781	106.6373	105.4039	97.3316	98.3944	101.3830 Total p	101.3635 er year (kW	110.1063 h/year) = S	113.3158 um(64)m =	123.5036 1308.8255	(64) (64)
Electric shower	73.6804	65.6499	71.6871	68.4101 Tot	69.6938 al Energy u	66.4812 sed by insta	68.6972 antaneous e	69.6938 lectric sho	68.4101 wer(s) (kWh	71.6871 /vear) = Su	70.3391 m(64a)m =	73.6804 838.1104	(64a) (64a)
Heat gains from	water hea	ting, kWh/r	month	77 5677	79 2122	72 0012	75 7222	76 9752	75 9142	90 3740	80 2706	95 2260	(65)
	03.30//	70.2355	82.7919	//.30//	78.3122	73.9913	/3./323	70.9752	/5.0142	80.3740	80.2700	65.5269	(65)
5. Internal gai	ins (see Ta	able 5 and 9	 5a)										
Metabolic gains	5 (Table 5)	, Watts											
(66)m	Jan 169.5788	Feb 169.5788	Mar 169.5788	Apr 169.5788	May 169.5788	Jun 169.5788	Jul 169.5788	Aug 169.5788	Sep 169.5788	Oct 169.5788	Nov 169.5788	Dec 169.5788	(66)
Lighting gains	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 gair	is (calcula 409.5503	413.8002	endix L, eq 403.0907	uation L13 380.2914	or L13a), a 351.5115	lso see Tab. 324.4624	le 5 306.3920	302.1421	312.8516	335.6509	364.4308	391.4799	(68)
Cooking gains (	calculated 54.7842	1 in Append: 54.7842	ix L, equat 54.7842	ion L15 or 54.7842	L15a), also 54.7842	see Table 54.7842	5 54.7842	54.7842	54.7842	54.7842	54.7842	54.7842	(69)
Pumps, tans Losses e.g. eva	o.0000 aporation (	0.0000 negative va	0.0000 alues) (Tab	0.0000 le 5)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
- Water heating g	ains (Tab	-113.0525 le 5)	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	-113.0525	(/1)
Total internal	115.0372 gains	113.4457	111.2795	107.7330	105.2583	102.7657	101.7908	103.4613	105.2975	108.0296	111.4869	114.6868	(72)
	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 int	ternal tempera	ture (heati	ng season)									
Temperature	e during heati	ng periods	in the livi	ng area fro	m Table 9,	Th1 (C)						21.0000 (85)
0011158010	l lactor for g	Feb	Mar	Anr	May	Jun	<b>Jul</b>	Aug	Sen	0ct	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	g 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 d	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	a fraction								fLA =	Living area	a / (4) =	0.1696 (91)
MIT Temperature	20.0501 e adjustment	20.2130	20.3739	20.4654	20.4781	20.4900	20.4872	20.4928	20.4899	20.4720	20.3271	20.0369 (92) 0.0000
adjusted MI	IT 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 rat	e 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	g 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	g requiremen	t - total p	er year (kWl	n/year)								726.6980
Solar heating	g 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	g contributi	on - total	per year (kl	wh/year)								0.0000
Space heating	g 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	g requiremen	t after sol	ar contribu	tion - total	l per year	(kWh/year)						726.6980
Space heating	g per m2									(98c)	) / (4) =	6.4884 (99)

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#### 8c. Space cooling requirement

