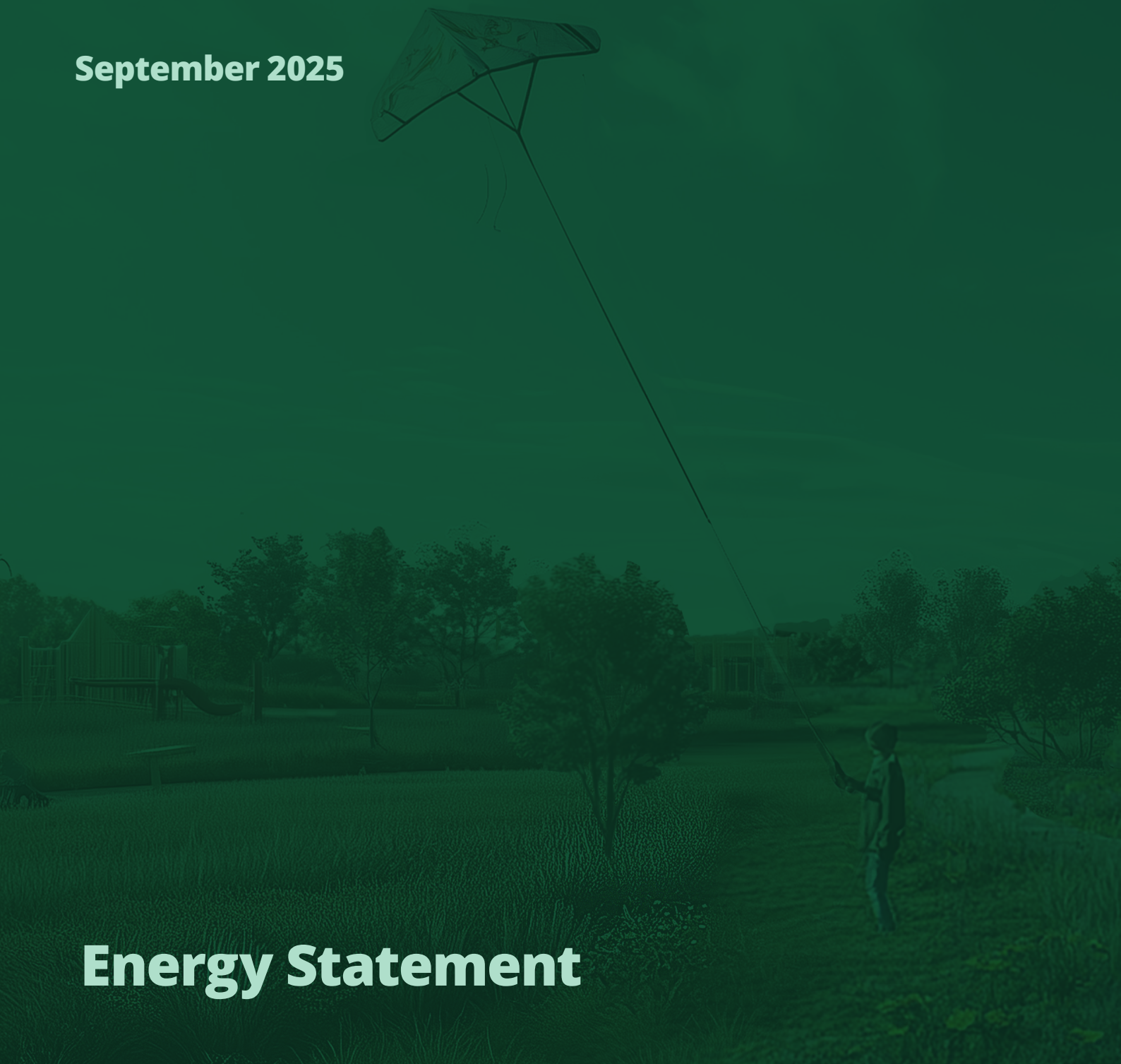
UNIVERSITY OF CAMBRIDGE

North West Cambridge

Future Phases of Eddington

September 2025



Energy Statement

North West Cambridge Masterplan

NWC.24_ENERGY STATEMENT_SEPTEMBER 2025

Energy and Carbon Reduction Statement in support of the Outline Planning Application

Applicant: The University of Cambridge

Delivering a better world

Prepared for:

The University of Cambridge

Prepared by:

AECOM Limited
Aldgate Tower
2 Leman Street
London E1 8FA
United Kingdom

aecom.com

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Executive Summary

Scope

AECOM was appointed by The University of Cambridge ('the Applicant') to prepare an Energy and Carbon Reduction Statement in support of the Outline Planning Application (OPA) for the future phases of North West Cambridge (the 'Proposed Development') located in Cambridge as per the description below.

'*Outline planning application (all matters reserved except for means of access to the public highway) for a phased mixed use development, including demolition of existing buildings and structures, such development comprising*

- *Living Uses, comprising residential floorspace (Class C3/C4, up to 3,800 dwellings), student accommodation (Sui Generis), Co-living (Sui Generis) and Senior Living (Class C2);*
- *Flexible Employment Floorspace (Class E(g) / Sui Generis research uses);*
- *Academic Floorspace (Class F1); and*
- *Floorspace for supporting retail, nursery, health and indoor sports and recreation uses (Class E (a) – E (f));*
- *Public open space, public realm, sports facilities, amenity space, outdoor play, allotments and hard and soft landscaping works alongside supporting facilities;*
- *Car and cycle parking, formation of new pedestrian, cyclist and vehicular accesses and means of access and circulation routes within the site;*
- *Highway works;*
- *Site clearance, preparation and enabling works;*
- *Supporting infrastructure, plant, drainage, utility, earthworks and engineering works.'*

This Energy and Carbon Reduction Statement sets out the proposed strategy for reducing the energy use of the Proposed Development and utilising low carbon and renewable energy sources. It also identifies how the scheme is compliant with the energy policies set out in the Development Plan.

Energy Strategy

The Energy and Carbon Reduction Statement follows the Energy Hierarchy - Be Lean, Be Clean, Be Green as set out below in Figure 1 and subsequent tables.

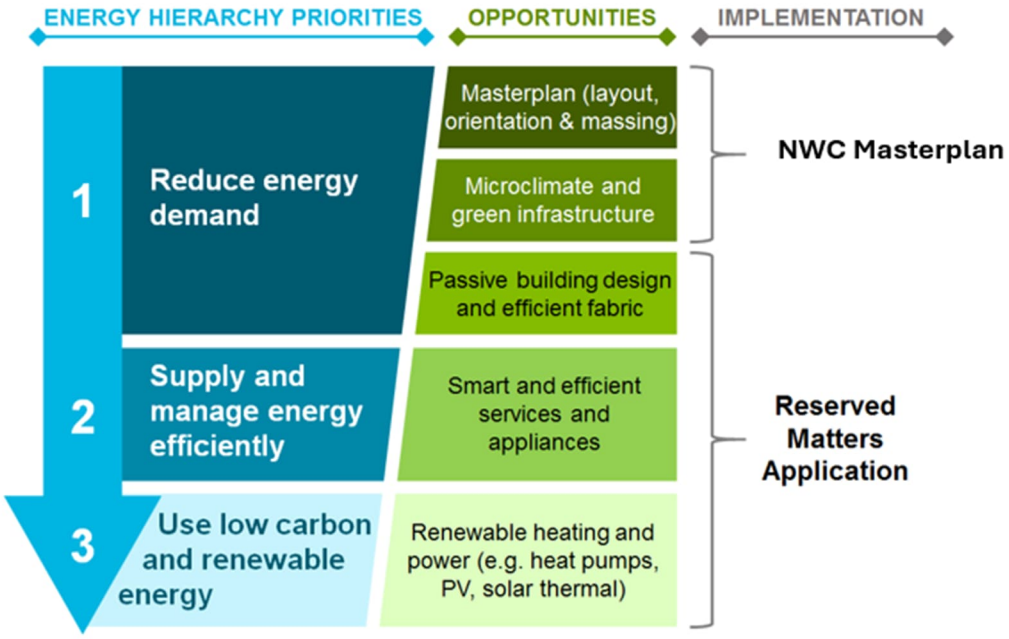


Figure 1 Energy Hierarchy

The strategy at each energy hierarchy stage is summarised below.

The reported savings within this Energy and Carbon Reduction Statement are based on the illustrative scheme to demonstrate how the proposals can address the relevant planning policy and guidance. At the Reserved Matters stage, a further energy assessment will be produced to consider the detailed design for each plot.

Be Lean	• A fabric first approach has been adopted to reduce energy demand with fabric specification deemed by the project team to be equivalent to Passivhaus Principles. • The resulting area weighted Dwelling Fabric Energy Efficiency (DFEE) is less than the Target Fabric Energy Efficiency (TFEE) Part L 2021 target by 26%. • The building services will include energy efficient lights, optimised heat distribution and mechanical ventilation with heat recovery. • The domestic units are currently showing a CO_2 emission saving of 37% from energy demand reduction.
Overheating	• GHA Early-Stage Assessment has been undertaken.
Be Clean	• The Applicant is not intending to connect future phases of the development to the existing District Heating network on site, as a plot by plot approach provides greater flexibility over the 10 to 15 year likely build out period and future-proofing for future technologies.
Be Green	• The preferred energy strategy utilises individual air source heat pumps (ASHPs) for dwellings and a local heating network supplied by building-mounted ASHPs for apartments. • On-site renewable energy generation will be maximised by utilising the available flat roof space for apartments and non-domestic buildings and suitably oriented pitched roofs on houses for solar photovoltaic (PV) panels.
Predicted carbon savings	• As a result of this energy strategy, on-site carbon emissions reduction associated with the high-level design information available at this stage is estimated to be a 52**%** saving against Building Regulations Part L 2021 compliant designs (regulated energy only).

The approach demonstrates compliance with the relevant planning policies, as described in Sections 4, 5 and 6.

Carbon Emissions Reductions

The tables below show the predicted carbon (CO_2) emissions savings at each stage of the Energy Hierarchy for the Proposed Development, separated into the Domestic and Non-Domestic components.

Table 1: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the dwellings (scaled from sample indicative dwellings)

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	3,417	-	-
Be Lean: After energy efficiency measures	2,148	1,270	37%
Be Clean: After heat network connection (no connection)	2,148	0	0%
Be Green: After renewable energy	695	1,452	42%
Total	**695**	**2,722**	**80%**

Table 2: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the non-domestic buildings (determined from benchmark energy use)

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	2,264	-	-
Be Lean: After energy efficiency measures	2,264	0	0%
Be Clean: After heat network connection (no connection)	2,264	0	0%
Be Green: After renewable energy	2,054	210	9%
Total	2,054	210	**9%**

Table 3: Site-Wide predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	5,681	-	-
Be Lean: After energy efficiency measures	4,411	1,270	22%
Be Clean: After heat network connection (no connection)	4,411	0.0	0%
Be Green: After renewable energy	2,749	1,662	29%
Total	2,749	2,932	52%

The Site-wide results in Table 3 combine the information in Table 1 and Table 2 and demonstrate that the development shows significant carbon emissions savings compared to a scheme built to comply with Building Regulations Part L 2021.

Overheating Risk Assessment

The Proposed Development will need to incorporate strategies to minimise cooling demand and mitigate overheating risks in compliance with Approved Document O of the Building Regulations; this has been considered by the applicant and the design team. Detailed thermal modelling is not feasible at this outline stage, noting a Part O-compliant assessment would be conducted for a representative sample of homes during the Reserved Matters Application (RMA) stage.

An early stage overheating risk evaluation using the Good Homes Alliance (GHA) tool identified potential risks:

- Dual-aspect flats scored 11 (moderate risk).
- Single-aspect flats scored 24 (high risk).

A dual aspect flat with full window operability scored 3 (low risk), highlighting the value of passive ventilation.

To address these risks, both passive solutions (e.g., low g-value glazing, external shading, natural ventilation) and active measures (e.g., mechanical cooling, retrofit readiness) will need to be considered at the appropriate design stage, with the passive measures reviewed first. In practice, different approaches will be adopted, depending on the dwelling location and site constraints.

1. Introduction

This Energy and Carbon Reduction Statement has been prepared by AECOM to accompany the Outline Planning Application being submitted by the Applicant, The University of Cambridge, for a phased mixed-use development, including demolition of existing buildings and structures.

