

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

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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Table of Contents

Exec	cutive Summary	1
Scope		1
Energy	y Strategy	1
Carbor	n Emissions Reductions	2
Overhe	eating Risk Assessment	3
1.	Introduction	4
1.1	Existing Site	4
1.2	Development Description	5
2.	Planning Policy and Drivers	6
2.1	Introduction	6
2.2	International Drivers	6
2.3	National Policy Drivers	6
2.3.1	UK Climate Change Act	6
2.3.2	National Energy Related Strategies	6
2.3.3	National Planning Policy Framework	7
2.3.4	Building Regulations and Future Homes Standard (FHS) and Future Buildings Standard (FBS)	7
2.4	Local Planning Policy and Guidance	8
2.4.1	Adopted Development Plan	8
2.4.2	Cambridge Local Plan (2018)	
2.4.3	South Cambridgeshire Local Plan (2018)	
2.4.4	North West Cambridge Area Action Plan (AAP) (2009)	
2.4.5	Greater Cambridge Sustainable Design & Construction Supplementary Planning Document (2020	•
2.5	Emerging Planning Policy	
3.	Baseline Energy Demands and CO ₂ Emissions	11
3.1	Introduction	
3.2	Representative dwellings for energy modelling	
3.3	Carbon Reporting: SAP Emission Factors	
3.4	Domestic Energy Modelling	
3.5	Non-Domestic Energy Modelling	
3.6	Predicted Baseline CO ₂ Emissions for the Total Development	
4.	Energy Efficiency Measures (Be Lean)	
4.1	Introduction	16
4.2	Dwellings	
4.2.1	Fabric and Energy Efficiency Approach	
4.2.2	Proposed Specifications	
4.2.3	Heating and Ventilation	
4.2.4	Lighting and Appliances	
4.2.5	Smart Energy and Flexibility	
4.3	Energy efficiency results summary	
5.	Decentralised Energy (Be Clean)	
5.1	District Heating Served by Gas CHP Engines	
5.2	Potential for a Heat Network served by Heat Pumps	
5.3	Local Communal Heat Networks	
5.4	Conclusions on the potential for heat networks	
6.	Renewable Energy (Be Green)	
6.1	Air source heat pumps	
6.2	Renewable energy generation (photovoltaics)	
6.2.1	Houses	
6.2.2	Flats	21

6.3	Energy results summary	22
6.4	Planning policy compliance	
6.5	Passivhaus Principles	
7.	Overheating Risk Assessment	
7.1	Introduction	
7.2	Overheating Analysis	
7.2.1	GHA Early-Stage Overheating Risk Tool Scenarios	
7.3	Cooling Strategy	
7.4	Future Climate Risks	
8.	Conclusions	26
Apper	ndix A Sample SAP DER/TER Worksheet for an indicative single dwelling	j 28
Figu	res	
Figure 1	1 Energy Hierarchy	1
Table	es	
	Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy technic	
	dwellings (scaled from sample indicative dwellings) Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy technic	
	non-domestic buildings (determined from benchmark energy use)	
	: Site-Wide predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy	
	ogies	
	: The 6 dwelling types used for energy modelling	
Table 5:	: Illustrative allocation of number of dwellings to representative SAP models	12
	: SAP 10.2 Carbon Emissions Factors	
	Baseline domestic regulated CO ₂ emissions	
	: Illustrative non-domestic benchmarks and build-up of annual energy demands and carbon emiss	
	9	
	: Baseline CO ₂ emissions 0: Fabric and energy efficiency specification for flats	
	1: Fabric and energy efficiency specification for houses	
	2: Heating and ventilation specification for the flats and houses	
	3 : Predicted cumulative CO_2 savings resulting from energy efficiency measures for the dwellings.	
	4: Predicted cumulative CO ₂ savings resulting from energy efficiency measures for the non-dome	
	S	
Table 15	5: Heating specification for domestic units	21
Table 16	6: Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy tech	nologies
	dwellings	
	7: Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy tech	•
	non-domestic	
	8: Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy tech	•
	dwellings9: Predicted cumulative CO ₂ savings resulting from energy efficiency and renewable energy tech	
	9: Predicted cumulative ${ m CO}_2$ savings resulting from energy efficiency and renewable energy tech non-domestic	•
	0: Site-Wide predicted cumulative CO ₂ savings resulting from energy efficiency and renewable er	
	ogies	••

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.

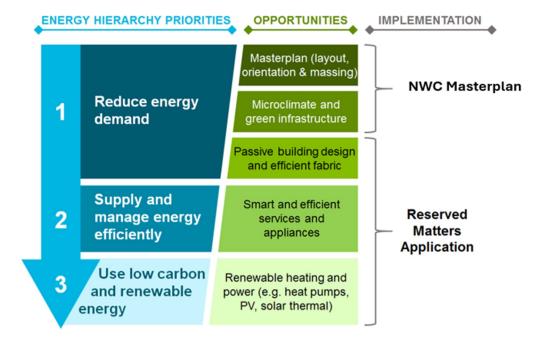


Figure 1 Energy Hierarchy

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 ${\rm CO_2}$ 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.
carbon the high		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 (CO₂) 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 CO₂ 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 CO₂ 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 CO₂ 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 Strategy¹ and Heat and Buildings Strategy² 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 Framework³, 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 L⁴ 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 CO₂ 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 O5, 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 TM596 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-approveddocument-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-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-methodology-for-the-portal/technical-memorandum-59-design-memora 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 CO₂ 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

1 bed ground floor flat

1 bed mid floor flat
And
2 bed mid floor flat

2 bed top floor flat

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 kgCO₂/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 CO₂ emissions

Total modelled dwelling area (m²)	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 (m²)	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-dome	estic		139,276					11,906	4,738	4,775	2,264	649
Benchmark References												
1 CIBSE TM46 (20			,		18 Ur	iversit	y Cam	npus				
	2 CIBSE TM46 (20					neral o						
3 CIBSE TM46 (20			08)		27 W	orksho	p					
4 CIBSE TM46 (20)			08)		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 CO₂ 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.