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

curcuracea ioi	June, Jury	una August	· See Tuble	100								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	0ct	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 fractio	n								fC =	cooled area	/ (4) =	0.9821 (105)
Intermittency	factor (Tabl	e 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 re	equirements												
Fraction of s Fraction of s Fraction of h Factor for cc Factor for cc Distribution Efficiency of Space heating	space heat fr space heat fr neat from con portrol and ch narging metho loss factor f secondary/s g: nequipement	rom secondar rom communit munity Boil harging meth bd (Table 4c (Table 12c) supplementar	y/supplemen y system ers-Space a od (Table 4 (3)) for wa for commun y heating s	tary system nd Water c(3)) for s ter heating ity heating ystem, %	(Table 11) pace heatin system	g						0.0000 1.0000 1.0000 1.0000 1.0000 1.1500 0.0000	(301) (302) (303a) (305) (305a) (306) (208)
space nearing	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 fr	rom Boilers =	= (98) x 1.0	0 x 1.00 x	1.15									<b>、</b> -,
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	g 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	f secondary/s	upplementar	y heating s	ystem in %	(from Table	4a or Appe	ndix E)					0.0000	(308)
Space heating	g fuel for se	condary/sup	plementary	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	00.0044	101 2020	101 2625	110 1000	112 2150	100 5006	(64)
124.28/8 109./203 11/.3/81 106.63/3 105.4039 9/.3316	98.3944	101.3830	101.3635	110.1063	113.3158	123.5036	(64)
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)
Flectricity generated by PVs (Appendix M) (negative quantity)	9.9785	12.9702	10.8470	22.1042	24.9000	27.3020	(332)
(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 quantit	ty)	0.0000	0.0000	0,0000	0 0000	0 0000	(225-)
(335d)M 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335d)
(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)	010000	010000	0.0000	010000	010000	0.0000	(5550)
(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 quantit	ty)						
(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						02E 7027	(207)
Space heating fuel - community heating						0 0000	(307)
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 tans (SFP = 0.6820)						282.9/68	(330a) (221)
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)
Electricity generated - Micro CHP (Appendix N)						0.0000	(335)
Appendix 0 - special features						0.0000	(555)
Energy saved or generated						-0.0000	(336)
Energy used						0.0000	(337)
Total delivered energy for all uses						3839.2152	(338)
10h Fuel costs - using REDE prices (511)							
		Fuel	F	uel price		Fuel cost	
	I	kWh/year		p/kWh		£/year	(a ·
Space neating from Boilers	:	835.7027		3.5000		29.2496	(340a)
Space meaning conditions with community systems						29.2496	(340)
Space heating - secondary		0.0000		0,0000		0.0000	(341)
Water heating from Boilers	1	505.1494		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)
Auditional standing charges						94.0000	(351)
TOTAL ENERGY COST						451.4/88	(300)

\_\_\_\_\_ 12b. Carbon dioxide emissions - Community heating scheme

	Energy	Emission factor	Emissions	
	kWh/year	kg CO2/kWh	kg CO2/year	
Efficiency of heat source Boilers			89.5000 (367	7)
Space and Water heating from Boilers	2615.4772	0.2100	196.0867 (367	7)
Electrical energy for heat distribution (space & water)	8.3570	0.0000	3.4462 (372	2)
Overall CO2 factor for heat network			0.2361 (386	6)
Total CO2 associated with community systems			552.6964 (373	3)
Energy for instantaneous electric shower(s)	838.1104	0.1391	116.5997 (264	4a)
Space and water heating			552.6964 (376	6)
Space cooling	161.3166	0.1141	18.4124 (377	7)
Pumps, fans and electric keep-hot	282.9768	0.1387	39.2524 (378	8)
Energy for lighting	215.9594	0.1443	31.1696 (379	Э)
Total CO2, kg/year			758.1305 (383	3)

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13b. Primary energy - Community heating scheme 

	Energy Pri	imary energy factor	Primary energy
kw	Wh/year	kg CO2/kWh	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**

XC<sub>@2</sub>

330 Gray's Inn Road

# 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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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<sup>2</sup>]: 150.13

### The CO<sub>2</sub> 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 <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	16.78	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	45.69	
Target primary energy rate (TPER), kWh <sub>PE</sub> /m <sup>2</sup> annum	121.79	
Building primary energy rate (BPER), kWh <sub>PE</sub> /m <sup>2</sup> 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	Ua-Limit	Ua-Calc	Ui-Calc	First surface with maximum value
Walls*	0.26	0.55	0.55	L000002:Surf[3]
Floors	0.18	0.31	1.2	L000007: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	L000002: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 <sub>a-Limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			Ui-Calc = Ca	Iculated maximum individual element U-values [W/(m²K)]

 $U_{a\text{-Limit}} = \text{Limiting area-weighted average U-values } [W/(m^2K)] \\ U_{a\text{-Calc}} = \text{Calculated area-weighted average U-values } [W/(m^2K)]$ 

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

^ For fire doors, limiting U-value is 1.8 W/m $^{2}$ K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	25

<sup>\*\*</sup> Display windows and similar glazing are excluded from the U-value check.

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		
Whole building electric power factor achieved by power factor correction	>0.95	

1- Gas Boilers - Existing

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(I/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
А	Local supply or extract ventilation units
В	Zonal supply system where the fan is remote from the zone
С	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
Е	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
Н	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter
NB: L	imiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	SFP [W/(I/s)]				HD officionov						
ID of system type	Α	В	С	D	E	F	G	Н	I	ппе	inciency
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	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
Standard value	95	80	0.3
L01_Refurb_Circulation	51	-	-

General lighting and display lighting	General luminaire	e Display light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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?			
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	% Are
Floor area [m <sup>2</sup> ]	839.7	839.7	
External area [m <sup>2</sup> ]	1176.7	1176.7	
Weather	LON	LON	
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	25	3	
Average conductance [W/K]	1102.57	523.93	100
Average U-value [W/m <sup>2</sup> K]	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
Storage or Distribution
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<sup>2</sup>]