This statement identifies how the development is responding to the energy policies in the Adopted Development Plan which addresses the relevant planning policy. The energy and carbon figures reported within this document have been prepared by AECOM and reflect the current design stage as is expected for an Outline Planning Application (OPA).

The Energy and Carbon Reduction Statement sets out the proposed strategy for reducing carbon associated with the energy use of the Proposed Development, utilising low carbon and renewable energy sources, reducing cooling demands and maintaining comfortable conditions for residents and building users.

1.1 Existing Site

The NWCM Site (“the Site”) is located approximately 2km north-west of Cambridge city centre. The Site is roughly triangular in shape and comprises land between Huntingdon Road (A1307), Madingley Road (A1303) and the M11. The Site forms part of the emerging settlement of Eddington.

The Site covers a total area of approximately 114 hectares (“ha”) and is located across the administrative boundary of South Cambridgeshire District Council (“SCDC”) and Cambridge City Council (“CCC”) which are therefore the Local Planning Authorities (“LPAs”) for the site. The Greater Cambridge Shared Planning Service (“GCSPS”) manages planning services on behalf of SCDC and CCC.

The Site predominantly comprises grassland fields, construction areas, and sections of Huntingdon Road (A1307) and Madingley Road (A1303). Barcroft Centre and associated buildings are located within the most northerly extent of the Site, along Huntingdon Road. The Site contains areas of hard standing, including an area utilised for parking to the south of the Site. There are a variety of amenity and green spaces on the Site including swales, ponds, grassland, areas of woodland, hedgerows and individual trees. A storm water recycling system pond, which has never been commissioned, is located along the western edge of the Site.

The Traveller’s Rest Pit Site of Special Scientific Interest (“SSSI”) is located within the eastern extent of the Site.

The Washpit Brook is the closest watercourse to the Site which runs through the Site from southeast to the northwest . Much of the Site comprises topsoil and clay that emerged as a result of development undertaken pursuant to the 2013 Outline Planning Permission (OPP) at North West Cambridge.

Vehicular access to the site can be gained via either Huntingdon Road to the north or Madingley Road to the south of the Site. Huntingdon Road and Madingley Road are linked via Eddington Avenue, which traverse the south-eastern extent of the site. Pedestrian access can be gained via the same routes. Pedestrian and cycle access can also be gained via Horse Chestnut Avenue and Bunkers Hill (from Huntingdon Road), as well as Storeys Way and Madingley Rise to the east of the site. A Public Rights of Way (Footpath 99/5) crosses the site in the north-west corner, running between Huntingdon Road to Cambridge Road, and crossing beneath the M11.

The Site is bound by:

- a small portion of the A14 to the north, and Girton College, residential properties and agricultural fields which front onto Huntingdon Road (A1307) to the north and north-east;
- residential properties located along Huntingdon Road, Ascension Parish Burial Ground, Trinity Hall (University of Cambridge student accommodation) and Trinity Hall sports grounds to the east of the site;
- Madingley Road Park and Ride, Madingley Road (A1303), and residential properties and buildings associated with the University of Cambridge to the south; and the M11 motorway to the west, beyond which lies agricultural fields.

1.2 Development Description

The University of Cambridge ("the Applicant") is seeking Outline Planning Permission ("OPP") for the future phases of the North West Cambridge Masterplan ("NWCM"). The Outline Planning Application ("OPA") seeks planning permission for:

> Outline planning application (all matters reserved except for means of access to the public highway) for a phased mixed use development, including demolition of existing buildings and structures, such development comprising

- Living Uses, comprising residential floorspace (Class C3/C4, up to 3,800 dwellings), student accommodation (Sui Generis), Co-living (Sui Generis) and Senior Living (Class C2);
- Flexible Employment Floorspace (Class E(g) / Sui Generis research uses);
- Academic Floorspace (Class F1); and
- Floorspace for supporting retail, nursery, health and indoor sports and recreation uses (Class E (a) – E (f);
- Public open space, public realm, sports facilities, amenity space, outdoor play, allotments and hard and soft landscaping works alongside supporting facilities;
- Car and cycle parking, formation of new pedestrian, cyclist and vehicular accesses and means of access and circulation routes within the site;
- Highway works;
- Site clearance, preparation and enabling works;
- Supporting infrastructure, plant, drainage, utility, earthworks and engineering works.

2. Planning Policy and Drivers

2.1 Introduction

The Energy and Carbon Reduction Statement for the Proposed Development has been developed in response to international, national, regional and local policy drivers that aim to reduce carbon emissions from new development, whilst protecting local air quality and indoor comfort for building occupiers.

The main policies of relevance are summarised below.

2.2 International Drivers

The need to reduce the growth of greenhouse gas emissions is a key focus for the international political agenda.

The United Nations Framework Convention on Climate Change is a main channel for international cooperation on climate change mitigation alongside related international agreements including the Kyoto Protocol, Paris Agreement and Glasgow Climate Pact.

The European Energy Performance of Buildings Directive (EPBD) requires that all new buildings should be 'nearly zero-energy buildings.' Typically, EPBD requirements are met through transposition into national legislation. At present there is no official position on whether future requirements of the EPBD will be implemented now that the UK has left the EU. However, in the Future Home Standard consultation (December 2023) the Government set out proposals to align with the latest changes to the requirements in the Directive for new dwellings.

2.3 National Policy Drivers

2.3.1 UK Climate Change Act

In 2019, the UK parliament declared a 'Climate Emergency' becoming the first parliament to do so. A subsequent amendment was made to the UK Climate Change Act 2008 (2050 Target Amendment Order (2019)), which legally commits the UK Government to reducing greenhouse gas emissions by 100% by the year 2050. The Committee on Climate Change advises the Government on the setting of binding 5-year carbon budgets on a pathway to achieving the 2050 target. The first six carbon budgets covering the period up to 2037 have been set in law. The current carbon budget requires a reduction of 52% by 2027.

This Act is the driver behind a framework of national strategy and policy documents such as the UK Low Carbon Transition Plan (2009) and previously anticipated zero-carbon homes policy. These, in turn, have informed the development of local planning policy and updates to the Building Regulations.

2.3.2 National Energy Related Strategies

The Government Department for Business, Energy & Industrial Strategy published the Energy White Paper in December 2020, to set out how the UK will reach its net zero emissions target by 2050. The Government at the time also published a Net Zero Strategy[1] and Heat and Buildings Strategy[2] in October 2021, outlining their vision to "lead the world in ending our contribution to climate change, while turning this mission into the greatest opportunity for jobs and prosperity for our country since the industrial revolution."

The strategies lay out the following aims relevant to new development:

- Ensuring all new buildings in England are ready for Net Zero from 2025;
- Reducing demand through a fabric first approach – enforced through Future Homes Standards;

[1] Net Zero Strategy: Build Back Greener. BEIS, October 2021. Available at: https://www.gov.uk/government/publications/net-zero-strategy
[2] Heat and Buildings Strategy. BEIS, October 2021. Available at: https://www.gov.uk/government/publications/heat-and-buildings-strategy

- Supplying heat to buildings through future proofed low carbon solutions such as heat networks or heat pumps; and
- Encouraging the use of renewables in conjunction with energy storage.

The Net Zero Strategy also indicates the Government is aiming to decarbonise power by 2035 with energy supplied via low carbon solutions, and look to rebalance energy prices, to make electricity prices cheaper.

2.3.3 National Planning Policy Framework

The National Planning Policy Framework[3], December 2024 (NPPF) prescribes government planning policy and outlines the way in which this is to be applied. The document sets out a framework for local plan development and illustrates national-scale policy aims. The NPPF includes requirements for new development which assist in supporting the transition to a low carbon future.

Chapter 14 of the NPPF states that the planning system should support the transition to a low carbon future in a changing climate. It confirms that the NPPF should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions and support renewable and low carbon energy and associated infrastructure.

2.3.4 Building Regulations and Future Homes Standard (FHS) and Future Buildings Standard (FBS)

Part L[4] of the Building Regulations in England is the key mechanism that prescribes standards for the energy performance of new and the refurbishment of existing buildings in the UK, based on metrics such as the estimated level of primary energy demand and CO_2 emissions. Approved Documents (AD) set out the measures required to comply with Building Regulations.

As of 15th June 2022, Part L 2021, the Government's update to the Building Regulation, came into effect and is the current set of Building Regulations with which development must comply.

An additional Building Regulation, Part O[5], was introduced by the Government, focussing on minimising the risk of overheating for new residential buildings. Approved Document O proposes changes to the approach for managing heat risk from previous Part L documents. The document proposes that new developments will be required to follow either a simplified or dynamic overheating assessment to demonstrate that designs sufficiently minimise overheating risk. It is expected that developments like North West Cambridge will be required to use the dynamic method. The dynamic method aligns with CIBSE's TM59[6] approach for domestic buildings. Approved Document O outlines a number of limitations that need to be applied to TM59 calculations; these include more conservative assumptions around the use of window opening for the purging of excess heat. Factors such as local acoustics, air quality, security and safety are all to be more carefully considered.

The Government's consultation response to the FHS/FBS also sets out initial timescales for the adoption. Following consultation in 2023, the Government intends to publish FHS/FBS in 2025 and bring it into force in 2026. Based on these timescales, it is expected that the FHS/FBS could be adopted by the Government prior to the commencement of construction for some, if not all, phases of the Proposed Development. In this case it is anticipated that these phases of the Proposed Development will be expected to comply with the FHS/FBS. There is currently limited information on the requirements for the FHS/FBS, however the Government has signalled that standards will be based on very high thermal efficiency measures including triple glazing and heat pumps in place of gas boilers for the heating strategy for dwellings.

[3] The National Planning Policy Framework, MHCLG, December 2024. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[4] Approved Document L, MHCLG, 2021. Available at: https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l
[5] Approved Document O, MHCLG, 2021.Available at: https://www.gov.uk/government/publications/overheating-approved-document-o
[6] TM59 Design methodology for the assessment of overheating risk in homes, CIBSE, May 2017. Available at: https://www.cibse.org/knowledge-research/knowledge-portal/technical-memorandum-59-design-methodology-for-the-assessment-of-overheating-risk-in-homes

2.4 Local Planning Policy and Guidance

2.4.1 Adopted Development Plan

The Site falls within the administrative boundaries of the GCSPS which comprises both Cambridge City Council and South Cambridgeshire District Council.

The Development Plan comprises:

- Cambridge Local Plan (2018);
- South Cambridgeshire Local Plan (2018);
- North West Cambridge Area Action Plan ("AAP") (2009).

2.4.2 Cambridge Local Plan (2018)

Policy 28, titled *"Carbon reduction, community energy networks, sustainable design and construction and water use"*, imposes rigorous carbon targets on all new development.

All new housing must achieve a 44% reduction in carbon emissions from a Part L 2006 Regulations baseline (equivalent to minimum 19% beyond the Part L 2013 standards).

All new non-residential buildings must meet the mandatory energy credits for a BREEAM 'Excellent' rating (Ene01 credit).

The policy also expects development to connect to or facilitate local low-carbon heat networks ("community energy networks") and to integrate sustainable design measures (on which the Supplementary SPD provides detailed guidance).

In practice, compliance with Policy 28 is demonstrated by a Carbon Reduction Statement for housing schemes and a BREEAM Pre-Assessment for commercial schemes, as required by the Greater Cambridge Sustainable Design SPD.

A carbon reduction target against Part L 2021 is not included, due to the date of the policy. However, in sections 6.3 and 8 AECOM have presented the predicted carbon savings against Part L 2021, being the applicable version of Part L at the time the modelling was carried out.

2.4.3 South Cambridgeshire Local Plan (2018)

This Plan embeds climate mitigation and adaptation into all development.

Policy CC/1 requires planning applications to demonstrate embedded mitigation/adaptation measures via a Sustainability Statement. To mitigate climate change, proposals should demonstrate:

- High levels of energy efficiency (Building Regulations);
- Use and generation of renewable and low carbon energy (Policy CC/3);
- Promotion of sustainable forms of transport, such as using buses, cycling or walking, and reduction of car use (Policy HQ/1 & Transport Policies);
- Recycling and waste reduction both during construction and occupation (Policy CC/6); and Inclusion of high-speed broadband to facilitate home working (Policy TI/10)

To adapt to the effects of climate change, proposals should:

- Manage and conserve water resources (Policy CC/4);
- Demonstrate that flood risk from all sources has been avoided or managed (Policy CC/9);
- Use Sustainable Drainage Systems (SuDS) (Policy CC/8);

- Use layout, building orientation, design, and materials to ensure properties are not susceptible to overheating and include open space and vegetation for shading and cooling, and to detain surface water run-off (Policy HQ/1); and
- Create a better linked habitat network by conserving, creating or enlarging existing habitats (Policy NH/4).