T	_	D	00	
lable	9:	Baseline	CO2	emissions

Regulated Emissions (tCO ₂ /year)	Unregulated Emissions (tCO₂/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	dows 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	Wall U-value W/m²K 0.00 (fully filled cavit	
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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ emissions than gas boilers. They would also have substantially greater CO₂ 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 4 th 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 Database⁸
**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 CO₂ 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 CO₂ 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 CO₂ 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) checklist⁹ is a useful tool for identifying and mitigating overheating risks; it also recommends that thermal modelling such as a CIBSE TM59 assessment¹⁰ 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.
 - o GHA overheating risk score: 11.
- 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
- 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 CO₂ 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 CO₂ 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 ${\rm CO_2}$ 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



Assessment Referen Property SAP Rating Environmental CO ₂ Emissions (t/yea Compliance Check % DPER < TPER Assessor Details Client		182	2P		86 B			Prop Type Ro	ef 1b2	'p			
SAP Rating Environmental CO: Emissions (t/yea Compliance Check % DPER < TPER Assessor Details Client	ir)				86 B								
Environmental CO: Emissions (t/yea Compliance Check % DPER < TPER Assessor Details Client	ır)				86 B								
Environmental CO: Emissions (t/yea Compliance Check % DPER < TPER Assessor Details Client	ir)						DER	10.	81	TER		15.81	
Compliance Check % DPER < TPER Assessor Details Client	ir)				92 A		% DER < TER					31.63	
% DPER < TPER Assessor Details Client				<u> </u>	0.53		DFEE	24.	10	TFE		36.75	
Assessor Details Client					See BREL	9	% DFEE < TFE	EE				34.43	
Client					26.57		DPER	62.	23	TPEI	₹	84.75	
Client		Mr Chris	topher Popa							Δεερ	essor ID	EH58-00	
			iopiioi i opa									2.100 00	
AP 10 WORKSHEET FO ALCULATION OF DWE	OR New Bu	ild (As De	esigned)	(Version 10	.2, February								
. Overall dwelling													
								Area	Store	height		Volume	
ain dwelling Ground floo:		. /1b) . /1 :	\ /1 -1\ · /5	.) /1-1	_	1 0000		(m2) 51.0000	(1b) x	(m) 2.5000	(2b) =	(m3) 127.5000	(1b) - (3
otal floor area T welling volume	FA = (1a)	+(1b)+(1c	/+(1d)+(1e	e)(1n)	5	1.0000		(3	Ba)+(3b)+(3c)+	(3d) + (3e)	(3n) =	127.5000	(4) (5)
. Ventilation rate													
											m	3 per hour	
umber of open chin											0 * 80 = 0 * 20 =	0.0000	
umber of chimneys umber of flues at	/ flues a			fire							0 * 10 = 0 * 20 =	0.0000	(6c)
umber of flues at	tached to										0 * 35 = 0 * 20 =	0.0000	(6e)
umber of blocked	tent extra	act fans									0 * 10 =	0.0000	(7a)
umber of passive v umber of flueless		3									0 * 10 = 0 * 40 =		
filtration due t	o obimnou	fluor	and fano	- (6a) ((6b)	(6a) (6d) (60) (6f) (6~\\((70\\ (*)	7b) (7a) =		0 0000	Air change		
nfiltration due to		s, riues a	and rans	= (6a)+(6b)	+(60)+(60)+(6e)+(6I)+(og)+(/a)+(/	/D)+(/C) =		0.0000	(5) =	Yes	
ressure Test Metho easured/design AP											В	lower Door	(17)
nfiltration rate umber of sides sh	eltered											0.0500	(18)
helter factor									(20) = 1 -			0.7750	
nfiltration rate	adjusted 1	o include	shelter	factor					(21)	= (18)	x (20) =	0.0388	(21)
	an	Feb	Mar	Apr	May	Jun 3.8000	Jul 3.8000	Aug 3.7000	Sep	Oct	Nov	Dec	(22)
	.1000 .2750	5.0000 1.2500	4.9000 1.2250		4.3000 1.0750	0.9500	0.9500	0.9250		4.3000 1.0750	4.5000 1.1250	4.7000 1.1750	(22a)
	.0494	0.0484	0.0475		0.0417	0.0368	0.0368	0.0358	0.0388	0.0417	0.0436	0.0455	(22b)
f mechanical vent	ilation			-	. Pour (-	on (ME)	o+ho'	(22h) - (22	201			0.5000	
f exhaust air hear f balanced with h									oa)			0.5000 82.8000	
ffective 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)
. Heat losses and													
lement				Gross			Area	U-value	Α×U	ī	-value	АхК	
ain dwelling Marlowe Ro	ad Window	3		m2	m2		2	W/m2K 0.8221	W/K 8.0397		kJ/m2K	kJ/K	
Marlowe Ros External Wa	ad Door			19.6500	9.7800	2.	4500	0.8500 0.1800	2.0825 1.7766				(26) (29a)
Sheltered Sheltered	Wall 2 (W)			19.6500 19.1800	2.4500	17.		0.1700 0.1700	2.9240 3.2606				(29a) (29a)
otal net area of abric heat loss,	external e	elements A					4800	30) + (32)					(31)
ain dwelling		(n X U)				10							
Party Wall Party Floo:	r 1					50.	1800 2000	0.0000	0.0000				(32) (32d)
Party Ceil:				. 0.		45.	1100					050 000	(32b)
	atam /mmp	= Cm / T	FA) in kJ/	m2K								250.0000	(35)