	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/m<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	511.49	326.56
Primary energy [kWh <sub>PE</sub> /m <sup>2</sup> ]	330.99	121.79
Total emissions [kg/m <sup>2</sup> ]	45.69	16.78

### IVAC Systems Performance

	TVAO Systems i enormance									
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	[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	[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 [M.I/m2]	= Heating energy demand
Cool dem [IVIJ/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

= 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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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<sup>2</sup>]: 150.13

### The CO<sub>2</sub> 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 <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	11.97	
Building CO2 emission rate (BER), kgCO2/m2annum12.9		
Target primary energy rate (TPER), kWh <sub>PE</sub> /m²annum132.5		
Building primary energy rate (BPER), kWh <sub>PE</sub> /m <sup>2</sup> 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	Ua-Limit	Ua-Calc	Ui-Calc	First surface with maximum value
Walls*	0.26	0.21	0.55	GF000002:Surf[3]
Floors	0.18	0.1	0.1	L000007:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	L00000A:Surf[0]
Windows** and roof windows	1.6	1.2	1.2	L000002: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 <sub>a-limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			U i-Calc = Ca	alculated maximum individual element U-values [W/(m <sup>2</sup> K)]

 $U_{a\text{-Limit}} = \text{Limiting area-weighted average U-values } [W/(m^2K)] \\ U_{a\text{-Calc}} = \text{Calculated area-weighted average U-values } [W/(m^2K)]$ 

\* 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.

^ For fire doors, limiting U-value is 1.8 W/m²K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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		
Whole building electric power factor achieved by power factor correction	>0.95	

1- Lean\_ASHP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(I/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 [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	% Are
Floor area [m <sup>2</sup> ]	839.7	839.7	
External area [m <sup>2</sup> ]	1176.7	1176.7	
Weather	LON	LON	
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	288.62	523.14	100
Average U-value [W/m <sup>2</sup> 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
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<sup>2</sup>]

	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<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	198.64	287.4
Primary energy [kWh <sub>PE</sub> /m <sup>2</sup> ]	142.14	132.5
Total emissions [kg/m <sup>2</sup> ]	12.9	11.97

### **HVAC Systems Performance** Aux con Cool dem Heat con Cool con Heat Cool Heat gen Cool gen Heat dem System Type MJ/m2 MJ/m2 kWh/m2 kWh/m2 kWh/m2 SSEEF SSEER SEFF 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 0 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 0 Notional 0 ----

### Kev 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

= Cooling fuel type

# BRUKL Output Document MGovernment

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**

**Certifier details** 

Address: Address 1, 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

Name: Name Telephone number: Phone Address: Street Address, City, Postcode

Foundation area [m<sup>2</sup>]: 150.13

### The CO<sub>2</sub> emission and primary energy rates of the building must not exceed the targets

Target CO <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	11.97	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	10.91	
Target primary energy rate (TPER), kWh <sub>PE</sub> /m <sup>2</sup> annum	132.5	
Building primary energy rate (BPER), kWh <sub>PE</sub> /m <sup>2</sup> 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	Ua-Limit	Ua-Calc	Ui-Calc	First surface with maximum value
Walls*	0.26	0.21	0.55	GF000002:Surf[3]
Floors	0.18	0.1	0.1	L000007: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	L000002: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 <sub>a-Limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			Ui-Calc = Ca	alculated maximum individual element U-values [W/(m²K)]

a-Limit = Limiting area-weighted average U-values [W/(m<sup>2</sup>K)] U<sub>a-Calc</sub> = Calculated area-weighted average U-values [W/(m<sup>2</sup>K)]

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

^ For fire doors, limiting U-value is 1.8 W/m<sup>2</sup>K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

<sup>\*\*\*</sup> Values for rooflights refer to the horizontal position. \*\* Display windows and similar glazing are excluded from the U-value check.

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/(I/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	4
Automatic moni	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 [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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?	
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	% Are
Floor area [m <sup>2</sup> ]	839.7	839.7	
External area [m <sup>2</sup> ]	1176.7	1176.7	
Weather	LON	LON	
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	288.62	523.14	100
Average U-value [W/m <sup>2</sup> 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
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<sup>2</sup>]

	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<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	180.86	287.4
Primary energy [kWh <sub>PE</sub> /m <sup>2</sup> ]	120.34	132.5
Total emissions [kg/m <sup>2</sup> ]	10.91	11.97

### **HVAC Systems Performance** Cool dem Heat con Cool con Aux con Heat Cool Heat gen Cool gen Heat dem System Type MJ/m2 MJ/m2 kWh/m2 kWh/m2 kWh/m2 SSEEF SSEER SEFF SEER [ST] Variable refrigerant flow, [HS] ASHP, [HFT] Electricity, [CFT] Electricity Actual 17.3 163.6 11.3 22.6 4.72 4.02 4.6 5.9 1 Notional 21 266.4 2.1 16 20.6 2.78 4.63 ----[ST] No Heating or Cooling 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 0 0 Notional 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