Policy CC/2 provides a positive framework for standalone renewable energy projects: energy generation proposals (excluding wind turbines) are permitted if they avoid unacceptable impacts on heritage, landscape, agriculture or neighbour amenity, include efficient grid or on-site connections, include decommissioning plans, and involve community consultation. Onshore wind proposals are only allowed in areas designated in Neighbourhood Plans and require clear demonstration of community support.

Policy CC/3 targets carbon reduction in new development: all new dwellings and new non-residential buildings over 1,000 m² must cut carbon emissions by at least 10% (relative to a Part L Building Regulations baseline) through on-site renewables or low-carbon technologies.

For major growth areas and new settlements, the Plan explicitly seeks site-wide renewable systems (for example, integrated on-site solar or low-carbon district heating) to maximise on-site generation.

2.4.4 North West Cambridge Area Action Plan (AAP) (2009)

This detailed plan for the University's North West Cambridge site sets exemplar sustainability standards.

All housing is required to meet very high efficiency standards: all developments above 50 dwellings must meet Code for Sustainable Homes Level 5 or higher which includes energy performance standards.

All non-residential and student accommodation buildings must achieve BREEAM 'Excellent'.

Note, the Code for Sustainable Homes was withdrawn by the Government in 2015, with elements incorporated into the Building Regulations instead.

The AAP describes a site-wide decentralised energy network to serve the whole development; this system must be chosen to minimise carbon emissions. In addition, if a renewable-fuelled system cannot deliver the required savings, non-residential buildings are still required to cut predicted carbon emissions by at least 20% using on-site renewables (e.g. solar PV, biomass, ground-source heat). These provisions together ensure the North West Cambridge development will be zero-carbon ready and exceed standard regulatory requirements.

2.4.5 Greater Cambridge Sustainable Design & Construction Supplementary Planning Document (2020)

This Supplementary Planning Document (SPD) supplements the adopted Local Plans and sets out the evidence required to meet their energy and carbon standards.

Paragraph 3.2.2 states that [Cambridge Local Plan] Policy 28 as drafted in 2011, requires all new residential development to reduce emissions by 44% compared to a Building Regulations 2006 baseline. This policy requirement is now equivalent to a 19% reduction under Part L 2013, which is the level of carbon reduction that must be demonstrated as a minimum in submitted Carbon Reduction Statements. The SPD shall hereafter refer to a 19% reduction on Part L 2013 (Residential). For new non-residential development, the requirement is to meet the mandatory credits required for achievement of BREEAM 'excellent' under the Ene 01 credit. Policy CC/3 from the South Cambridgeshire Local Plan states that a 10% carbon reduction from onsite renewable or low carbon energy must be achieved for all new residential development and major non-residential development.

The SPD elaborates on technical requirements (fabric standards, energy hierarchies, passive design, heat network design) to ensure that developments achieve the Local Plan targets.

The SPD thus ensures that new schemes deliver the carbon reductions and energy efficiency required by Policy 28 and Policy CC/3 of the South Cambridgeshire Local Plan.

2.5 Emerging Planning Policy

The GCSPS has begun to prepare a joint Local Plan for Cambridge City Council and South Cambridgeshire District Council. A Regulation 18: 'Preferred Options' consultation was undertaken in 2021.

A further Draft Plan Consultation is planned for Autumn/Winter 2025 with a Proposed Submission Plan Consultation (Regulation 19) scheduled for Summer / Autumn 2026 with Submission to the Secretary of State for examination by the end of 2026. The new Local Plan is therefore unlikely to be adopted by the time the NWCM Outline Planning Application is determined.

3. Baseline Energy Demands and CO_2 Emissions

3.1 Introduction

This section of the report outlines the methodology that has been used to establish the baseline energy demands for the Proposed Development, including the building use types modelled and their associated gross internal floor areas, based on the Illustrative Masterplan.

Both the domestic and non-domestic components of the Proposed Development will be evaluated under the applicable Part L of the Building Regulations; currently this is Part L 2021. The use types for the Proposed Development as comprised in the Illustrative Scheme (which have been used as the basis for this assessment) are:

- 325,223 m² (GIA) and 263,905 m² (NIA) residential floorspace
- 139,276 m² (GIA) of Use Class E, F1 (Academic) and Sui Generis floorspace

The planning targets for the Proposed Development relate only to the regulated energy demands of the dwellings and the non-domestic units.

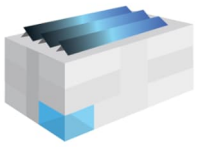
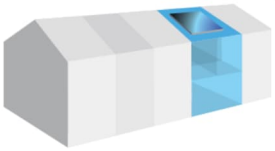
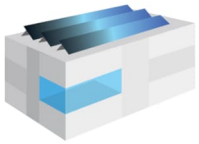
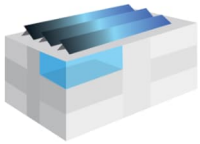
The modelling scope has been defined at a high level, employing illustrative representative dwelling types using the SAP 10.2 methodology. To efficiently assess the energy performance of the proposed residential component of the development, AECOM adopted a representative sampling approach for SAP modelling. A strategic sample of units was selected that reflect the range of apartment types across the scheme. Each SAP model represented a group of similar, non-modelled units—based on factors such as orientation, floor level, layout, and thermal envelope characteristics. This approach allowed an estimate of performance data across the wider development. The modelling strategy aimed to achieve approximately 98% representational coverage of the total residential floorspace. This level of coverage ensured that the energy performance outcomes would be robust and reflective of the overall building design. This methodology aligns with industry best practices for large-scale residential developments and has been adopted to balance accuracy with efficiency in compliance reporting.

3.2 Representative dwellings for energy modelling

Six representative dwelling typologies were selected to reflect the anticipated residential mix, providing a robust basis for this assessment. They were used to estimate their baseline energy demands and evaluate the potential improvements from energy efficiency measures and low- and zero-carbon technologies. The NWC development will ultimately contain a wider variety of dwelling types as indicated by the accommodation schedule; however, having regard to the illustrative scheme of the OPA, dwelling types representing 5% or less of the total residential units were excluded from this initial modelling scope. AECOM considered the selected typologies sufficient to establish robust likely carbon savings at the outline planning stage.

The six dwelling types selected for modelling are outlined in Table 4 below.

Table 4: The 6 dwelling types used for energy modelling

Flats		Houses	
	1 bed ground floor flat		3 bed mid terrace house
	1 bed mid floor flat And 2 bed mid floor flat		4 bed detached house
	2 bed top floor flat		

For the purpose of subsequent analysis, including the estimation of available roof areas for solar photovoltaic (PV) installations, it was assumed each apartment block consists of five storeys, with eight apartments per storey - comprising four 2-bedroom and four 1-bedroom units per floor - resulting in a total of 40 apartments per block.

Table 5 shows the number of units allocated to each model to estimate the total energy demand and carbon emissions from all homes. Whilst the dwelling numbers and types are based on the residential mix from the Hawkins Brown Design Freeze issue, Rev 16, the table aligns to the assumption that there are only 6 dwelling types as explained above.

Table 5: Illustrative allocation of number of dwellings to representative SAP models

Unit description	Unit ID	TFA (m²)	No. of units
1-bed ground floor flat (one person)	1b1p GFFL	39.0	691
1-bed mid floor flat (two persons)	1b2p MFFL	51.0	1,123
2-bed mid-floor flat	2b MFFL	70.0	1,000
2-bed top-floor flat	2b TFFL	70.0	288
3-bed mid-terrace townhouse	3b MTTH	111.5	224
4-bed end-terrace or detached house	4b ET/DH	144.4	417
	Total		**3,743**

3.3 Carbon Reporting: SAP Emission Factors

The carbon emissions reporting is based on SAP 10.2 emissions factors. Table 6 shows the SAP 10.2 carbon emission factors.

Mains gas has been assumed for the baseline specification only, it is not included within the proposed energy strategy.

Table 6: SAP 10.2 Carbon Emissions Factors

	SAP 10.2 (Part L 2021)
Mains Gas	0.210 kgCO_2/kWh
Mains Electric	0.136 kgCO_2/kWh

3.4 Domestic Energy Modelling

The Design SAP software (Elmhurst Design SAP 10.2) has been used by AECOM to model the energy demands of a representative sample of dwellings in Part L 2021. The modelling exercise provided the Target Emission Rate (TER) for each sample unit modelled as well as the projected demands for space heating and domestic hot water.

Sample Design SAP 10 model TER and Dwelling Emission Rate (DER) worksheets have been provided for one of the sample units; these are provided in Appendix A.

Table 7 details the total baseline carbon emissions for the domestic element of the future phases for NWC.

Table 7: Baseline domestic regulated CO_2 emissions

Total modelled dwelling area (m^2)	Baseline 'Regulated' CO_2 Emissions (tCO_2/year)
259,440	3,417.4

The emissions for the sample domestic units have been used to calculate the overall baseline Part L 2021 regulated domestic carbon emissions.

3.5 Non-Domestic Energy Modelling

Building designs for the proposed non-domestic buildings have yet to be developed. The energy demands for non-domestic buildings were therefore estimated based on benchmarks or existing AECOM modelling of similar use types. The benchmarks used and the corresponding build-up of baseline energy demand and carbon emissions are set out in the table below. The CIBSE TM46 benchmarks used for the purposes of the assessment, the benchmarks will most likely have been derived from buildings using gas boilers for heating. Recognising that buildings delivered for the Proposed Development will be fossil fuel free and use heat pumps, the gas consumption element of the relevant CIBSE benchmark was converted to a heat demand assuming a boiler efficiency of 90% and then converted back to an equivalent delivered electricity use assuming a conservative ASHP/split unit Coefficient of Performance (CoP) of 2.5, see Table 8.

Table 8: Illustrative non-domestic benchmarks and build-up of annual energy demands and carbon emissions baseline

Non-domestic buildings illustrative schedule				Annual delivered energy intensity [kWh/m²/year]				Total annual delivered energy consumption [MWh/year]			Total annual emissions [tCO_2/year]	
Use Class	Building type		Area (m^2)	Gas	Gas to electricity	Regulated electricity	Un-regulated	Sp heating & DHW electricity	Regulated electricity	Un-regulated electricity	Regulated	Un-regulated
Use Class F1 (Academic)	1	University Campus	54,931	240	86	40	40	4,746	2,197	2,197	944	299
Use Class E (Commercial)	2	Office	16,363	120	43	47	48	707	769	785	201	107
Use Class E (Mid-Tech)	3	Workshop	20,590	180	65	17	18	1,334	350	371	229	50
PBSA (Sui Generis)	4	Student Accommodation	47,392	300	108	30	30	5,118	1,422	1,422	889	193
Total non-domestic			139,276					11,906	4,738	4,775	2,264	649

Benchmark References

1	CIBSE TM46 (2008)	18 University Campus
2	CIBSE TM46 (2008)	1 General office
3	CIBSE TM46 (2008)	27 Workshop
4	CIBSE TM46 (2008)	22 General Accommodation

Without detailed building models it is not possible to accurately assess the energy efficiency improvements for non-domestic buildings; however, because these make up a small proportion of the overall development, the savings potential will be small in relation to the domestic element.

The following best practice approaches to passive design have been deployed within the masterplan where possible:

- Use massing and orientation to provide good access to daylight and to limit shading between one building and another to increase solar generation potential.
- Integration of green infrastructure and trees to provide additional shade in summer, reduce heat absorption, provide natural transpiration and hence need for cooling.
- Use of narrow plan form to increase the perimeter zone benefiting from daylight and to reduce demand for artificial lighting.

As the design of the non-domestic elements within the Proposed Development is progressed, the following measures will be adopted where possible to reduce the carbon emissions associated with regulated energy use:

Building Design – Passive Design

- Use of effective façade design including fixed external shading where appropriate, adjustable internal shading and use of glazing with high light transmittance and low solar heat gain factors.
- Consideration of night ventilation to pre-cool building structures requiring window and shutter arrangements that allow ventilation at night without compromising security.
- Improved insulation standards for walls, roofs, glazing and floors and improved airtightness and cold bridging details, compared to minimum building regulation backstop values.