SAP 10 Online 2.22.1 Page 1 of 7

Full SAP Calculation Printout



Total fabric h	eat loss								(:	33) + (36) -	+ (36a) =	21.5922	(37)
Ventilation he					(25)m x (5)								
(38) m	Jan 5.6972	Feb 5.6565	Mar 5.6157	Apr 5.4119	May 5.3711	Jun 5.1673	Jul 5.1673	Aug 5.1266	Sep 5.2489	Oct 5.3711	Nov 5.4527	Dec 5.5342	(38)
Heat transfer	27.2894	27.2486	27.2078	27.0040	26.9633	26.7595	26.7595	26.7187	26.8410	26.9633	27.0448	27.1263	
Average = Sum(3	M	T	71	3	0	0-4	N	26.9939	
HLP HLP (average)	Jan 0.5351	Feb 0.5343	Mar 0.5335	Apr 0.5295	May 0.5287	Jun 0.5247	Jul 0.5247	Aug 0.5239	Sep 0.5263	Oct 0.5287	Nov 0.5303	Dec 0.5319 0.5293	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4. Water heati													
Assumed occupa Hot water usag	e for mixer											1.7196	
Hot water usag			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Hot water usag		60.2056 uses	58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	
Average daily	32.2401 hot water u	31.0678 use (litres	29.8954 /day)	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401 85.9708	
Daily hot wate	Jan r use	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy conte	93.3534	91.2734 129.9721	88.8229 136.5175	85.2939 116.7631	82.3570 110.8683	79.2279 97.4200	78.1710 94.5411	80.6126 99.8152	83.1668 102.5530	86.4329 117.2886	90.0104 128.2364	93.1468 145.8454	
Energy content Distribution 1	(annual)										um (45) m =	1427.6696	
Water storage	22.1773 loss:	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)
Store volume b) If manufa												110.0000	
Hot water st Volume facto	r from Tabl	.e 2a	m Table 2 (kWh/litre/	day)							0.0152 1.0294	(52)
Temperature Enter (49) or	(54) in (55											0.6000 1.0327	
Total 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	(56)
If cylinder co	32.0144	28.9162	32.0144	30.9817 22.5120	32.0144	30.9817 22.5120	32.0144 23.2624	32.0144	30.9817	32.0144 23.2624	30.9817	32.0144	
Primary loss Combi loss	23.2624 0.0000	21.0112 0.0000	23.2624	0.0000	23.2624 0.0000	0.0000	0.0000	23.2624	22.5120 0.0000	0.0000	22.5120 0.0000	23.2624	
Total heat req	203.1257 0.0000	179.8995 0.0000	191.7943 0.0000	170.2568 0.0000	166.1451 0.0000	150.9137 0.0000	149.8179	155.0920 0.0000	156.0467 0.0000	172.5654 0.0000	181.7300 0.0000	201.1222	
PV diverter Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63b)
FGHRS Output from w/	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
odepac IIom #/	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179		156.0467 er year (kWl			201.1222 2078.5094	
12Total per ye Electric showe		ır)						-				2079	
	0.0000												
		0.0000	0.0000	0.0000 Tot	0.0000 tal Energy us	0.0000 sed by inst	0.0000 antaneous e	0.0000 lectric sho	0.0000 wer(s) (kWh	0.0000 /year) = Sur	0.0000 m(64a)m =	0.0000	
Heat gains fro	m water hea 93.3812												(64a)
Heat gains fro		ting, kWh/	month	Tot	tal Energy us	sed by inst	antaneous e	lectric sho	wer(s) (kWh	/year) = Sur	m(64a)m =	0.0000	(64a)
	93.3812	83.1577	month 89.6135	To:	tal Energy us	75.1871	75.6564	77.4100	wer(s) (kWh	/year) = Sur	m(64a)m =	0.0000	(64a)
5. Internal ga	93.3812 ins (see Ta	83.1577	month 89.6135 5a)	Tot 81.6187	81.0852	75.1871	75.6564	77.4100	wer(s) (kWh	/year) = Sur	m(64a)m =	0.0000	(64a)
5. Internal ga	93.3812 ins (see Ta	83.1577	month 89.6135 5a)	Tot 81.6187	81.0852	75.1871	75.6564	77.4100	wer(s) (kWh, 76.8938	/year) = Sur	m(64a)m = 85.4335	0.0000 92.7150 Dec	(64a) (65)
5. Internal ga	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate	kting, kWh/1 83.1577 bble 5 and , Watts Feb 85.9785 d in Appen	month 89.6135 5a) Mar 85.9785 dix L, equa	81.6187 Apr 85.9785 tion L9 or	81.0852 81.0852 May 85.9785	75.1871 Jun 85.9785 see Table 5	Jul 85.9785	77.4100 77.4100	wer(s) (kWh. 76.8938 5ep 85.9785	/year) = Sur 83.2199 Oct	M(64a)m = 85.4335 Nov 85.9785	0.0000 92.7150 Dec 85.9785	(64a) (65)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 149.8308	% watts Feb 85.9785 d in Appen 86.5001 tted in App 151.3856	89.6135 5a) Mar 85.9785 dix L, equa 78.1291 endix L, eq 147.4676	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267	May 85,9785 L9a), also s 78,1291 or L13a), al 128,5978	Jun 85.9785 see Table 5 80.7334 Lso see Tab	Jul 85.9785 78.1291 le 5 112.0911	77.4100 77.4100 Aug 85.9785 78.1291	Sep 85.9785 80.7334	year) = Sur 83.2199 Oct 85.9785 78.1291	Nov 85.4335	0.0000 92.7150 Dec 85.9785 78.1291	(64a) (65) (66) (67)
5. Internal ga Metabolic gain (66) m Lighting gains Appliances gai	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calcula 149.8308 (calculated	ting, kWh/i 83.1577 bble 5 and , Watts Feb 85.9785 din Appen 151.3856 in Append	Mar 85.9785 dix L, equa 147.4676 ix L, equat	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or	May 85.9785 19a), also c 78.1291 or L13a), also 128.5978 L15a), also also 3.48	75.1871 Jun 85.9785 see Table 5 80.7334 Lso see Tab 118.7021 see Table	Jul 85.9785 78.1291 le 5 112.0911 5	Aug 85.9785 78.1291	Sep 85.9785 80.7334	/year) = Sur 83.2199 Oct 85.9785 78.1291 122.7953 31.5979	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979	0.0000 92.7150 Dec 85.9785 78.1291 143.2199 31.5979	(64a) (65) (66) (67) (68) (69)