= Cooling fuel type

# BRUKL Output Document MGovernment

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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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 [m<sup>2</sup>]: 434.21

### The CO<sub>2</sub> emission and primary energy rates of the building must not exceed the targets

Target CO <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	16.42	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	16.3	
Target primary energy rate (TPER), kWh/m2annum	182.14	
Building primary energy rate (BPER), kWh/m²annum	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	Ua-Limit	Ua-Calc	Ui-Calc	First surface with maximum value
Walls*	0.26	0.14	0.15	LG000010:Surf[0]
Floors	0.18	0.1	0.1	L000003: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 <sub>a-Limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			U i-Calc = Ca	alculated maximum individual element U-values [W/(m <sup>2</sup> K)]

a-Limit = Limiting area-weighted average U-values [W/(m<sup>2</sup>K)] U<sub>a-Calc</sub> = Calculated area-weighted average U-values [W/(m<sup>2</sup>K)]

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

\*\*\* Values for rooflights refer to the horizontal position. \*\* Display windows and similar glazing are excluded from the U-value check.

^ For fire doors, limiting U-value is 1.8 W/m<sup>2</sup>K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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/(I/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	aire Display light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	ire Display light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	-	-

EntempEfficacy [Im/V]Pficacy [Im/V]Power density [V/Vm]109_Circ135600.3L09_Circ135L10_Bathrooms135L10_Intell Rooms135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L11_Circ135L12_Circ135L12_Circ135L12_Circ135L12_Circ135L12_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L13_Circ135L05_Circ135	General lighting and display lighting	General luminaire	re Display light source	
Standard value         95         80         0.3           L09_Circ         135         -         -           L00_Bathrooms         135         -         -           L10_Bathrooms         135         -         -           L10_Hotel Rooms         135         -         -           L11_Circ         135         -         -           L11_Circ         135         -         -           L11_Circ         135         -         -           L11_Circ         135         -         -           L11_Eathrooms         135         -         -           L11_Circ         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L13_Circ         135         -         -           L13_Bathrooms <th>Zone name</th> <th>Efficacy [Im/W]</th> <th>Efficacy [lm/W]</th> <th>Power density [W/m<sup>2</sup>]</th>	Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
L09_Circ         135         -         -           L09_Circ         135         -         -           L10_Bathrooms         135         -         -           L10_Bathrooms         135         -         -           L10_Bathrooms         135         -         -           L11_Circ         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Girc         135         -         -           L13_Girc         135         -         -           L13_Girc         135         -         -           L13_Bathrooms         1	Standard value	95	80	0.3
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         -         -           L12_Circ         135         -         -           L12_Dire         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Bathrooms         135         -         -           L09_Circ <td< td=""><td>L09_Circ</td><td>135</td><td>-</td><td>-</td></td<>	L09_Circ	135	-	-
L10_Bathrooms         135         -         -           L10_Iotel Rooms         135         -         -           L11_Cire         135         -         -           L12_Cire         135         -         -           L12_Cire         135         -         -           L12_Cire         135         -         -           L12_Cire         135         -         -           L12_Bathrooms         135         -         -           L13_Cire         135         -         -           L13_Cire         135         -         -           L13_Cire         135         -         -           L13_Cire         135         -         -           L13_Bathrooms         135         -         -           L09_Cire <td< td=""><td>L09_Circ</td><td>135</td><td>-</td><td>-</td></td<>	L09_Circ	135	-	-
L10_Hotel Rooms         136         -         -           L11_Circ         135         -         -           L11_Circ         135         -         -           L11_Circ         135         -         -           L11_Bathrooms         135         -         -           L11_Bathrooms         135         -         -           L11_Bathrooms         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L12_Circ         135         -         -           L12_Bathrooms         135         -         -           L12_Dire         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Circ         135         -         -           L13_Dithrooms         135         -         -           L13_Dithrooms         135         -         -           L09_Circ         135         -         -           L09_Circ </td <td>L10_Bathrooms</td> <td>135</td> <td>-</td> <td>-</td>	L10_Bathrooms	135	-	-
L11_Circ       135       -       -         L11_Circ       135       -       -         L11_Circ       135       -       -         L11_Bathrooms       135       -       -         L11_Bathrooms       135       -       -         L11_Bathrooms       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Dathrooms       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Girc       135       -       -         L13_Girc       135       -       -         L13_Circ       135       -       -         L13_Det Rooms       135       -       -         L09_Circ       135       -       -         L09_Girc       135       -       -	L10_Hotel Rooms	135	-	-
L11_Circ       135       -       -         L11_Circ       135       -       -         L11_Circ       135       -       -         L11_Circ       135       -       -         L11_Attrooms       135       -       -         L11_Circ       135       -       -         L12_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L09_Circ       135       -       -         L09_Circ       135       -       -         L09_Bathrooms       135       -       -         L09_Circ       135       -       -         L06_Circ       135       -       -	L11_Circ	135	-	-
L11_Circ       135       -       -         L11_Bathrooms       135       -       -         L11_Bathrooms       135       -       -         L11_Bathrooms       135       -       -         L11_Circ       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Circ       135       -       -         L12_Bathrooms       135       -       -         L12_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L13_Girc       135       -       -         L13_Girc       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Lotel Rooms       135       -       -         L06_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_Iotel Rooms       135       -       -         L13_Circ       135       -       -         L13_Detif Rooms       135       -       -         L09_Idel Rooms       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -	L11_Circ	135	-	-
L11_Bathrooms       135       -       -         L11_Hotel Rooms       135       -       -         L12_Circ       135       -       -         L12_Edit Rooms       135       -       -         L12_Hotel Rooms       135       -       -         L13_Circ       135       -       -         L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L13_Circ       135       -       -         L13_Girc       135       -       -         L13_Bathrooms       135       -       -         L09_Circ       135       -       -         L09_Edit Rooms       135       -       -         L09_Edit Rooms       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L06_Circ       135       - <td>L11_Circ</td> <td>135</td> <td>-</td> <td>-</td>	L11_Circ	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_Girc       135       -       -         L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L13_Bathrooms       135       -       -         L13_Bathrooms       135       -       -         L09_Circ       135       -       -         L09_Bathrooms       135       -       -         L05_HotelRoom       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -	L11_Bathrooms	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_Dathrooms       135       -       -         L13_Bathrooms       135       -       -         L09_Circ       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       - </td <td>L11_Hotel Rooms</td> <td>135</td> <td>-</td> <td>-</td>	L11_Hotel Rooms	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_Bathrooms       135       -       -         L05_HotelRoom       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -	L12_Circ	135	-	-