Building Design – Efficient Services and Demand Management

- Increasing the size of air-distribution and air-handling plant to reduce pressure drops and fan power and incorporate heat recovery.
- Use of the most efficient variable speed fan technology with electronic commutation.
- Use of the most efficient chillers.
- Use of effective lighting control systems incorporating manual on with automatic absence detection or automatic dimming down in response to daylight.
- Using high efficacy lighting equipment with efficient lamps and luminaires with high light output ratios.
- Use of effective control of heating and air-conditioning systems to allow mechanical cooling at peak periods of the year only.
- Provision of smart metering and consideration of smarter control systems, storage and demand management systems as technical solutions emerge.

These measures will contribute to reducing heat build-up, providing greater resilience to the now unavoidable rise in average and peak summer temperatures that will occur over the coming decades, and help to avoid or reduce the use of mechanical cooling.

The detailed proposals for non-residential buildings will be presented as part of Reserved Matters Applications as building designs are developed.

3.6 Predicted Baseline CO_2 Emissions for the Total Development

Based on the methodology outlined above, the regulated, unregulated and total CO_2 emissions for the Proposed Development are set out in Table 9.

Table 9: Baseline CO_2 emissions

Regulated Emissions (tCO_2/year)	Unregulated Emissions (tCO_2/year)
5,681	1,832
Total Site Emissions	**7,513**

4. Energy Efficiency Measures (Be Lean)

4.1 Introduction

This section outlines proposals for reducing CO_2 emissions from the buildings beyond the standard required by Building Regulations Part L 2021, where applicable through fabric and energy efficiency measures, before considering low and zero carbon energy supply options.

It should be noted that the Part L 2021 notional building includes a proportion of PV in certain cases. To demonstrate the improvement from fabric measures, this notional building saving through PV has been removed.

4.2 Dwellings

4.2.1 Fabric and Energy Efficiency Approach

Consideration has been given to the passive design, fabric and services of the buildings within the Proposed Development, including the following key measures:

- High-performance U-values for the building fabric;
- High levels of air tightness; and
- High efficiency lighting and ventilation systems including heat recovery.

4.2.2 Proposed Specifications

The six typical homes set out above were modelled with a fabric energy efficiency specification deemed by the project team to be equivalent to the Passivhaus Principles, noting that detailed building designs are not available at this stage or for the OPA. These indicative specifications are shown in Table 10 and Table 11 below. The only differences between the specifications for the houses and the flats are the thermal performance of the external walls and that some flats may have no heat loss roofs and/or floors.

The proposed fabric specification will be developed further as part of the Reserved Matters Applications by the developer at the time. The developers will be free to vary the specification set out below as they intend while also adhering to the Passivhaus Principles demonstrated by more detailed PHPP modelling. Some of them may choose to achieve Passivhaus certification but the University does not intend to require this.

Table 10: Fabric and energy efficiency specification for flats

Element	Unit of Measurement	Indicative Specification
External Wall U-value	W/m²K	0.18
Party Wall U-value	W/m²K	0.00 (fully filled cavity)
Floor U-value	W/m²K	0.11
Roof U-value	W/m²K	0.11
Windows U-value	W/m²K	0.85 – triple glazing
Windows g-value	-	0.40
External doors U-value	W/m²K	0.85
Air Permeability	m³/m²h@50Pa	1.00
Thermal Bridging	W/m²K	Targeted y-value=0.06

Table 11: Fabric and energy efficiency specification for houses

Element	Unit of Measurement	Indicative Specification
External Wall U-value	W/m²K	0.11
Party Wall U-value	W/m²K	0.00 (fully filled cavity)
Floor U-value	W/m²K	0.11
Roof U-value	W/m²K	0.11
Windows U-value	W/m²K	0.85 – triple glazing
Windows g-value	-	0.40
External doors U-value	W/m²K	0.85
Air Permeability	m³/m²h@50Pa	1.00
Thermal Bridging	W/m²K	Targeted y-value=0.06

4.2.3 Heating and Ventilation

For the purposes of calculating the CO_2 emissions savings from the proposed energy efficiency measures, the sample modelled dwellings were assumed to be served by gas boilers, as per the heat source defined for the baseline.

All dwellings were proposed to incorporate highly efficient mechanical ventilation systems with heat recovery (MVHR) to provide sufficient background air change rates because of the level of air tightness being targeted. During the heating season, the MVHR will reduce the space heating demand by recovering heat from the background ventilation exhaust air. All dwellings will have openable windows to provide natural purge ventilation.

Table 12: Heating and ventilation specification for the flats and houses

Element	System specification assumed
Heating	Gas boiler to match the notional building, efficiency 89.5%
Domestic Hot Water	Same source as space heating
Ventilation	Whole building mechanical ventilation with heat recovery in line with Passivhaus Principles efficiency>85% and SFP*<1.62 W/l/s

**SFP = Specific Fan Power*

4.2.4 Lighting and Appliances

100% low energy fixed lighting is proposed for use within the dwellings.

4.2.5 Smart Energy and Flexibility

Smart meters and sub metering would ensure data is being monitored and could be used to address the performance gap. The metering strategy will be further developed at the detailed design stage.

The use of smart meters coupled with smart-appliances and equipment could also be considered to provide demand side response. This demand flexibility could reduce energy costs and reduce reliance on the grid during peak times.

4.3 Energy efficiency results summary

The carbon emissions reduction benefit from the energy efficiency measures has been assessed through energy modelling of the sample dwelling typologies following the methodology as set out above.

A 37% reduction is predicted to be achieved against the Building Regulations Part L 2021 baseline for the dwellings, see Table 13.

Table 13: Predicted cumulative CO_2 savings resulting from energy efficiency measures for the dwellings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions saving	% saving
Baseline (Part L 2021)	3,417	-	-
Be Lean: After energy efficiency measures	2,148	1,270	37%

Policy 28 requires all new housing to achieve a 44% reduction in carbon emissions from a Part L 2006 Regulations baseline (equivalent to minimum 19% beyond the Part L 2013 standards). Demonstrating compliance with Part L 2021 would better this. The predicted performance is a significant carbon reduction compared to Part L 2021 of 37%, complying with policy.

A Carbon Reduction Statement setting out the predicted carbon emissions reduction against a Part L baseline will be submitted for housing schemes as part of Reserved Matters Application (RMA) on a plot by plot basis.

Table 14: Predicted cumulative CO_2 savings resulting from energy efficiency measures for the non-domestic buildings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions saving	% saving
Baseline (Part L 2021)	2,264	-	-
Be Lean: After energy efficiency measures	2,264	0	0%

For the non-domestic buildings, the predicted achievement of mandatory energy credits (Ene 01) for a BREEAM Excellent rating will be demonstrated through the BREEAM pre-assessment included within the RMA.

5. Decentralised Energy (Be Clean)

This section assesses opportunities for reducing CO_2 emissions using decentralised energy generation such as connection to district heating networks and the use of combined heat and power (CHP).

5.1 District Heating Served by Gas CHP Engines

Rapid decarbonisation of the electricity grid and the need to substantially reduce the energy demands of new homes means that district heating is becoming a less favourable solution for new low carbon development.

While historically heat networks served by CHP engines were able to displace high carbon electricity from the grid, resulting in substantial carbon savings, rapid decarbonisation of the UK's electricity grid means this is no longer the case.

Falling electricity grid CO_2 emissions factors has significantly reduced the benefits of gas CHP systems, particularly when supplying new development. Analysis by the Department of Business Enterprise and Industrial Strategy (BEIS)[7] confirmed that new gas CHP engines installed after 2025 would have greater lifetime CO_2 emissions than gas boilers. They would also have substantially greater CO_2 emissions than heat pumps.

A heat network served by gas CHP engines would not be expected to be viable or save carbon compared to heat pump solutions that could be delivered on plot.

5.2 Potential for a Heat Network served by Heat Pumps

Unlike CHP engines, the efficiency of heat pumps does not increase significantly with scale compared to their deployment at a plot level. This removes one of the historic benefits of delivering large scale heat networks served by gas CHP engines, which was to increase the scale and hence efficiency of the heat generation plant The cost of generating heat from heat pumps is also higher than the cost of generating heat from gas CHP engines as electricity is a more expensive fuel. This further undermines the economic viability for a heat network serving a low heat density development with heat pumps.

For a heat network served by heat pumps to offer carbon savings against a plot level solution, the centralised heat source would have to have a significantly higher Seasonal Coefficient of Performance (SCoP) than the CoP that could be achieved for heat pumps deployed at a plot level. This is because there will be significant heat loss in the distribution network. In some locations if the heat network allows access to an existing source of waste heat, for example low temperature industrial heat or deep geothermal energy, that increases the efficiency of the heat pump as the source heat is warmer, a heat pump heat network may be beneficial in carbon terms.

Based on existing studies, the Proposed Development is not situated in close vicinity to any existing or planned Heating Network supplied with an external source of low carbon energy.

For these reasons a district heating network served by heat pumps has been discounted.

5.3 Local Communal Heat Networks

Local communal heat networks served by heat pumps can potentially offer a carbon saving benefit if they allow sharing of heat between uses, for example waste heat from refrigeration in a commercial use being recovered for providing hot water to homes. This would be dependent on a suitable balance of loads in relatively close proximity to minimise the cost of connecting infrastructure. For the initial modelling and the outline planning application stage it is assumed that the blocks of flats will have block communal systems in the form of traditional 4th generation systems that include centralised ASHPs on the roofs and a centralised thermal store with distribution to a Hydraulic Interface Unit (HIU) within each dwelling. It is assumed that the distribution losses for the centralised heating network will be minimised through minimising lateral pipe runs, having good levels of

[7] SAP 10.2 – updates for heat networks, covering proposals to natural-gas CHP, the Products Characteristics Database, Biomass and recovered heat factors. BEIS. March 2022.

pipework insulation and flow and return temperatures that are optimised for the end use. The assumed Distribution Loss Factor (DLF) assumed in the SAP modelling is 1.50.

5.4 Conclusions on the potential for heat networks

The University is not intending to connect future phases of the development to the existing District Heating Network (DHN) on site, as a plot by plot approach provides greater flexibility over the 10 to 15 year likely build out period and future-proofing for future technologies. A DHN connection would not be expected to offer carbon savings against centralised heat pump block communal systems.

While the NWC AAP promotes connection to a district heating network (DHN), the proposed approach will deliver greater carbon savings than connection to a DHN which uses fossil fuels and/or incurs distribution losses; it anticipates the use of renewable energy technologies (likely to be heat pumps and solar PV) and it provides flexibility to adopt the most appropriate low carbon technologies given the proposed build out period for the future phases.

6. Renewable Energy (Be Green)

This section assesses opportunities for reducing carbon emissions using renewable energy technologies.

6.1 Air source heat pumps

Air source heat pumps (ASHPs) are considered the most viable renewable energy technology to be used for space heating the Proposed Development, after consideration of ASHPs, Ground Source Heat Pumps and biomass boilers.

For the houses individual ASHPs are proposed connected to a DHW storage cylinder and a wet heating system as they are considered the most viable renewable energy technology.

For the initial modelling and the outline planning application stage it is assumed that the flats will have block-level communal systems in the form of traditional 4th generation systems that include centralised ASHPs on the roofs and a centralised thermal store with distribution to a Hydraulic Interface Unit (HIU) within each dwelling. The distribution flow temperature is typically 45-55°C for 4th generation systems.

Table 15: Heating specification for domestic units

Element	System specification assumed
Heating	Individual ASHP for houses selected from PCDB* database with SCoP** of 3.24-3.38; Communal system (assumed 4th generation) with SCoP of 3 and distribution loss factor (DLF) of 1.5
Heat emitters	Radiators
Domestic Hot Water	Same source as space heating

**PCDB: Product Characteristics Database*[8]

***SCoP; Seasonal Coefficient of Performance*

6.2 Renewable energy generation (photovoltaics)

Solar photovoltaic panels (PV) are considered the most viable renewable energy technology to generate electricity on site, after considering them and wind turbines. There is an aspiration for the roofs to generate as much electricity as possible via PV panels but we have been conservative in the assumptions of available roof area.