5. Internal ga Metabolic gain (66) m Lighting gains Appliances gai	93.3812	ting, kWh/i 83.1577 bble 5 and , Watts Feb 85.9785 din Appen 151.3856 in Append 31.5979 0.0000 negative v.	Mar 85.9785 dix L, equa endix L, eq 147.4676 ix L, equat 31.5979 0.0000 alues) (Tab	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5)	May 85.9785 19a), also 78.1291 or L13a), also 31.5979 0.0000	Jun 85.9785 80.7334 Lso see Table 5 80.7334 Lso see Table 31.5979 0.0000	Jul 85.9785 78.1291 le 5 12.0911 5 31.5979 0.0000	Aug 85.9785 78.1291 110.5364 31.5979 0.0000	Sep 85.9785 80.7334 114.4543 31.5979 0.0000	/year) = Sur 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000	0.0000 92.7150 Dec 85.9785 78.1291 143.2199 31.5979 0.0000	(64a) (65) (66) (67) (68) (69) (70)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl	Mating, kWh/1 83.1577 bble 5 and 1 , Watts Feb 85.9785 dd in Append 86.5001 tted in Append 31.5979 0.0000 negative v. -68.7828 e 5)	Mar 85.9785 dix L, equa 78.1291 endix L, eq 147.4676 ix L, equat 31.5979 0.0000 alues) (Tab	Apr 85.9785 tion L9 or 80.7334 uation L13 139.126 or 31.5979 0.0000 le 5) -68.7828	May 81.0852 May 85.9785 L9a), also s 78.1291 or L13a), also 128.5978 L15a), also 31.5979 0.0000 -68.7828	Jun 85.9785 80.7334 Lso see Table 5 80.7334 1.80.7021 31.5979 0.0000 -68.7828	Jul 85.9785 78.1291 le 5 112.0911 5 31.5979 0.0000 -68.7828	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828	(64a) (65) (66) (67) (68) (69) (70) (71)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains	watts, kWh/1 83.1577 bble 5 and 1 1, Watts Feb 85.9785 din Appen 86.5001 tted in Appen 151.3856 in Append 31.5979 0.0000 negative v. -68.7828 e 5) 123.7465	Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593	May 85.9785 L9a), also 8 1.281, or L13a), also 8 128.5978 L15a), also 8 31.5979 0.0000 -68.7828 108.9854	Jun 85.9785 80.7334 so see Table 5 80.7334 so see Table 3118.7021 see Table 31.5979 0.0000 -68.7828	Jul 85.9785 78.1291 15 31.5979 0.0000 -68.7828 101.6886	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170	(64a) (65) (66) (67) (68) (69) (70) (71) (72)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains	watts, kWh/1 83.1577 bble 5 and 1 1, Watts Feb 85.9785 din Appen 86.5001 tted in Appen 151.3856 in Append 31.5979 0.0000 negative v. -68.7828 e 5) 123.7465	Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593	May 81.0852 May 85.9785 L9a), also s 78.1291 or L13a), also 128.5978 L15a), also 31.5979 0.0000 -68.7828	Jun 85.9785 80.7334 so see Table 5 80.7334 so see Table 3118.7021 see Table 31.5979 0.0000 -68.7828	Jul 85.9785 78.1291 15 31.5979 0.0000 -68.7828 101.6886	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170	(64a) (65) (66) (67) (68) (69) (70) (71) (72)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev	93.3812	withing, kWh/r 83.1577 bble 5 and 	Mar 85.9785 dix L, equa 78.1291 endix L, eq 147.4676 ix L, equat 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593	May 85.9785 L9a), also 578.1291 or L13a), al 128.5978 L128.5978 0.0000 -68.7828 108.9854 364.5058	Jun 85.9785 80.7334 Lso see Table 5 80.7334 Lso see Table 31.5979 0.0000 -68.7828 104.4265 352.6555	Jul 85.9785 78.1291 le 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170	(64a) (65) (66) (67) (68) (69) (70) (71) (72)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 149.8308 (calculated 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains 402.2659	Matts Feb 85.9785 din Append 31.5979 0.0000 negative v68.7828 e 5) 123.7465	Mar 85.9785 dix L, equa 78.1291 endix I, equa 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593 382.0129	May 81.0852 May 85.9785 L9a), also s 78.1291 or L13a), also 128.5978 L15a), also 31.5979 0.0000 -68.7828 108.9854 364.5058	Jun 85.9785 85.9785 80.7334 150 218.7021 8ee Table 31.5979 0.0000 -68.7828 104.4265 352.6555	Jul 85.9785 78.1291 16 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170	(64a) (65) (66) (67) (68) (69) (70) (71) (72)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 149.8308 (calculated 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains 402.2659	Matts Feb 85.9785 din Append 31.5979 0.0000 negative v68.7828 e 5) 123.7465	Mar 85.9785 85.9785 1291 endix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 81.6187 Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also s 78.1291 or L13a), also 31.5979 0.0000 -68.7828 108.9854 364.5058	Jun 85. 9785 80. 7334 150 26 27 28 28 28 28 28 28 28 28 28 28 28 28 28	Jul 85.9785 78.1291 15 112.0911 5 112.0911 5 112.0912 5 112.0912 5 112.0912 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta S (Table 5) Jan 85.9785 (calculate 78.1291 149.8308 (calculated 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 qains 402.2659	Matts Feb 85.9785 din Append 31.5979 0.0000 negative v68.7828 e 5) 123.7465	Mar 89.6135 5a) Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also 9 78.1291 or L13a), also 128.5978 L15a), also 31.5979 0.0000 -68.7828 108.9854 364.5058	Jun 85. 9785 80. 7334 80 80 7334 80 80 7334 80 80 7334 80 80 738 91 80 70000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 80000 800000 800000 800000 800000 800000 800000 800000 800000 800000 8000000	Jul 85.9785 78.1291 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 149.8308 (calculated 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains 402.2659	white states the states of the	Mar 89.6135 5a) Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 uation L13 or 31.5979 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also s 78.1291 or L13a), also s 31.5979 0.0000 -68.7828 108.9854 364.5058	Jun 85.9785 80.7334 so see Table 5 80.7334 so See Table 57 0.0000 -68.7828 104.4265 352.6555	Jul 85.9785 78.1291 18 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 149.8308 (calculated 31.5979 0.0000 aporation (-68.7828 gains (Tabl) 125.5124 gains 402.2659	ble 5 and	Mar 89.6135 Mar 85.9785 dix L, equa 78.1291 endix L, eq 147.4676 ix L, equat 31.597 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 81.6187 Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 0.0000 le 5) -68.7828 113.3593 382.0129	May 81.0852 May 85.785 L9a), also s 78.1291 0.0000 -68.7828 108.9854 364.5058	Jun 85.9785 see Table 5 80.7334 lso see Table 118.7021 see Table 31.5979 0.0000 -68.7828 104.4265 352.6555	Jul 85.9785 78.1291 12.