L12_Circ       135       -       -         L12_Bathrooms       135       -       -         L12_Hotel Rooms       135       -       -         L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Hotel Rooms       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       - <td< td=""><td>L12_Circ</td><td>135</td><td>-</td><td>-</td></td<>	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_Hotel Rooms       135       -       -         L06_Circ       135       -       -         L06_Girc       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Girc       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       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       - <td< td=""><td>L12_Circ</td><td>135</td><td>-</td><td>-</td></td<>	L12_Circ	135	-	-
L12_Hotel Rooms       135       -       -         L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Bathrooms       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -	L12_Bathrooms	135	-	-
L13_Circ       135       -       -         L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Hotel Rooms       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -	L12_Hotel Rooms	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_HotelRooms       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_Circ       135       -       -         L08_Circ       135       -	L13_Circ	135	-	-
L13_Circ       135       -       -         L13_Dirc       135       -       -         L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Hotel Rooms       135       -       -         L09_Bathrooms       135       -       -         L09_Bathrooms       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L08_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       -       -         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       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -       -         L08_Circ	L13_Circ	135	-	-
L13_Bathrooms       135       -       -         L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Hotel Rooms       135       -       -         L09_Bathrooms       135       -       -         L05_Hotel Room       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -	L13_Circ	135	-	-
L13_Hotel Rooms       135       -       -         L09_Circ       135       -       -         L09_Hotel Rooms       135       -       -         L09_Bathrooms       135       -       -         L05_HotelRoom       135       -       -         L06_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -	L13_Bathrooms	135	-	-
L09_Circ         135         -         -           L09_Hotel Rooms         135         -         -           L09_Bathrooms         135         -         -           L05_HotelRoom         135         -         -           L06_Circ         135         -         -           L06_Torc         135         -         -           L06_Torc         135         -         -           L06_Torc         135         -         -           L06_Torc         135         -         -           L07_Circ         135         -         -           L07_HotelRoom         135         -         -           L07_HotelRoom         135         -         -           L08_Circ         135         -         -           L08_Circ	L13_Hotel Rooms	135	-	-
L09_Hotel Rooms         135         -         -           L09_Bathrooms         135         -         -           L05_HotelRoom         135         -         -           L06_Circ         135         -         -           L06_HotelRoom         135         -         -           L07_Circ         135         -         -           L07_Circ         135         -         -           L07_HotelRoom         135         -         -           L07_HotelRoom         135         -         -           L07_HotelRoom         135         -         -           L08_Circ         135         -         -           L08_Circ         135         -         -           L08_HotelRoom         135         -         -           L08_HotelRoom         135         -         -	L09_Circ	135	-	-
L09_Bathrooms       135       -       -         L05_HotelRoom       135       -       -         L06_Circ       135       -       -         L06_Tote       135       -       -         L06_Tote       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       - <td>L09_Hotel Rooms</td> <td>135</td> <td>-</td> <td>-</td>	L09_Hotel Rooms	135	-	-
L05_HotelRoom       135       -       -         L06_Circ       135       -       -         L06_HotelRoom       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05_Circ       135       -	L09_Bathrooms	135	-	-
L06_Circ       135       -       -         L06_HotelRoom       135       -       -         L07_Circ       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       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05_Circ       135       -       -	L05_HotelRoom	135	-	-
L06_Circ       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L06_Circ       135       -       -         L06_HotelRoom       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       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05_Circ       135       -       -	L06_Circ	135	-	-
L06_Circ       135       -       -         L06_Circ       135       -       -         L06_HotelRoom       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_LotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L06_Circ	135	-	-
L06_Circ       135       -       -         L06_HotelRoom       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -         L05 Circ       135       -       -	L06_Circ	135	-	-
L06_HotelRoom       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       -       -         L08_Elicc       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -         L05 Circ       135       -       -	L06_Circ	135	-	-
L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L06_HotelRoom	135	-	-
L07_Circ       135       -       -         L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L07_Circ	135	-	-
L07_Circ       135       -       -         L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L07_Circ	135	-	-
L07_HotelRoom       135       -       -         L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L07_Circ	135	-	-
L07_HotelRoom       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L07 HotelRoom	135	-	-
L08_Circ       135       -       -         L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05_Circ       135       -       -	L07_HotelRoom	135	-	-
L08_Circ       135       -       -         L08_Circ       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L08_HotelRoom       135       -       -         L05_Bathroom       135       -       -         L05 Circ       135       -       -	L08 Circ	135	-	-
L08_Circ         135         -         -           L08_HotelRoom         135         -         -           L08_HotelRoom         135         -         -           L08_HotelRoom         135         -         -           L05_Bathroom         135         -         -           L05_Circ         135         -         -	L08 Circ	135	-	-
L08_HotelRoom         135         -         -           L08_HotelRoom         135         -         -           L05_Bathroom         135         -         -           L05_Circ         135         -         -	L08_Circ	135	-	-
L08_HotelRoom         135         -         -           L05_Bathroom         135         -         -           L05 Circ         135         -         -	L08 HotelRoom	135	-	-
L05_Bathroom         135         -         -           L05 Circ         135         -         -	L08 HotelRoom	135	-	-
L05 Circ 135	L05_Bathroom	135	-	-
	L05_Circ	135	-	-