6.2.1 Houses

It has been assumed that houses would typically be able to accommodate an area of PV equivalent to up to 30% of their footprint area. As some roofs may not be suitable for PV installation due to overshading by retained trees or adjacent buildings, a conservative suitability factor of 70% was applied to the overall house roof area generated. This is a conservative estimate at this stage and a more detailed assessment should be made based on the more detailed design information as part of RMAs submitted by the developers.

6.2.2 Flats

For the flats, a PV contribution shared evenly among the units within the block based on a panel area equivalent to 30% of the footprint area of the block was assumed. The roof areas for blocks were estimated using the assumption presented in section 3.1 whereby each apartment block is five storeys and contains 8 apartments – four 2-bed and four 1-bed – on each floor, i.e. 40 apartments per block. This is an assumption only and more detail will be available at the RMA stage, by plot.

[8] https://www.ncm-pcdb.org.uk/sap/

6.3 Energy results summary

Table 16 shows the predicted CO_2 emissions and resulting savings after the different steps considered when developing the energy strategy. The results demonstrate that the dwellings are predicted to achieve an 80% reduction over Part L 2021 baseline which is a significant carbon saving.

Table 16: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the dwellings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline	3,417	-	-
Be Lean: After energy efficiency measures	2,148	1,270	37%
Be Clean: After heat network connection	2,148	0.0	0%
Be Green: After renewable energy	695	1,452	42%
Total	**695**	**2,722**	**80%**

The predicted carbon savings for the non-domestic buildings are a much lower percentage because the baseline has been assumed to include heat pumps rather than gas boilers. As the savings are due to the inclusion of the PV panels only, they are estimated to be 9%, see Table 17.

Table 17: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the non-domestic

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline	2,264	-	-
Be Lean: After energy efficiency measures	2,264	0	0%
Be Clean: After heat network connection	2,264	0	0%
Be Green: After renewable energy	2,054	210	9%
Total	2,054	210	**9%**

6.4 Planning policy compliance

In the table above, the renewable energy stage includes the ASHPs and the PVs. The predicted percentage reduction of 42% greatly exceeds South Cambridgeshire Local plan policy CC/2 target of 10% reduction in carbon dioxide emissions from on-site renewable energy generation and low carbon technologies. It also complies fully with Cambridge Local Plan Policy 28 which seeks all developments to minimise carbon emissions and incorporate sustainable design and construction.

In accordance with Policy NW24 of the North West Cambridge Area Action Plan, the residential component of the development is expected to meet the equivalent of Code for Sustainable Homes Level 5. Although the Code has been withdrawn, the proposed development far surpasses the regulated energy targets under CSH Level 5, especially given the more ambitious Building Regulations Part L 2021 baseline.

6.5 Passivhaus Principles

The modelling results for the sample dwellings have been compared to Passivhaus requirements, due to the desire to adopt Passivhaus Principles, in particular reducing the space heating demand through the building fabric performance and airtightness, prior to considering the form of heating provided.

The space heating demand currently estimated through via the SAP 10.2 modelling is 4.8kWh/m². However, it should be noted that the Passivhaus Planning Package (PHPP) software estimates a much higher heating demand in comparison with SAP 10.2 because of significant different assumptions and methodology. Therefore, this value should be further calculated at the detailed RMA Stage using PHPP to ensure adherence with Passivhaus Principles and compliance with the target within PH of space heating demand of less than or equal to 15kWh/m².

7. Overheating Risk Assessment

7.1 Introduction

Recognising that overheating can be a risk in well insulated dwellings, especially those with particular orientations or solar exposure, Approved Document O of the Building Regulations (Part O) applies to new residential buildings and covers the overheating mitigation requirements. The document requires that new developments follow either a simplified or dynamic overheating assessment to demonstrate that designs sufficiently minimise overheating risk. This section addresses the approach that has been taken by the design team, reflecting that the future phases for NWC are still at Outline Planning stage only.

7.2 Overheating Analysis

The Greater Cambridge Local Plan (Regulation 18: Preferred Options 2021) states that the Good Homes Alliance (GHA) checklist[9] is a useful tool for identifying and mitigating overheating risks; it also recommends that thermal modelling such as a CIBSE TM59 assessment[10] is used to understand the performance of a new development.

At this outline stage, the design of the residential development is not progressed sufficiently to enable either the use of the simplified method or a dynamic thermal modelling assessment to provide a useful evaluation of North West Cambridge overheating risk.

At the RMA stage, a Part O compliant assessment would be undertaken for an appropriate sample of homes to inform the designs and it would be reported in the Energy and Carbon Reduction Statement. This will ensure that all homes are designed to mitigate the risk of overheating with passive measures in line with Cambridge cooling hierarchy, where possible.

To ensure the risk of overheating is minimised at the masterplan stage, the GHA Early Stage Overheating Risk Tool was completed by AECOM. The aim was to evaluate potential overheating scenarios and to inform subsequent discussions with the design team and client.

7.2.1 GHA Early-Stage Overheating Risk Tool Scenarios

Two dwelling scenarios were modelled as best case (dual aspect) and worst case (single aspect) using the GHA tool to assess overheating risks:

1. Scenario 1 – Dual Aspect Flat:
    - Maximisation of passive overheating mitigation measures, assuming night-time window opening is not feasible due to acoustic constraints.
    - GHA overheating risk score: **11**.
2. Scenario 2 – Single Aspect Flat:
    - Minimal passive overheating mitigation measures with night-time window opening also not feasible.
    - GHA overheating risk score: **24**.

For context, a score below **8** would indicate a low overheating risk and no requirement for dynamic thermal modelling (DTM) at subsequent stages. Both scenarios exceeded this threshold, highlighting the need for further detailed modelling and mitigation measures.

An additional scenario was also assessed (Scenario 3) of a dual aspect flat with full window operability. This significantly reduces the overheating risk score to **3**, demonstrating the substantial benefit of effective passive ventilation where acoustically viable.

[9] Available from: https://goodhomes.org.uk/wp-content/uploads/2019/07/GHA-Overheating-in-New-Homes-Tool-and-Guidance-Tool-only.pdf
[10] CIBSE. TM59 design methodology for the assessment of overheating risk in homes (May 2017).

It is important to note that the GHA Overheating Risk Tool is a simplified tool to identify a development's risk profile at the early design stage and to recommend appropriate next steps to reduce the risk of overheating during detailed design. The tool is not intended to determine whether mitigation measures will be sufficient to reduce overheating risk. A Part O compliant assessment should be undertaken at RMA stage to ensure that appropriate mitigation measures are incorporated to reduce the risk of overheating and to show compliance with Approved Document O.

7.3 Cooling Strategy

To support future design development, a high-level overheating mitigation strategy/cooling strategy has been developed for the North West Cambridge development which addresses the cooling hierarchy. The following measures should be considered to reduce the risk of overheating within the dwellings and to limit the need for active cooling in domestic and non-domestic buildings. The cooling strategy should be further developed as the designs progress and the approach set out in RMAs.

The guidance points below will be explored further during the detailed design stage.

Passive Design

- The amount of heat entering a building will be reduced, as much as possible, through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure.
- The residential units should aspire to achieving a glazing ratio of less than 35% (as a proportion of the façade) to minimise risk of overheating while allowing optimum levels of daylighting.
- High efficiency fabric should be specified to limit solar gains in the summer and mitigate overheating risk.
- Where possible, window details should be designed to maximise local shading using deep reveals; shading from balconies and from surrounding buildings should also be utilised, where possible.
- Solar control glazing with a low g-value should be explored and, where appropriate, specified.
- Internal heat generation should be minimised through energy efficient design, to include low energy lighting and high efficiency mechanical plant.
- The dwellings should aim to benefit from a high floor to slab height to encourage mixing of air, where possible.

Passive/Natural Cooling

- Passive ventilation should be provided, where possible, subject to noise, air quality, security and health and safety requirements being met.

Mixed Mode Cooling

- If a passive ventilation strategy cannot provide adequate ventilation in dwellings, the use of MVHR systems with summer bypass, will be considered.

Mechanical Ventilation / Cooling System

- The introduction of cooling trim units integrated with MVHR systems or reversible heat pumps for acoustically constrained units will be needed where window opening is not viable.

7.4 Future Climate Risks

The design team acknowledge that overheating risks would increase under future climate scenarios, particularly due to anticipated rises in summertime temperatures. Future modelling at the Reserved Matters Application (RMA) stage could potentially use updated climate files (2050 Prometheus weather data for Cambridge) and align with upcoming revisions of CIBSE TM59 which is expected to be released prior to RMA planning submissions.

8. Conclusions

The energy strategy for the Proposed Development follows the policy guidance and proposes passive design and efficiency measures to reduce the space heating and domestic hot water demands, before meeting the designs with low/zero carbon heating systems and also generating renewable electricity on site.

A plot by plot approach to space heating is proposed. For the initial modelling to inform the outline planning application it is assumed that the flats will be supplied via block-level communal systems in the form of traditional 4th generation system that includes centralised ASHPs on the roofs and a centralised thermal store with distribution to a HIU within each dwelling. For the houses individual ASHPs are proposed, connected to a DHW storage cylinder and a wet heating system. Roof-level PV will be maximised to generate electricity for use within the development.

Table 18 demonstrates that the development is predicted to achieve an 80% carbon reduction over Part L 2021 for the domestic element, based on the assumed specification, heating strategy and extent of PV.

Table 19 demonstrates that the non-domestic element is predicted to deliver a 9% carbon emissions saving over Part L 2021.

The energy strategy has been estimated to achieve a reduction of 2,932 tonnes CO2 per annum (52%) in regulated carbon emissions across the Proposed Development (dwellings and non-domestic buildings) when compared to a Part L 2021 Building Regulations compliant development. The Site-wide results are shown in Table 20.

Table 18: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the dwellings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	3,417	-	-
Be Lean: After energy efficiency measures	2,148	1,270	37%
Be Clean: After heat network connection (no connection)	2,148	0.0	0%
Be Green: After renewable energy	695	1,452	42%
Total	**695**	**2,722**	**80%**

Table 19: Predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies for the non-domestic

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	2,264	-	-
Be Lean: After energy efficiency measures	2,264	0	0%
Be Clean: After heat network connection (no connection)	2,264	0	0%
Be Green: After renewable energy	2,054	210	9%
Total	**2,054**	**210**	**9%**

Table 20: Site-Wide predicted cumulative CO_2 savings resulting from energy efficiency and renewable energy technologies

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 emissions savings (tCO_2/yr)	% saving
Baseline (Part L 2021 compliance)	5,681	-	-
Be Lean: After energy efficiency measures	4,411	1,270	22%
Be Clean: After heat network connection (no connection)	4,411	0	0%
Be Green: After renewable energy	2,749	1,662	29%
Total	**2,749**	**2,932**	**52%**

Appendix A Sample SAP DER/TER Worksheet for an indicative single dwelling

Full SAP Calculation Printout

Property Reference	1B ground floor flat Be Lean	**Issued on Date**	22/05/2025
Assessment Reference	1B2P	**Prop Type Ref**	1b2p
Property			

SAP Rating	86 B	**DER**	10.81	**TER**	15.81
Environmental	92 A	**% DER < TER**			31.63
CO_2 Emissions (t/year)	0.53	**DFEE**	24.10	**TFEE**	36.75
Compliance Check	See BREL	**% DFEE < TFEE**			34.43
% DPER < TPER	26.57	**DPER**	62.23	**TPER**	84.75

Assessor Details	Mr. Christopher Popa	**Assessor ID**	EH58-0001
Client			

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

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1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Main dwelling							
Ground floor		51.0000	(1b)	x 2.5000	(2b) =	127.5000	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	51.0000						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	127.5000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.0000	(17)
Infiltration rate		0.0500	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0388	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.0494	0.0484	0.0475	0.0426	0.0417	0.0368	0.0368	0.0358	0.0388	0.0417	0.0436	0.0455	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	82.8000 (23c)

Effective ac	0.1354	0.1344	0.1335	0.1286	0.1277	0.1228	0.1228	0.1218	0.1248	0.1277	0.1296	0.1315	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Main dwelling								
Marlowe Road Windows			9.7800	0.8221	8.0397			(27)
Marlowe Road Door			2.4500	0.8500	2.0825			(26)
External Wall 1 (E)	19.6500	9.7800	9.8700	0.1800	1.7766			(29a)
Sheltered Wall 2 (W)	19.6500	2.4500	17.2000	0.1700	2.9240			(29a)
Sheltered Wall 3 (N)	19.1800		19.1800	0.1700	3.2606			(29a)
Total net area of external elements Aum(A, m2)			58.4800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		18.0834			(33)
Main dwelling								
Party Wall 1 (S)			19.1800	0.0000	0.0000			(32)
Party Floor 1			50.2000					(32d)
Party Ceiling 1			45.1100					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (User defined value 0.060 * total exposed area)	3.5088	(36)
Point Thermal bridges (36a) =	0.0000	