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aportation (calculate 42.8328 gains (Tabl 125.5124 gains 402.2659	Mating, kWh/1 83.1577 bble 5 and 1 Watts Feb 85.9785 din Append 31.5979 0.0000 negative v. -68.7828 e 5) 123.7465 410.4258	Mar 89.6135 5a) ————————————————————————————————————	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also 8 78.1291 or L13a), also 8 78.297 0.0000 -68.7828 108.9854 364.5058	Jun 85.9785 80.7334 so see Table 5 80.7334 so See Table 3118.7021 see Table 31.5979 0.0000 -68.7828 104.4265 352.6555	Jul 85.9785 78.1291 15 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024 101.6886	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595 Gains W	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal 6. Solar gains [Jan] East Solar gains Total gains	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains 402.2659	ble 5 and ble 5 and , Watts Feb 85.9785 din Appen. 86.5001 tted in Appen. 151.3856 in Append. 31.5979 0.0000 negative v68.7828 e 5) 123.7465 410.4258	Mar 89.6135 Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.597 0.0000 alues) (Tab 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 0.0000 le 5) -68.7828 113.3593 382.0129	May 81.0852 May 85.785 L9a), also 78.1291 or L13a), al 128.5978 L15a), also 31.5979 0.0000 -68.7828 108.9854 364.5058 Solar flux Table 6a W/m2 19.6403 214.6173 579.1231	Jun 85.9785 88.9785 88.9785 80.7334 180 see Table 31.5979 0.0000 -68.7828 104.4265 352.6555 Speci or -219.6990 572.3545	Jul 85.9785 78.1291 1e 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024 fic data Table 6b 0.4000 209.1624 549.8648	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595 Gains W	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal 6. Solar gains [Jan] East Solar gains Total gains	93.3812	ble 5 and , Watts Feb 85.9785 din Appen 86.5001 1151.3856 in Appen 151.3856 in Appen 151.3856 in Appen 151.3856 in Appen 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000 10.0000	month 89.6135 5a) Mar 85.9785 dix L, equa 78.1291 endix L, eq 147.4676 ix L, equa 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 81.6187 Apr 85.9785 tion L9 or 80.7334 uation L15 or 0.0000 le 5) -68.7828 113.3593 382.0129 	May 85.9785 L9a), also consistent of the state of the sta	Jun 85.9785 see Table 5 80.7334 118.7021 see Table 31.5979 0.0000 -68.7828 104.4265 352.6555 Speci or	Jul 85.9785 78.1291 le 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024 fic data Table 6b 0.4000 209.1624 549.8648	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595 Gains W	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gain (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal 6. Solar gains [Jan] East Solar gains Total gains Total gains Total gains	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl 125.5124 gains 402.2659 37.2715 439.5374	Matts Feb 85.9785 din Append 31.5979 0.0000 negative v68.7828 e 5) 123.7465 410.4258	Mar 89.6135 5a) 	Apr 85.9785 tion L9 or 80.7334 uation L13 139.1267 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also 87.8.1291 or L13a), also 87.9785 L95a, also 87.8.1291 or L13a), also 87.8	Jun 85.9785 80.7334 48 80.7334 48 18.7021 8ee Table 31.5979 0.0000 -68.7828 104.4265 352.6555 8peci or	Jul 85.9785 78.1291 le 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024 fic data Table 6b 0.4000 209.1624 549.8648	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595 Gains W	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73)
5. Internal ga Metabolic gains (66)m Lighting gains Appliances gai Cooking gains Pumps, fans Losses e.g. ev Water heating Total internal 6. Solar gains [Jan] East Solar gains Total gains	93.3812 ins (see Ta s (Table 5) Jan 85.9785 (calculate 78.1291 ns (calculate 149.8308 (calculate 31.5979 0.0000 aporation (-68.7828 gains (Tabl) 125.5124 gains 402.2659 37.2715 439.5374	### 1577 ### 15	Mar 85.9785 dix L, equa 78.1291 endix L, equat 31.5979 0.0000 alues) (Tab -68.7828 120.4483 394.8385	Apr 85.9785 tion L9 or 80.7334 wation L13 139.1267 ion L15 or 31.5979 0.0000 le 5) -68.7828 113.3593 382.0129	May 85.9785 L9a), also 87.8.1291 or L13a), also 87.9785 L95a, also 87.8.1291 or L13a), also 87.8	Jun 85.9785 80.7334 so see Table 5 118.7021 see Table 5 31.5979 0.0000 -68.7828 104.4265 352.6555 Speci or 219.6990 572.3545	Jul 85.9785 78.1291 18 5 112.0911 5 31.5979 0.0000 -68.7828 101.6886 340.7024	Aug 85.9785 78.1291 110.5364 31.5979 0.0000 -68.7828 104.0457 341.5047 Specific or Tab 179.6674 521.1721	Sep 85.9785 80.7334 114.4543 31.5979 0.0000 -68.7828 106.7970 350.7783 FF data le 6c .7000 139.6512 490.4295	Oct 83.2199 Oct 85.9785 78.1291 122.7953 31.5979 0.0000 -68.7828 111.8547 361.5726 Acces fact Table 0 0.770 86.5151 448.0878	Nov 85.4335 Nov 85.9785 80.7334 133.3242 31.5979 0.0000 -68.7828 118.6577 381.5088	Dec 85.9785 78.1291 143.2199 31.5979 0.0000 -68.7828 124.6170 394.7595 Gains W 37.2715 30.6503 425.4098	(64a) (65) (66) (67) (68) (69) (70) (71) (72) (73) (76) (83) (84)