General lighting and display lighting	General luminaire	re Display light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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
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_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
111 Hotel Booms	NO (-57.9%)	NO
	N/A	N/A
112_Circ	NO (-99.6%)	NO
112_0irc	N/A	N/A
112_010	N/A	N/A
112 Bathrooms	NO (-50.9%)	NO
112 Hotel Booms	NO (-57.6%)	NO
	Ν/Δ	
	NO (-99.5%)	
	N/A	
	IN/A	IN/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**

	A	N - 2 1	0/ 1
	Actual	Notional	% Are
Floor area [m²]	7615.7	7615.7	
External area [m <sup>2</sup> ]	7412.6	7412.6	
Weather	LON	LON	
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	2303.49	3535.81	100
Average U-value [W/m <sup>2</sup> K]	0.31	0.48	
Alpha value* [%]	25	10	
Average conductance [W/K] Average U-value [W/m²K] Alpha value* [%]	2303.49 0.31 25	3535.81 0.48 10	100

\* 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
Storage or Distribution
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<sup>2</sup>]

	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<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	114.13	154.12
Primary energy [kWh/m <sup>2</sup> ]	177.46	182.14
Total emissions [kg/m <sup>2</sup> ]	16.3	16.42

### **HVAC Systems Performance** Cool dem Heat con Cool con Aux con Heat Cool Heat gen Cool gen Heat dem System Type MJ/m2 MJ/m2 kWh/m2 kWh/m2 kWh/m2 SSEEF SSEER SEFF 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 0 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 0 Notional 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

= Cooling fuel type

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# BRUKL Output Document MGovernment

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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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 [m<sup>2</sup>]: 434.21

### The CO<sub>2</sub> emission and primary energy rates of the building must not exceed the targets

Target CO <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	16.42	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	15.51	
Target primary energy rate (TPER), kWh/m2annum	182.14	
Building primary energy rate (BPER), kWh/m²annum	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	Ua-Limit	Ua-Calc	Ui-Calc	First surface with maximum value
Walls*	0.26	0.14	0.15	LG000010:Surf[0]
Floors	0.18	0.1	0.1	L000003: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 <sub>a-Limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			Ui-Calc = Ca	Iculated maximum individual element U-values [W/(m²K)]

a-Limit = Limiting area-weighted average U-values [W/(m<sup>2</sup>K)] U<sub>a-Calc</sub> = Calculated area-weighted average U-values [W/(m<sup>2</sup>K)]

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

^ For fire doors, limiting U-value is 1.8 W/m<sup>2</sup>K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

<sup>\*\*\*</sup> Values for rooflights refer to the horizontal position. \*\* Display windows and similar glazing are excluded from the U-value check.