Total fabric heat loss (33) + (36) + (36a) = 21.5922 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	5.6972	5.6565	5.6157	5.4119	5.3711	5.1673	5.1673	5.1266	5.2489	5.3711	5.4527	5.5342	(38)
Heat transfer coeff	27.2894	27.2486	27.2078	27.0040	26.9633	26.7595	26.7595	26.7187	26.8410	26.9633	27.0448	27.1263	(39)
Average = Sum(39)m / 12 =												26.9939	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.5351	0.5343	0.5335	0.5295	0.5287	0.5247	0.5247	0.5239	0.5263	0.5287	0.5303	0.5319	(40)
HLP (average)												0.5293	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.7196 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	61.1133	60.2056	58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	(42b)
Hot water usage for other uses	32.2401	31.0678	29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	(42c)
Average daily hot water use (litres/day)												85.9708	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	93.3534	91.2734	88.8229	85.2939	82.3570	79.2279	78.1710	80.6126	83.1668	86.4329	90.0104	93.1468	(44)
Energy conte	147.8489	129.9721	136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886	128.2364	145.8454	(45)
Energy content (annual)										Total = Sum(45)m =		1427.6696	
Distribution loss (46)m = 0.15 x (45)m	22.1773	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)
Water storage loss:													
Store volume												110.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0152	(51)
Volume factor from Table 2a												1.0294	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.0327	(55)
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(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	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(64)
										Total per year (kWh/year) = Sum(64)m =		2078.5094	(64)
12Total per year (kWh/year)												2079	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	93.3812	83.1577	89.6135	81.6187	81.0852	75.1871	75.6564	77.4100	76.8938	83.2199	85.4335	92.7150	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	78.1291	86.5001	78.1291	80.7334	78.1291	80.7334	78.1291	78.1291	80.7334	78.1291	80.7334	78.1291	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	149.8308	151.3856	147.4676	139.1267	128.5978	118.7021	112.0911	110.5364	114.4543	122.7953	133.3242	143.2199	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	(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)	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	(71)
Water heating gains (Table 5)	125.5124	123.7465	120.4483	113.3593	108.9854	104.4265	101.6886	104.0457	106.7970	111.8547	118.6577	124.6170	(72)
Total internal gains	402.2659	410.4258	394.8385	382.0129	364.5058	352.6555	340.7024	341.5047	350.7783	361.5726	381.5088	394.7595	(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	
East	9.7800	19.6403	0.4000	0.7000	0.7700	37.2715	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	37.2715	72.9111	120.0741	175.1209	214.6173	219.6990	209.1624	179.6674	139.6512	86.5151	46.4732	30.6503	(83)
Total gains	439.5374	483.3368	514.9127	557.1339	579.1231	572.3545	549.8648	521.1721	490.4295	448.0878	427.9821	425.4098	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	129.7819	129.9761	130.1708	131.1532	131.3514	132.3518	132.3518	132.5537	131.9498	131.3514	130.9555	130.5620

alpha	9.6521	9.6651	9.6781	9.7435	9.7568	9.8235	9.8235	9.8369	9.7967	9.7568	9.7304	9.7041	
util living area	0.9216	0.8566	0.7517	0.5851	0.4329	0.2992	0.2141	0.2358	0.3776	0.6234	0.8381	0.9346	(86)
MIT	20.8801	20.9416	20.9824	20.9982	20.9999	21.0000	21.0000	21.0000	21.0000	20.9974	20.9592	20.8623	(87)
Th 2	20.4888	20.4895	20.4902	20.4939	20.4946	20.4982	20.4982	20.4990	20.4968	20.4946	20.4931	20.4917	(88)
util rest of house	0.9084	0.8380	0.7285	0.5611	0.4094	0.2758	0.1897	0.2101	0.3501	0.5939	0.8155	0.9229	(89)
MIT 2	20.3597	20.4295	20.4734	20.4924	20.4945	20.4982	20.4982	20.4990	20.4968	20.4925	20.4531	20.3418	(90)
Living area fraction										fLA = Living area / (4) =		0.7239	(91)
MIT	20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	20.7186	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	20.7186	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9150	0.8495	0.7446	0.5784	0.4264	0.2927	0.2074	0.2287	0.3700	0.6151	0.8303	0.9283	(94)
Useful gains	402.1930	410.6080	383.4041	322.2595	246.9593	167.5532	114.0349	119.2103	181.4668	275.6287	355.3422	394.9110	(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	448.5406	433.2595	390.2110	322.9297	246.9940	167.5539	114.0349	119.2104	181.4736	276.5900	371.0401	448.0884	(97)
Space heating kWh	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98a)
Space heating requirement - total per year (kWh/year)												106.8588	
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	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												106.8588	
Space heating per m2											(98c) / (4) =	2.0953	(99)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(301)
Fraction of space heat from community system												1.0000	(302)
Fraction of heat from community Boilers-Space and Water												1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating												1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating												1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system												1.0000	(306)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating:													
Space heating requirement	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98)
Space heat from Boilers = (98) x 1.00 x 1.00 x 1.00													
307a	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	
Space heating requirement	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)
Water heating													
Annual water heating requirement	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(64)
Water heat from Boilers = (64) x 1.00 x 1.00 x 1.00													
310a	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	
Water heating fuel	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(310)
Cooling System Energy Efficiency Ratio												0.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	9.4129	8.5020	9.4129	9.1093	9.4129	9.1093	9.4129	9.4129	9.1093	9.4129	9.1093	9.4129	(331)
Lighting	17.2533	13.8413	12.4625	9.1306	7.0527	5.7621	6.4337	8.3628	10.8625	14.2521	16.0977	17.7328	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Annual totals kWh/year													
Space heating fuel - community heating												106.8588	(307)
Space heating fuel - secondary												0.0000	(309)
Water heating fuel - community heating												2078.5094	(310)
Efficiency of water heater												0.0000	(311)
Electricity used for heat distribution												1.0686	(313)
Space cooling fuel												0.0000	(321)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)													
mechanical ventilation fans (SFP = 0.7125)												110.8294	(330a)
Total electricity for the above, kWh/year												110.8294	(331)
Electricity for lighting (calculated in Appendix L)												139.2442	(332)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												0.0000	(333)
Wind generation												0.0000	(334)
Hydro-electric generation (Appendix N)												0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)												0.0000	(335)
Appendix Q - special features													
Energy saved or generated												-0.0000	(336)
Energy used												0.0000	(337)
Total delivered energy for all uses												2435.4418	(338)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Boilers			89.5000	(367)
Space and Water heating from Boilers	2441.7521	0.2100	25.0730	(367)
Electrical energy for heat distribution (space & water)	1.0686	0.0000	3.0951	(372)
Overall CO2 factor for heat network			0.2361	(386)
Total CO2 associated with community systems			515.8631	(373)
Space and water heating			515.8631	(376)
Pumps, fans and electric keep-hot	110.8294	0.1387	15.3734	(378)
Energy for lighting	139.2442	0.1443	20.0972	(379)
Total CO2, kg/year			551.3337	(383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			10.8100	(384)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Boilers			89.5000	(467a)
Space and Water heating from Boilers	2441.7521	1.1300	134.9166	(467)
Electrical energy for heat distribution (space & water)	1.0686	0.0000	33.2986	(472)
Overall CO2 factor for heat network			1.2778	(486)
Total CO2 associated with community systems			2792.4786	(473)
Space and water heating			2792.4786	(476)
Pumps, fans and electric keep-hot	110.8294	1.5128	167.6627	(478)
Energy for lighting	139.2442	1.5338	213.5774	(479)
Total Primary energy kWh/year			3173.7187	(483)
Dwelling Primary energy Rate (DPER)			62.2300	(484)

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

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1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Main dwelling							
Ground floor		51.0000	(1b) x	2.5000	(2b) =	127.5000	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	51.0000						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	127.5000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	2 * 10 =	20.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1569	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4069	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3153	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4020	0.3941	0.3863	0.3469	0.3390	0.2996	0.2996	0.2917	0.3153	0.3390	0.3547	0.3705	(22b)
Effective ac	0.5808	0.5777	0.5746	0.5602	0.5574	0.5449	0.5449	0.5425	0.5497	0.5574	0.5629	0.5686	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Main dwelling								
TER Opaque door			2.4500	1.0000	2.4500			(26)
TER Opening Type			9.7800	1.1450	11.1985			(27)
External Wall 1 (E)	19.6500	9.7800	9.8700	0.1800	1.7766			(29a)
Sheltered Wall 2 (W)	19.6500	2.4500	17.2000	0.1800	3.0960			(29a)
Sheltered Wall 3 (N)	19.1800		19.1800	0.1800	3.4524			(29a)
Total net area of external elements Aum(A, m2)			58.4800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		21.9735			(33)
Main dwelling								
Party Wall 1 (S)			19.1800	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K			250.0000 (35)
List of Thermal Bridges			
K1 Element	Length	Psi-value	Total

E2 Other lintels (including other steel lintels)	6.9300	0.0500	0.3465	
E3 Sill	5.9100	0.0500	0.2955	
E4 Jamb	18.0000	0.0500	0.9000	
E20 Exposed floor (normal)	14.3500	0.3200	4.5920	
E7 Party floor between dwellings (in blocks of flats)	14.3500	0.0700	1.0045	
E18 Party wall between dwellings	8.2200	0.0600	0.4932	
E25 Staggered party wall between dwellings	2.7400	0.0600	0.1644	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	14.0000	0.0000	0.0000	
P7 Party Wall - Exposed floor (normal)	7.0000	0.1600	1.1200	
P8 Party Wall - Exposed floor (inverted)	7.0000	0.2400	1.6800	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 10.5961 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 32.5696 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	24.4378	24.3057	24.1763	23.5684	23.4547	22.9252	22.9252	22.8272	23.1292	23.4547	23.6848	23.9253	(38)
Heat transfer coeff	57.0073	56.8753	56.7459	56.1380	56.0243	55.4948	55.4948	55.3968	55.6987	56.0243	56.2543	56.4949	(39)
Average = Sum(39)m / 12 =												56.1375	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1178	1.1152	1.1127	1.1007	1.0985	1.0881	1.0881	1.0862	1.0921	1.0985	1.1030	1.1077	(40)
HLP (average)												1.1007	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.7196 (42)
Hot water usage for mixer showers

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)

Hot water usage for baths

61.1133	60.2056	58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	(42b)

Hot water usage for other uses

32.2401	31.0678	29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	(42c)

Average daily hot water use (litres/day) 85.9708 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	93.3534	91.2734	88.8229	85.2939	82.3570	79.2279	78.1710	80.6126	83.1668	86.4329	90.0104	93.1468	(44)
Energy conte	147.8489	129.9721	136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886	128.2364	145.8454	(45)
Energy content (annual)											Total = Sum(45)m =	1427.6696	
Distribution loss (46)m = 0.15 x (45)m	22.1773	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)

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

23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)

If cylinder contains dedicated solar storage

23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss 23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Total heat required for water heating calculated for each month

194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(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													
194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(64)
									Total per year (kWh/year) = Sum(64)m =		1976.2870	(64)
12Total per year (kWh/year)												1976	(64)

Electric shower(s)

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

Heat gains from water heating, kWh/month

86.4357	76.8843	82.6680	74.8972	74.1396	68.4656	68.7108	70.4645	70.1724	76.2744	78.7121	85.7695	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	76.4805	84.6748	76.4805	79.0298	76.4805	79.0298	76.4805	76.4805	79.0298	76.4805	79.0298	76.4805	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	149.8308	151.3856	147.4676	139.1267	128.5978	118.7021	112.0911	110.5364	114.4543	122.7953	133.3242	143.2199	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	(69)
Pumps, fans 3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	(71)
Water heating gains (Table 5)	116.1770	114.4112	111.1129	104.0239	99.6500	95.0911	92.3533	94.7103	97.4616	102.5193	109.3223	115.2816	(72)
Total internal gains	394.2818	402.2651	386.8545	373.9739	356.5218	341.6166	329.7184	330.5207	339.7393	353.5886	373.4698	386.7755	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	9.7800	19.6403	0.6300	0.7000	0.7700	58.7027	(76)