SAP 10 Online 2.22.1 Page 2 of 7



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 Th 2 20.4888 util rest of house	20.9416 20.4895	20.9824 20.4902	20.9982 20.4939	20.9999 20.4946	21.0000 20.4982	21.0000 20.4982	21.0000 20.4990	21.0000 20.4968	20.9974 20.4946	20.9592 20.4931	20.8623 20.4917	
0.9084 MIT 2 20.3597 Living area fraction	0.8380 20.4295	0.7285 20.4734	0.5611 20.4924	0.4094 20.4945	0.2758 20.4982	0.1897 20.4982	0.2101 20.4990	0.3501 20.4968	0.5939 20.4925 Living area	0.8155	0.9229 20.3418 0.7239	(90)
MIT 20.7365 Temperature adjustment	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	20.7186	(92)
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	
8. Space heating requirem												
Utilisation 0.9150 Useful gains 402.1930 Ext temp. 4.3000	Feb 0.8495 410.6080 4.9000	Mar 0.7446 383.4041 6.5000	Apr 0.5784 322.2595 8.9000	May 0.4264 246.9593 11.7000	Jun 0.2927 167.5532 14.6000	Jul 0.2074 114.0349 16.6000	Aug 0.2287 119.2103 16.4000	Sep 0.3700 181.4668 14.1000	Oct 0.6151 275.6287 10.6000	Nov 0.8303 355.3422 7.1000	Dec 0.9283 394.9110 4.2000	(95)
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 Space heating requirement	15.2218 - total pe	5.0644 er year (kW	0.4826 h/year)	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639 106.8588	
Solar heating kWh 0.0000 Solar heating contributio	0.0000 on - total p	0.0000 per year (k	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
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 Space heating per m2	after sola	ir contribu	tion - tota.	1 per year	(kWh/year)				(98c)	/ (4) =	106.8588 2.0953	(99)
9b. Energy requirements												
Fraction of space heat fr											0.0000	(301)
Fraction of space heat fr Fraction of heat from com Factor for control and ch Factor for charging metho Distribution loss factor Efficiency of secondary/s	com communit munity Boil arging meth d (Table 4c (Table 12c)	y system Lers-Space nod (Table c(3)) for w for commu	and Water 4c(3)) for a ater heating	space heati							1.0000 1.0000 1.0000 1.0000 1.0000 0.0000	(302) (303a) (305) (305a) (306)
Space heating: Space heating requirement		.1	-,,									(=++)
	15.2218	5.0644 00 x 1.00 x	0.4826 1.00	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	(98)
307a 34.4826 Space heating requirement	15.2218	5.0644	0.4826	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639	
34.4826 Efficiency of secondary/s				0.0258 (from Tabl	0.0000 e 4a or App	0.0000 endix E)	0.0000	0.0000	0.7152	11.3025	39.5639 0.0000	
Space heating fuel for se 0.0000	condary/sup 0.0000	oplementary 0.0000	system 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(309)
Water heating												
Annual water heating requ 203.1257	179.8995	191.7943		166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	(64)
	(64) x 1.0 179.8995			166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	
Water heating fuel 203.1257 Cooling System Energy Eff	179.8995		170.2568	166.1451	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	
Space coolin 0.0000 Pumps and Fa 9.4129	0.0000 8.5020	0.0000	0.0000 9.1093	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	(315)
Lighting 17.2533 Electricity generated by	13.8413	12.4625	9.1306	7.0527	5.7621	6.4337	8.3628	10.8625	14.2521	16.0977	17.7328	
(333a)m 0.0000 Electricity generated by	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333a)
(334a)m 0.0000 Electricity generated by	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(334a)
(335a)m 0.0000 Electricity generated by	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335a)
(333b)m 0.0000 Electricity generated by	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(333b)
(334b)m 0.0000 Electricity generated by	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 itv)	0.0000	0.0000	0.0000	0.0000	0.0000	(334b)
(335b)m 0.0000 Annual totals kWh/year	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(335b)
Space heating fuel - comm Space heating fuel - seco		ng									106.8588	
Water heating fuel - comm Efficiency of water heate Electricity used for heat Space cooling fuel	nunity heati r	-									2078.5094 0.0000 1.0686 0.0000	(310) (311) (313)
Electricity for pumps and (BalancedWithHeatReco mechanical ventilation Total electricity for the Electricity for lighting	very, Datab fans (SFP above, kWh	= 0. n/year	7125)	1.2500, SFP	= 0.7125)						110.8294 110.8294 139.2442	(331)
Energy saving/generation	technologie	es (Appendi	ces M ,N and	d Q)								
PV generation Wind generation	(Anno-di	M)									0.0000	(334)
Hydro-electric generation Electricity generated - M	Micro CHP (A										0.0000	
Appendix Q - special feat Energy saved or generated											-0.0000	
Energy used Total delivered energy fo	or all uses										0.0000 2435.4418	

12b. Carbon dioxide emissions - Community heating scheme

SAP 10 Online 2.22.1 Page 3 of 7



Efficiency of he Space and Water Electrical energ Overall CO2 fact Total CO2 associ Space and water Pumps, fans and Energy for light Total CO2, kg/ye EPC Dwelling Car 13b. Primary ene Efficiency of he Space and Water Electrical energ Overall CO2 fact Total CO2 associ Space and water Pumps, fans and Energy for light Total Primary en Dwelling P	heating fr yy for heat or for hea ated with heating electric k ing ar bon Dioxid	om Boilers distributi t network community s eep-hot e Emission unity heat: Boilers om Boilers distributi t network community s eep-hot	Rate (DER) 					kg Primary energy kg	CO2/kWh 0.2100 0.0000 0.1387 0.1443	Prin	Emissions cg CC2/year 89.5000 25.0730 3.0951 1515.8631 515.8631 515.8631 15.3734 20.0972 551.3337 10.8100 134.9166 33.2986 1.2778 2792.4786 2792.4786 2792.4786 2792.4786 2792.4787 3173.7187 62.2330	(367) (367) (372) (386) (373) (376) (378) (383) (384) (467a) (467a) (467) (472) (486) (473) (478) (478) (478) (478)
SAP 10 WORKSHEET CALCULATION OF T	FOR New B	uild (As De SIONS	esigned)	(Version 10	.2, February	2022)		Area (m2) 51.0000		height (m) 2.5000 3d)+(3e)	(2b) =	Volume (m3) 127.5000	(1b) - (3b (4)
Number of open c Number of open for the series of control of chimne number of flues number of flues number of blocke number of passiv number of passiv number of fluele Infiltration due pressure test pressure Test Me Measured/design Infiltration rat number of sides Shelter factor Infiltration rat	chimneys clues clues cys / flues attached t d chimneys clittent ext e vents exts gas fir cto chimne chod AP50 e sheltered	attached to solid fue o other hear ract fans es	co closed el boiler ater	fire = (6a)+(6b)				(b)+(7c) =	(20) = 1 -	[0.075 x	0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 20 = 0 * 35 = 0 * 20 = 2 * 10 = 0 * 10 = 0 * 40 = Air change	0.0000 0.0000 0.0000 0.0000 0.0000 20.0000 0.0000 0.0000 0.0000 yes slower Door 5.0000 0.4069	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c) (8)
Wind speed Wind factor	Jan 5.1000 1.2750		Mar 4.9000 1.2250		May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250		Oct 4.3000 1.0750			
	0.4020 0.5808			0.3469 0.5602		0.2996 0.5449		0.2917 0.5425	0.3153 0.5497		0.3547 0.5629		
Sheltere	que door ing Type Wall 1 (E d Wall 2 (d Wall 3 (f external	ss paramete) W) N) elements A	er 	Gross m2 19.6500 19.6500 19.1800		Net 2. 9. 9. 17. 19. 58.	.Area m2 4500 7800 8700 2000 1800 4800		W/K 2.4500 11.1985 1.7766 3.0960 3.4524		(-value kJ/m2K	A x K kJ/K	
Thermal mass par List of Thermal K1 Eleme	ameter (TM Bridges	P = Cm / TF	FA) in kJ/	m2K		19.				-value	Tot	250.0000	