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		
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/(I/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 [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	-	-
109 Circ	125	_	-

eneral lighting and display lighting General luminaire Display light sour		y light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	-	-
	125	-	_
	125	_	-
	125	_	-
L08 HotelBoom	125	-	_
	125		_
	125	_	
	125	-	-
	120	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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
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_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
111 Hotel Booms	NO (-57.9%)	NO
	N/A	N/A
112_Circ	NO (-99.6%)	NO
112_0irc	N/A	N/A
112_010	N/A	N/A
112 Bathrooms	NO (-50.9%)	NO
112 Hotel Booms	NO (-57.6%)	NO
	Ν/Δ	
	NO (-99.5%)	
	N/A	
	IN/A	IN/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?	
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**

	A	N - 2 1	0/ 1
	Actual	Notional	% Are
Floor area [m²]	7615.7	7615.7	
External area [m <sup>2</sup> ]	7412.6	7412.6	
Weather	LON	LON	
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	2303.49	3535.81	100
Average U-value [W/m <sup>2</sup> K]	0.31	0.48	
Alpha value* [%]	25	10	
Average conductance [W/K] Average U-value [W/m²K] Alpha value* [%]	2303.49 0.31 25	3535.81 0.48 10	100

\* 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
Hotels
Residential Institutions: Hospitals and Care Homes Residential Institutions: Residential Schools Residential Institutions: Universities and Colleges
Secure Residential Institutions
Besidential 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<sup>2</sup>]

	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/m<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	114.16	154.12
Primary energy [kWh/m <sup>2</sup> ]	169.09	182.14
Total emissions [kg/m <sup>2</sup> ]	15.51	16.42

### **HVAC Systems Performance** Cool dem Heat con Cool con Aux con Heat Cool Heat gen Cool gen Heat dem System Type MJ/m2 MJ/m2 kWh/m2 kWh/m2 kWh/m2 SSEEF SSEER SEFF 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 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 0 0 Notional 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

= Cooling fuel type

# BRUKL Output Document MGovernment

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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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 [m<sup>2</sup>]: 1606.66

### The CO<sub>2</sub> emission and primary energy rates of the building must not exceed the targets

Target CO <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	3.52	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	3.32	
Target primary energy rate (TPER), kWh/m2annum	38.84	
Building primary energy rate (BPER), kWh/m²annum	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	Ua-Limit	Ua-Calc	Ui-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	L000006: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 <sub>a-Limit</sub> = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)]			U i-Calc = Ca	Iculated maximum individual element U-values [W/(m²K)]

a-Limit = Limiting area-weighted average U-values [W/(m<sup>2</sup>K)] U<sub>a-Calc</sub> = Calculated area-weighted average U-values [W/(m<sup>2</sup>K)]

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

\*\*\* Values for rooflights refer to the horizontal position. \*\* Display windows and similar glazing are excluded from the U-value check.

^ For fire doors, limiting U-value is 1.8 W/m<sup>2</sup>K

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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/(I/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			
Α	Local supply or extract ventilation units			
В	Zonal supply system where the fan is remote from the zone			
С	Zonal extract system where the fan is remote from the zone			
D	Zonal balanced supply and extract ventilation system			
Е	Local balanced supply and extract ventilation units			
F	Other local ventilation units			
G	Fan assisted terminal variable air volume units			
Н	Fan coil units			
1	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/(I/s)]									UD officiency	
ID of system type	Α	В	С	D	Е	F	G	Н	I	ппе	inciency
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 [Im/W]	Power density [W/m <sup>2</sup> ]		
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 so		y light source			
--	-----------------	-----------------	-----------------------------------		
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]		
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	minaire Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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
	I	I

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?	
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 <sup>2</sup> ]	21297	21297	
External area [m <sup>2</sup> ]	15399.6	15399.6	
Weather	LON	LON	80
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	3935.48	5542.94	
Average U-value [W/m <sup>2</sup> K]	0.26	0.36	
Alpha value* [%]	25	10	20

\* 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/m<sup>2</sup>]