Solar gains 58.7027	114.8349	189.1167	275.8155	338.0222	346.0259	329.4308	282.9762	219.9506	136.2613	73.1954	48.2742	(83)
Total gains 452.9845	517.1000	575.9713	649.7894	694.5441	687.6425	659.1492	613.4969	559.6899	489.8499	446.6652	435.0497	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.1265	62.2707	62.4127	63.0886	63.2167	63.8198	63.8198	63.9327	63.5861	63.2167	62.9581	62.6900	
alpha	5.1418	5.1514	5.1608	5.2059	5.2144	5.2547	5.2547	5.2622	5.2391	5.2144	5.1972	5.1793	
util living area	0.9884	0.9764	0.9464	0.8569	0.6999	0.5086	0.3692	0.4130	0.6535	0.9023	0.9759	0.9904	(86)
MIT	19.9337	20.1310	20.4123	20.7402	20.9259	20.9885	20.9982	20.9969	20.9605	20.7016	20.2664	19.9023	(87)
Th 2	20.4411	20.4424	20.4437	20.4496	20.4507	20.4559	20.4559	20.4569	20.4539	20.4507	20.4485	20.4461	(88)
util rest of house	0.9866	0.9728	0.9385	0.8379	0.6677	0.4677	0.3240	0.3651	0.6100	0.8847	0.9716	0.9889	(89)
MIT 2	19.4405	19.6366	19.9131	20.2293	20.3945	20.4488	20.4551	20.4554	20.4274	20.1993	19.7766	19.4133	(90)
Living area fraction										fLA = Living area / (4) =		0.7239	(91)
MIT	19.7976	19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312	19.7673	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7976	19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312	19.7673	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9840	0.9695	0.9358	0.8433	0.6872	0.4967	0.3566	0.3996	0.6389	0.8885	0.9688	0.9866	(94)
Useful gains	445.7500	501.3030	538.9876	547.9740	477.3024	341.5206	235.0742	245.1539	357.6059	435.2366	432.7263	429.2350	(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	883.4748	858.5045	781.6456	656.7681	508.6551	346.2584	235.7575	246.3701	373.9240	558.1629	733.0601	879.4703	(97)
Space heating kWh	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98a)
Space heating requirement - total per year (kWh/year)												1490.5750	
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	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1490.5750	
Space heating per m2											(98c) / (4) =	29.2270	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 92.3000 (206)

Efficiency of main space heating system 2 (in %) 0.0000 (207)

Efficiency of secondary/supplementary heating system, % 0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)	352.8356	260.0644	195.5987	84.8665	25.2724	0.0000	0.0000	0.0000	0.0000	99.0869	234.2799	362.9199	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.2074	84.8066	84.0280	82.5278	80.8574	79.8000	79.8000	79.8000	79.8000	82.8060	84.5570	85.2902	(217)
Fuel for water heating, kWh/month	228.2008	202.8826	217.9183	196.1217	194.7419	178.5862	176.8621	183.4713	185.0186	197.9126	204.9839	225.6300	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	15.8911	12.7485	11.4786	8.4097	6.4959	5.3072	5.9258	7.7025	10.0048	13.1269	14.8268	16.3328	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-11.4110	-17.1730	-26.3354	-31.6653	-35.9911	-34.2931	-33.8929	-31.0795	-26.4446	-20.5310	-12.9298	-9.7441	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-3.5238	-7.6237	-15.5498	-23.9454	-32.2402	-32.5917	-32.1918	-26.9767	-19.4206	-11.0755	-4.7606	-2.7700	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1 1614.9242 (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 2392.3301 (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) 128.2505 (232)

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

PV generation	-504.1606	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3717.3443	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1614.9242	0.2100	339.1341	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2392.3301	0.2100	502.3893	(264)
Space and water heating			841.5234	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	128.2505	0.1443	18.5105	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-291.4908	0.1332	-38.8333	
PV Unit electricity exported	-212.6698	0.1252	-26.6231	
Total			-65.4564	(269)
Total CO2, kg/year			806.5068	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			15.8100	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1614.9242	1.1300	1824.8644	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2392.3301	1.1300	2703.3330	(278)
Space and water heating			4528.1974	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	128.2505	1.5338	196.7149	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-291.4908	1.4923	-434.9893	
PV Unit electricity exported	-212.6698	0.4595	-97.7181	
Total			-532.7074	(283)
Total Primary energy kWh/year			4322.3056	(286)
Target Primary Energy Rate (TPER)			84.7500	(287)

Full SAP Calculation Printout

Property Reference	1B ground floor flat	**Issued on Date**	22/05/2025
Assessment Reference	1B2P	**Prop Type Ref**	1b2p
Property			

SAP Rating	86 B	**DER**	3.04	**TER**	15.81
Environmental	98 A	**% DER < TER**			80.77
CO_2 Emissions (t/year)	0.15	**DFEE**	24.10	**TFEE**	36.75
Compliance Check	See BREL	**% DFEE < TFEE**			34.43
% DPER < TPER	61.80	**DPER**	32.38	**TPER**	84.75

Assessor Details	Mr. Christopher Popa	**Assessor ID**	EH58-0001
Client			

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

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1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Main dwelling							
Ground floor		51.0000	(1b)	x 2.5000	(2b) =	127.5000	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	51.0000						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	127.5000	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	0 * 10 =	0.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		1.0000	(17)
Infiltration rate		0.0500	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.0388	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.0494	0.0484	0.0475	0.0426	0.0417	0.0368	0.0368	0.0358	0.0388	0.0417	0.0436	0.0455	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	82.8000 (23c)

Effective ac	0.1354	0.1344	0.1335	0.1286	0.1277	0.1228	0.1228	0.1218	0.1248	0.1277	0.1296	0.1315	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Main dwelling								
Marlowe Road Windows			9.7800	0.8221	8.0397			(27)
Marlowe Road Door			2.4500	0.8500	2.0825			(26)
External Wall 1 (E)	19.6500	9.7800	9.8700	0.1800	1.7766			(29a)
Sheltered Wall 2 (W)	19.6500	2.4500	17.2000	0.1700	2.9240			(29a)
Sheltered Wall 3 (N)	19.1800		19.1800	0.1700	3.2606			(29a)
Total net area of external elements Aum(A, m2)			58.4800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		18.0834			(33)
Main dwelling								
Party Wall 1 (S)			19.1800	0.0000	0.0000			(32)
Party Floor 1			50.2000					(32d)
Party Ceiling 1			45.1100					(32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000	(35)
Thermal bridges (User defined value 0.060 * total exposed area)	3.5088	(36)
Point Thermal bridges (36a) =	0.0000	

Total fabric heat loss (33) + (36) + (36a) = 21.5922 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	5.6972	5.6565	5.6157	5.4119	5.3711	5.1673	5.1673	5.1266	5.2489	5.3711	5.4527	5.5342	(38)
Heat transfer coeff	27.2894	27.2486	27.2078	27.0040	26.9633	26.7595	26.7595	26.7187	26.8410	26.9633	27.0448	27.1263	(39)
Average = Sum(39)m / 12 =												26.9939	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.5351	0.5343	0.5335	0.5295	0.5287	0.5247	0.5247	0.5239	0.5263	0.5287	0.5303	0.5319	(40)
HLP (average)												0.5293	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.7196 (42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	61.1133	60.2056	58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	(42b)
Hot water usage for other uses	32.2401	31.0678	29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	(42c)
Average daily hot water use (litres/day)												85.9708	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	93.3534	91.2734	88.8229	85.2939	82.3570	79.2279	78.1710	80.6126	83.1668	86.4329	90.0104	93.1468	(44)
Energy conte	147.8489	129.9721	136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886	128.2364	145.8454	(45)
Energy content (annual)										Total = Sum(45)m =		1427.6696	
Distribution loss (46)m = 0.15 x (45)m	22.1773	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)
Water storage loss:													
Store volume												110.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0152	(51)
Volume factor from Table 2a												1.0294	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.0327	(55)
Total storage loss	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(56)
If cylinder contains dedicated solar storage	32.0144	28.9162	32.0144	30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(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	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(64)
										Total per year (kWh/year) = Sum(64)m =		2078.5094	(64)
12Total per year (kWh/year)												2079	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	93.3812	83.1577	89.6135	81.6187	81.0852	75.1871	75.6564	77.4100	76.8938	83.2199	85.4335	92.7150	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	78.1291	86.5001	78.1291	80.7334	78.1291	80.7334	78.1291	78.1291	80.7334	78.1291	80.7334	78.1291	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	149.8308	151.3856	147.4676	139.1267	128.5978	118.7021	112.0911	110.5364	114.4543	122.7953	133.3242	143.2199	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	(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)	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	(71)
Water heating gains (Table 5)	125.5124	123.7465	120.4483	113.3593	108.9854	104.4265	101.6886	104.0457	106.7970	111.8547	118.6577	124.6170	(72)
Total internal gains	402.2659	410.4258	394.8385	382.0129	364.5058	352.6555	340.7024	341.5047	350.7783	361.5726	381.5088	394.7595	(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	
East	9.7800	19.6403	0.4000	0.7000	0.7700	37.2715	(76)

Solar gains	37.2715	72.9111	120.0741	175.1209	214.6173	219.6990	209.1624	179.6674	139.6512	86.5151	46.4732	30.6503	(83)
Total gains	439.5374	483.3368	514.9127	557.1339	579.1231	572.3545	549.8648	521.1721	490.4295	448.0878	427.9821	425.4098	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	129.7819	129.9761	130.1708	131.1532	131.3514	132.3518	132.3518	132.5537	131.9498	131.3514	130.9555	130.5620

alpha	9.6521	9.6651	9.6781	9.7435	9.7568	9.8235	9.8235	9.8369	9.7967	9.7568	9.7304	9.7041	
util living area	0.9216	0.8566	0.7517	0.5851	0.4329	0.2992	0.2141	0.2358	0.3776	0.6234	0.8381	0.9346	(86)
MIT	20.8801	20.9416	20.9824	20.9982	20.9999	21.0000	21.0000	21.0000	21.0000	20.9974	20.9592	20.8623	(87)
Th 2	20.4888	20.4895	20.4902	20.4939	20.4946	20.4982	20.4982	20.4990	20.4968	20.4946	20.4931	20.4917	(88)
util rest of house	0.9084	0.8380	0.7285	0.5611	0.4094	0.2758	0.1897	0.2101	0.3501	0.5939	0.8155	0.9229	(89)
MIT 2	20.3597	20.4295	20.4734	20.4924	20.4945	20.4982	20.4982	20.4990	20.4968	20.4925	20.4531	20.3418	(90)
Living area fraction										fLA = Living area / (4) =		0.7239	(91)
MIT	20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	20.7186	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	20.7186	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9150	0.8495	0.7446	0.5784	0.4264	0.2927	0.2074	0.2287	0.3700	0.6151	0.8303	0.9283	(94)
Useful gains	402.1930	410.6080	383.4041	322.2595	246.9593	167.5532	114.0349	119.2103	181.4668	275.6287	355.3422	394.9110	(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	448.5406	433.2595	390.2110	322.9297	246.9940	167.5539	114.0349	119.2104	181.4736	276.5900	371.0401	448.0884	(97)
Space heating kWh	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98a)
Space heating requirement - total per year (kWh/year)												106.8588	
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	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												106.8588	
Space heating per m2											(98c) / (4) =	2.0953	(99)