SAP 10 Online 2.22.1 Page 4 of 7



E3 Sil: E4 Jamb E20 Exp E7 Pari E18 Pa: E25 St P3 Pari P7 Pari	looposed floor ty floor be- rty wall be- aggered par- ty wall - E: ty Wall - E: ty Wall - E: s (Sum(L x : pridges	(normal) tween dwell tween dwell ty wall bet ntermediate xposed floo xposed floo	ween dwelli floor betw or (normal) or (inverted	ocks of fl. ngs meen dwelli:	3)	5. 18. 14. 14. 8. 2. 14.	9300 9100 9000 3500 3500 2200 7400 0000 0000	0.0500 0.0500 0.0500 0.3200 0.0700 0.0600 0.0600 0.0000 0.1600 0.2400	0.34 0.29 0.90 4.59 1.00 0.49 0.16 0.00 1.12 1.68	55 00 20 45 32 44 00			
Ventilation hea												_	
(38) m	Jan 24.4378	Feb 24.3057	Mar 24.1763	Apr 23.5684	May 23.4547	Jun 22.9252	Jul 22.9252	Aug 22.8272	Sep 23.1292	Oct 23.4547	Nov 23.6848	Dec 23.9253	(38)
Heat transfer of Average = Sum (57.0073	56.8753	56.7459	56.1380	56.0243	55.4948	55.4948	55.3968	55.6987	56.0243	56.2543	56.4949 56.1375	(39)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	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)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	
4 Water back													
4. Water heatin												1.7196	(42)
Hot water usage		showers 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	. ,
Hot water usage			58.9275	56.5709	54.8063	52.8496	51.7927	53.0619	54.4438	56.5375	58.9427	60.9067	
Hot water usage	e for other 32.2401	uses 31.0678	29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	
Average daily h						_			_			85.9708	(43)
Daily hot wate:		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(44)
Energy conte Energy content	(annual)	91.2734 129.9721	88.8229 136.5175	85.2939 116.7631	82.3570 110.8683	79.2279 97.4200	78.1710 94.5411	80.6126 99.8152	83.1668 102.5530	86.4329 117.2886 Total = Si	90.0104 128.2364 um(45)m =	93.1468 145.8454 1427.6696	
Distribution lo	22.1773	= 0.15 x (4 19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	(46)
Store volume a) If manufact		red loss fa	ctor is kno	own (kWh/d	av):							150.0000 1.3938	
Temperature : Enter (49) or	factor from	Table 2b		(11117, 4	-27.							0.5400 0.7527	(49)
Total storage		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 con	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	
Primary loss Combi loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120 0.0000	23.2624 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	22.5120 0.0000	23.2624 0.0000	
Total heat requ	194.4438		183.1124 0.0000	161.8550 0.0000	157.4632 0.0000	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282 0.0000	192.4403	
PV diverter Solar input	0.0000 -0.0000 0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	0.0000 -0.0000 0.0000	(63b)
FGHRS Output from w/l	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101 Total pe	147.6449 er year (kWh	163.8835 n/year) = Su	173.3282 um(64)m =	192.4403 1976.2870	(64)
12Total per year Electric showe:	r(s)											1976	
	0.0000	0.0000	0.0000		0.0000 al Energy us			0.0000 lectric show	0.0000 ver(s) (kWh		0.0000 m(64a)m =	0.0000	
Heat gains from				74.8972	74.1396	68.4656	68.7108	70.4645	70.1724	76.2744	78.7121	85.7695	(65)
E Internal car													
5. Internal gas 													
(66) m	Jan	Feb	Mar 85.9785	Apr 85.9785	May 85.9785	Jun 85.9785	Jul 85.9785	Aug 85.9785	Sep 85.9785	Oct 85.9785	Nov 85.9785	Dec 85.9785	(66)
Lighting gains	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)
	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	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979	31.5979			31.5979		31.5979	
Pumps, fans Losses e.g. eva	aporation (negative va	lues) (Tabl	.e 5)	3.0000			0.0000		3.0000		3.0000	
Water heating	gains (Table	e 5)			-68.7828 99.6500		92.3533	-68.7828 94.7103		-68.7828 102.5193		-68.7828 115.2816	
Total internal	gains				356.5218					353.5886	373.4698	386.7755	
	22.2010			2.2.2,22	223.0210		2_2.,104	223.0207		223.0000	2.3.1030	,,,	,
6. Solar gains													
[Jan]				rea m2	Solar flux Table 6a W/m2	Specif	g fic data	Specific	FF data	Acces facto Table 6	ss or	Gains W	
East			9.78	100	19.6403		0.6300	0.		0.770		58.7027	(76)
Solar gains Total gains	58.7027 452.9845	114.8349 517.1000	189.1167 575.9713	275.8155 649.7894	338.0222 694.5441	346.0259 687.6425	329.4308 659.1492	282.9762 613.4969	219.9506 559.6899	136.2613 489.8499	73.1954 446.6652	48.2742 435.0497	