	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/m<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	60.89	115.41
Primary energy [kWh/m <sup>2</sup> ]	36.55	38.84
Total emissions [kg/m <sup>2</sup> ]	3.32	3.52

#### **HVAC Systems Performance** Cool dem Heat con Cool con Aux con Heat Cool Heat gen Cool gen Heat dem System Type kWh/m2 MJ/m2 MJ/m2 kWh/m2 kWh/m2 SSEEF **SSEER** SEFF 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 7.1 5.4 2.78 4.63 1 ----\_\_\_\_ [ST] No Heating or Cooling 0 0 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 Notional 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	<ul> <li>Heating generator seasonal efficiency</li> </ul>
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

= Cooling fuel type

Page 9 of 9

## BRUKL Output Document MGovernment

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**

**Certifier details** 

Telephone number: Phone

Name: Name

Address: Address 1, City, Postcode

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 [m<sup>2</sup>]: 1606.66

#### The CO<sub>2</sub> emission and primary energy rates of the building must not exceed the targets

Target CO <sub>2</sub> emission rate (TER), kgCO <sub>2</sub> /m <sup>2</sup> annum	3.52	
Building CO <sub>2</sub> emission rate (BER), kgCO <sub>2</sub> /m <sup>2</sup> annum	3.15	
Target primary energy rate (TPER), kWh/m2annum	38.84	
Building primary energy rate (BPER), kWh/m <sup>2</sup> 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	Ua-Limit	Ua-Calc	Ui-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	L000006: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	
Ua-Limit = Limiting area-weighted average U-values [W/(m <sup>2</sup> K)] U+Calc = Calculated maximum individual element U-values [W/(m <sup>2</sup> K)]					

U a-Limit = Limiting area-weighted average U-values [W/(m<sup>2</sup>K)] U<sub>a-Calc</sub> = Calculated area-weighted average U-values [W/(m<sup>2</sup>K)]

\* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

\*\*\* Values for rooflights refer to the horizontal position. \*\* Display windows and similar glazing are excluded from the U-value check.

^ For fire doors, limiting U-value is 1.8 W/m<sup>2</sup>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
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/(I/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
Α	Local supply or extract ventilation units
В	Zonal supply system where the fan is remote from the zone
С	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
Е	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
Н	Fan coil units
Ι	Kitchen extract with the fan remote from the zone and a grease filter
NB: L	imiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name		SFP [W/(I/s)]						UD officianay			
ID of system type	Α	В	С	D	E	F	G	Η	I	пк епісіепсу	
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	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	Displa	y light source
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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	-	-
LGF_RB_Office stairs LGF_RB_Office BS3_RB_Plant BS3_RB_Circulation Corridor BS3_RB_Core Circulation	125 125 125 125 125	- - - -	- - - -

General lighting and display lighting	General luminaire	Displa	y light source
Zone name	Efficacy [Im/W]	Efficacy [lm/W]	Power density [W/m <sup>2</sup> ]
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 Boom Female	N/A	N/A
BS1 OB Female Showers	N/A	N/A
BS1_OB_Changing Boom 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/Δ	N/A
BS1_BB_Teaching	Ν/Δ	Ν/Δ
BS1_RB_Ciruclation		
BS1_RB_Store		
RS1_RB_Office		
BS1_RB_Olice		
BS1_RB_Audiology		N/A
		N/A
BS1_RB_WCS		N/A
BS1_RB_Circulation		N/A
BS2_RB_Ciruciation		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 [m <sup>2</sup> ]	21297	21297	
External area [m <sup>2</sup> ]	15399.6	15399.6	
Weather	LON	LON	80
Infiltration [m <sup>3</sup> /hm <sup>2</sup> @ 50Pa]	3	3	
Average conductance [W/K]	3940.06	5542.94	
Average U-value [W/m <sup>2</sup> K]	0.26	0.36	
Alpha value* [%]	25	10	20

\* 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/m<sup>2</sup>]

	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/m<sup>2</sup>]

	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<sub>2</sub> Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m <sup>2</sup> ]	61.21	115.41
Primary energy [kWh/m <sup>2</sup> ]	34.76	38.84
Total emissions [kg/m <sup>2</sup> ]	3.15	3.52

#### **HVAC Systems Performance** Cool dem Heat con Cool con Aux con Heat Cool Heat gen Cool gen Heat dem System Type MJ/m2 MJ/m2 kWh/m2 kWh/m2 kWh/m2 SSEEF **SSEER** SEFF 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 7.1 5.4 2.78 4.63 1 ----\_\_\_\_ [ST] No Heating or Cooling 0 0 0 0 0 0 Actual 0 0 0 0 0 0 0 0 0 Notional 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	<ul> <li>Cooling generator seasonal energy efficiency ratio</li> </ul>
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

= Cooling fuel type

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