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(301)
Fraction of space heat from community system												1.0000	(302)
Fraction of heat from community Heat pump-Space and Water												1.0000	(303a)
Factor for control and charging method (Table 4c(3)) for space heating												1.0000	(305)
Factor for charging method (Table 4c(3)) for water heating												1.0000	(305a)
Distribution loss factor (Table 12c) for community heating system												1.5000	(306)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating:													
Space heating requirement	34.4826	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98)
Space heat from Heat pump = (98) x 1.00 x 1.00 x 1.50													
307a	51.7239	22.8327	7.5966	0.7238	0.0387	0.0000	0.0000	0.0000	0.0000	1.0728	16.9537	59.3459	
Space heating requirement	51.7239	22.8327	7.5966	0.7238	0.0387	0.0000	0.0000	0.0000	0.0000	1.0728	16.9537	59.3459	(307)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)												0.0000	(308)
Space heating fuel for secondary/supplementary system	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)
Water heating													
Annual water heating requirement	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(64)
Water heat from Heat pump = (64) x 1.00 x 1.00 x 1.50													
310a	304.6886	269.8493	287.6915	255.3852	249.2176	226.3705	224.7268	232.6380	234.0701	258.8482	272.5950	301.6832	
Water heating fuel	304.6886	269.8493	287.6915	255.3852	249.2176	226.3705	224.7268	232.6380	234.0701	258.8482	272.5950	301.6832	(310)
Cooling System Energy Efficiency Ratio												0.0000	(314)
Space coolin	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(315)
Pumps and Fa	9.4129	8.5020	9.4129	9.1093	9.4129	9.1093	9.4129	9.4129	9.1093	9.4129	9.1093	9.4129	(331)
Lighting	17.2533	13.8413	12.4625	9.1306	7.0527	5.7621	6.4337	8.3628	10.8625	14.2521	16.0977	17.7328	(332)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333a)m	-11.4974	-17.3811	-26.8254	-32.4612	-37.0484	-35.3656	-34.9354	-31.9409	-27.0282	-20.8422	-13.0490	-9.8067	(333a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
Electricity generated by PVs (Appendix M) (negative quantity)													
(333b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(334b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(335b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Annual totals kWh/year													
Space heating fuel - community heating												160.2881	(307)
Space heating fuel - secondary												0.0000	(309)
Water heating fuel - community heating												3117.7641	(310)
Efficiency of water heater												0.0000	(311)
Electricity used for heat distribution												1.6029	(313)
Space cooling fuel												0.0000	(321)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)													
mechanical ventilation fans (SFP = 0.7125)												110.8294	(330a)
Total electricity for the above, kWh/year												110.8294	(331)
Electricity for lighting (calculated in Appendix L)												139.2442	(332)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-298.1815	(333)
Wind generation												0.0000	(334)
Hydro-electric generation (Appendix N)												0.0000	(335a)
Electricity generated - Micro CHP (Appendix N)												0.0000	(335)
Appendix Q - special features													
Energy saved or generated												-0.0000	(336)
Energy used												0.0000	(337)
Total delivered energy for all uses												3229.9443	(338)

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Efficiency of heat source Heat pump			300.0000	(367)
Space and Water heating from Heat pump	1092.6841	0.1606	8.5781	(367)
Electrical energy for heat distribution (space & water)	1.6029	0.0000	4.6427	(372)
Overall CO2 factor for heat network			0.0486	(386)
Total CO2 associated with community systems			159.3990	(373)
Space and water heating			159.3990	(376)
Pumps, fans and electric keep-hot	110.8294	0.1387	15.3734	(378)
Energy for lighting	139.2442	0.1443	20.0972	(379)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-298.1815	0.1331	-39.6916	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-39.6916	(380)
Total CO2, kg/year			155.1780	(383)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			3.0400	(384)

13b. Primary energy - Community heating scheme

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Efficiency of heat source Heat pump			300.0000	(467a)
Space and Water heating from Heat pump	1092.6841	1.5942	85.1763	(467)
Electrical energy for heat distribution (space & water)	1.6029	0.0000	49.9480	(472)
Overall CO2 factor for heat network			0.5231	(486)
Total CO2 associated with community systems			1714.8802	(473)
Space and water heating			1714.8802	(476)
Pumps, fans and electric keep-hot	110.8294	1.5128	167.6627	(478)
Energy for lighting	139.2442	1.5338	213.5774	(479)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-298.1815	1.4919	-444.8499	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-444.8499	(480)
Total Primary energy kWh/year			1651.2704	(483)
Dwelling Primary energy Rate (DPER)			32.3800	(484)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Main dwelling						
Ground floor	51.0000	(1b)	x 2.5000	(2b) =	127.5000	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	51.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	127.5000	(5)

2. Ventilation rate

	m3 per hour		
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	2 * 10 =	20.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1569	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4069	(18)
Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7750	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3153	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4020	0.3941	0.3863	0.3469	0.3390	0.2996	0.2996	0.2917	0.3153	0.3390	0.3547	0.3705	(22b)
Effective ac	0.5808	0.5777	0.5746	0.5602	0.5574	0.5449	0.5449	0.5425	0.5497	0.5574	0.5629	0.5686	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Main dwelling								
TER Opaque door			2.4500	1.0000	2.4500			(26)
TER Opening Type			9.7800	1.1450	11.1985			(27)
External Wall 1 (E)	19.6500	9.7800	9.8700	0.1800	1.7766			(29a)

Sheltered Wall 2 (W)	19.6500	2.4500	17.2000	0.1800	3.0960	(29a)
Sheltered Wall 3 (N)	19.1800		19.1800	0.1800	3.4524	(29a)
Total net area of external elements Aum(A, m2)			58.4800			(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		21.9735	(33)
Main dwelling						
Party Wall 1 (S)			19.1800	0.0000	0.0000	(32)

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

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	6.9300	0.0500	0.3465
E3 Sill	5.9100	0.0500	0.2955
E4 Jamb	18.0000	0.0500	0.9000
E20 Exposed floor (normal)	14.3500	0.3200	4.5920
E7 Party floor between dwellings (in blocks of flats)	14.3500	0.0700	1.0045
E18 Party wall between dwellings	8.2200	0.0600	0.4932
E25 Staggered party wall between dwellings	2.7400	0.0600	0.1644
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	14.0000	0.0000	0.0000
P7 Party Wall - Exposed floor (normal)	7.0000	0.1600	1.1200
P8 Party Wall - Exposed floor (inverted)	7.0000	0.2400	1.6800

Thermal bridges (Sum(L x Psi) calculated using Appendix K)		10.5961 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	32.5696 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	24.4378	24.3057	24.1763	23.5684	23.4547	22.9252	22.9252	22.8272	23.1292	23.4547	23.6848	23.9253	(38)
Heat transfer coeff	57.0073	56.8753	56.7459	56.1380	56.0243	55.4948	55.4948	55.3968	55.6987	56.0243	56.2543	56.4949	(39)
Average = Sum(39)m / 12 =												56.1375	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1178	1.1152	1.1127	1.1007	1.0985	1.0881	1.0881	1.0862	1.0921	1.0985	1.1030	1.1077	(40)
HLP (average)												1.1007	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy												1.7196	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	61.1133	60.2056	58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	(42b)
Hot water usage for other uses	32.2401	31.0678	29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	(42c)
Average daily hot water use (litres/day)												85.9708	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	93.3534	91.2734	88.8229	85.2939	82.3570	79.2279	78.1710	80.6126	83.1668	86.4329	90.0104	93.1468	(44)
Energy conte	147.8489	129.9721	136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886	128.2364	145.8454	(45)
Energy content (annual)										Total = Sum(45)m =		1427.6696	
Distribution loss (46)m = 0.15 x (45)m	22.1773	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)
Water storage loss:													
Store volume												150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3938	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7527	(55)
Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(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	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(64)
										Total per year (kWh/year) = Sum(64)m =		1976.2870	(64)
12Total per year (kWh/year)												1976	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	86.4357	76.8843	82.6680	74.8972	74.1396	68.4656	68.7108	70.4645	70.1724	76.2744	78.7121	85.7695	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	85.9785	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	76.4805	84.6748	76.4805	79.0298	76.4805	79.0298	76.4805	76.4805	79.0298	76.4805	79.0298	76.4805	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	149.8308	151.3856	147.4676	139.1267	128.5978	118.7021	112.0911	110.5364	114.4543	122.7953	133.3242	143.2199	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	(71)
Water heating gains (Table 5)	116.1770	114.4112	111.1129	104.0239	99.6500	95.0911	92.3533	94.7103	97.4616	102.5193	109.3223	115.2816	(72)
Total internal gains	394.2818	402.2651	386.8545	373.9739	356.5218	341.6166	329.7184	330.5207	339.7393	353.5886	373.4698	386.7755	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	9.7800	19.6403	0.6300	0.7000	0.7700	58.7027	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	58.7027	114.8349	189.1167	275.8155	338.0222	346.0259	329.4308	282.9762	219.9506	136.2613	73.1954	48.2742	(83)
Total gains	452.9845	517.1000	575.9713	649.7894	694.5441	687.6425	659.1492	613.4969	559.6899	489.8499	446.6652	435.0497	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	62.1265	62.2707	62.4127	63.0886	63.2167	63.8198	63.8198	63.9327	63.5861	63.2167	62.9581	62.6900	
alpha	5.1418	5.1514	5.1608	5.2059	5.2144	5.2547	5.2547	5.2622	5.2391	5.2144	5.1972	5.1793	
util living area	0.9884	0.9764	0.9464	0.8569	0.6999	0.5086	0.3692	0.4130	0.6535	0.9023	0.9759	0.9904	(86)
MIT	19.9337	20.1310	20.4123	20.7402	20.9259	20.9885	20.9982	20.9969	20.9605	20.7016	20.2664	19.9023	(87)
Th 2	20.4411	20.4424	20.4437	20.4496	20.4507	20.4559	20.4559	20.4569	20.4539	20.4507	20.4485	20.4461	(88)
util rest of house	0.9866	0.9728	0.9385	0.8379	0.6677	0.4677	0.3240	0.3651	0.6100	0.8847	0.9716	0.9889	(89)
MIT 2	19.4405	19.6366	19.9131	20.2293	20.3945	20.4488	20.4551	20.4554	20.4274	20.1993	19.7766	19.4133	(90)
Living area fraction									fLA = Living area / (4) =			0.7239	(91)
MIT	19.7976	19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312	19.7673	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.7976	19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312	19.7673	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9840	0.9695	0.9358	0.8433	0.6872	0.4967	0.3566	0.3996	0.6389	0.8885	0.9688	0.9866	(94)
Useful gains	445.7500	501.3030	538.9876	547.9740	477.3024	341.5206	235.0742	245.1539	357.6059	435.2366	432.7263	429.2350	(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	883.4748	858.5045	781.6456	656.7681	508.6551	346.2584	235.7575	246.3701	373.9240	558.1629	733.0601	879.4703	(97)
Space heating kWh	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98a)
Space heating requirement - total per year (kWh/year)												1490.5750	
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	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1490.5750	
Space heating per m2											(98c) / (4) =	29.2270	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	92.3000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	325.6672	240.0394	180.5376	78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)	352.8356	260.0644	195.5987	84.8665	25.2724	0.0000	0.0000	0.0000	0.0000	99.0869	234.2799	362.9199	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(64)
Efficiency of water heater												79.8000	(216)
(217)m	85.2074	84.8066	84.0280	82.5278	80.8574	79.8000	79.8000	79.8000	79.8000	82.8060	84.5570	85.2902	(217)
Fuel for water heating, kWh/month	228.2008	202.8826	217.9183	196.1217	194.7419	178.5862	176.8621	183.4713	185.0186	197.9126	204.9839	225.6300	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	15.8911	12.7485	11.4786	8.4097	6.4959	5.3072	5.9258	7.7025	10.0048	13.1269	14.8268	16.3328	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-11.4110	-17.1730	-26.3354	-31.6653	-35.9911	-34.2931	-33.8929	-31.0795	-26.4446	-20.5310	-12.9298	-9.7441	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-3.5238	-7.6237	-15.5498	-23.9454	-32.2402	-32.5917	-32.1918	-26.9767	-19.4206	-11.0755	-4.7606	-2.7700	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)
Annual totals kWh/year													
Space heating fuel - main system 1												1614.9242	(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	2392.3301	(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)	128.2505	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-504.1606	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3717.3443	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1614.9242	0.2100	339.1341	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2392.3301	0.2100	502.3893	(264)
Space and water heating			841.5234	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	128.2505	0.1443	18.5105	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-291.4908	0.1332	-38.8333	
PV Unit electricity exported	-212.6698	0.1252	-26.6231	
Total			-65.4564	(269)
Total CO2, kg/year			806.5068	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			15.8100	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1614.9242	1.1300	1824.8644	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2392.3301	1.1300	2703.3330	(278)
Space and water heating			4528.1974	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	128.2505	1.5338	196.7149	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-291.4908	1.4923	-434.9893	
PV Unit electricity exported	-212.6698	0.4595	-97.7181	
Total			-532.7074	(283)
Total Primary energy kWh/year			4322.3056	(286)
Target Primary Energy Rate (TPER)			84.7500	(287)

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