SAP 10 Online 2.22.1 Page 5 of 7



THE STATE OF COLOR 19 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1														
20. 12. 12. 12. 12. 12. 12. 12. 12. 12. 12							Th1 (C)						21.0000	(85)
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	tau alpha	62.1265 5.1418	62.2707	62.4127	63.0886	63.2167	63.8198	63.8198	63.9327	63.5861	63.2167	62.9581	62.6900	
13	util living ar		0.9764	0.9464	0.8569	0.6999	0.5086	0.3692	0.4130	0.6535	0.9023	0.9759	0.9904	(86)
1	MIT Th 2 util rest of h	20.4411												
Commercial existance	MIT 2	0.9866 19.4405								20.4274	20.1993	19.7766	19.4133	(90)
7. Boson basiling requirement. Filtraction	MIT Temperature ad		19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312		(92)
1. Space backing requirements 1. Space backing requirement	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 heati	ng requirer	ment											
## 1983-6728 598-505 781-656 587-7881 508-5051 346-2584 237-379 246-3701 371-240 598-1629 731-601 879-1703 371-240 371-2	Utilisation Useful gains Ext temp.	0.9840 445.7500 4.3000	0.9695 501.3030	0.9358 538.9876	0.8433 547.9740	0.6872 477.3024	0.4967 341.5206	0.3566 235.0742	0.3996 245.1539	0.6389 357.6059	0.8885 435.2366	0.9688 432.7263	0.9866 429.2350	(95)
335.6672 240.0384 188.5376 Pt.3318 23.264 0.0000 0.		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)
Description Company	Space heating	325.6672 requirement				23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403		(98a)
23.6.672 240.094 180.376 78.318 23.3264 0.0000 0.0000 0.0000 0.0000 0.0000 91.4572 216.2403 344.7790 (98c) pages heating per all 140.5775 180.2470 180.2770 180.	Solar heating	0.0000 contribution				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		(98b)
	Space heating	325.6672 requirement						0.0000	0.0000	0.0000			1490.5750	
Praction of space heat from secondary/supplementary system (Table 11) 1.000 (202)	9a. Energy req	uirements -	- Individua	al heating s	ystems, incl	uding mic	ro-CHP							
pace heating requirement	Fraction of sp Fraction of sp Efficiency of se Efficiency of	ace heat fr ace heat fr main space main space	rom seconda rom main sy heating sy heating sy	ary/suppleme ystem(s) ystem 1 (in ystem 2 (in	ntary system %) %)								1.0000 92.3000 0.0000	(202) (206) (207)
Sign efficiency (main heating system 1) Space heating efficiency (main heating system 2) Space heating fittle (main heating system 2				Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
92,300 92,300 92,300 92,300 92,300 92,300 0.000 0.000 0.000 0.000 92,300 92,300 92,300 (210) Space heating fuel (main heating system 2) Space heating fuel (secondary) Space he	-	325.6672	240.0394			23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	(98)
332.2356 260.0644 195.9987 84.8665 25.2724 0.0000 0.0000 0.0000 99.0869 234.7799 362.9199 (211) space heating efficiency main heating system 2) space heating fuel (main heating system 2) space (main fuel heating system 2) space heating requirement space cooling fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space (main heating system 2) space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel requirement space (main heating system 2) space heating fuel reguirement space (main heating system 2) space (main heating system 2) space heating f		92.3000	92.3000	92.3000		92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
0,0000 0,		352.8356	260.0644	195.5987		25.2724	0.0000	0.0000	0.0000	0.0000	99.0869	234.2799	362.9199	(211)
Atter 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	(212)
Aster heating ster heating requirement ster heating ster heating requirement ster heating s		0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Nater 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) Efficiency of water heating, XWH/month 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) Nuel for water heating, XWH/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) Number of coloring fuel requirement (221m 0.0000 0				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
St.2074 84.8066 84.0280 82.5278 80.8574 79.8000 79.8000 79.8000 79.8000 79.8000 82.8060 84.5570 85.2902 (217)	Water heating	194.4438	172.0578	183.1124	161.8550	157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282		
Space cooling fuel requirement C221m	(217)m Fuel for water													
Example and Fa 7.3041 6.5973 7.3041 7.0685 7.3041 7.3081 7		fuel requir	rement											
11.4110	Pumps and Fa Lighting	7.3041 15.8911	6.5973 12.7485	7.3041 11.4786	7.0685 8.4097	7.3041 6.4959	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
(234a)m 0.0000 0	(233a)m	-11.4110	-17.1730	-26.3354	-31.6653	-35.9911		-33.8929	-31.0795	-26.4446	-20.5310	-12.9298	-9.7441	(233a)
(235a)m 0.0000 0	(234a) m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
(235c)m 0.0000 0	(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000	(235a)
(233b)m	(235c) m	0.0000	0.0000	0.0000	0.0000	0.0000				0.0000	0.0000	0.0000	0.0000	(235c)
(234b)m 0.0000 0	(233b) m	-3.5238	-7.6237	-15.5498	-23.9454	-32.2402		-32.1918	-26.9767	-19.4206	-11.0755	-4.7606	-2.7700	(233b)
(235b)m 0.00000 0.0000	(234b)m Electricity ge	0.0000 nerated by	0.0000 hydro-elec	0.0000 ctric genera	0.0000 tors (Append	0.0000 ix M) (nec	0.0000 gative quant	ity)						
Annual totals kWh/year Annual totals kWh/year Annual totals kWh/year Annual totals kWh/year 1614.9242 (211) 1614.9242 (21) 1614.9242 (2	(235b)m Electricity us	0.0000 ed or net e	0.0000 electricity	0.0000 generated	0.0000 by micro-CHP	0.0000 (Appendi:	0.0000 k N) (negati	0.0000 ve if net g	eneration)					
2 0.0000 (213)	(235d)m Annual totals	kWh/year		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
Rectricity for pumps and fans: Notal electricity for the above, kWh/year 86.0000 (231)	Space heating Space heating Efficiency of Water heating	fuel - main fuel - seco water heate fuel used	n system 2 ondary										0.0000 0.0000 79.8000 2392.3301	(213) (215) (219)
Stectricity for lighting (calculated in Appendix L) 128.2505 (232)	Electricity fo Total electric	r pumps and	e above, kW										86.0000	(231)
Energy saving/generation technologies (Appendices M , $\mathbb N$ and $\mathbb Q$)						Q)							128.2505	(232)

SAP 10 Online 2.22.1 Page 6 of 7



PV generation Wind generation Hydro-electric generation (Appendix N) Electricity generated - Micro CHP (Appendix N) Appendix O - special features			-504.1606 (233) 0.0000 (234) 0.0000 (235a) 0.0000 (235)
Energy saved or generated Energy used Total delivered energy for all uses			-0.0000 (236) 0.0000 (237) 3717.3443 (238)
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP			
	Energy	Emission factor	Emissions
Space heating - main system 1	kWh/year 1614.9242	kg CO2/kWh 0.2100	kg CO2/year 339.1341 (261)
Total CO2 associated with community systems	1014.5242	0.2100	0.0000 (373)
Water heating (other fuel)	2392.3301	0.2100	502.3893 (264)
Space and water heating Pumps, fans and electric keep-hot	86.0000	0.1387	841.5234 (265) 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 EPC Target Carbon Dioxide Emission Rate (TER)			806.5068 (272) 15.8100 (273)
13a. Primary energy - Individual heating systems including micro-CHP			
		rimary energy factor	Primary energy
Ones backing main sustant 1	kWh/year 1614.9242	kg CO2/kWh 1.1300	kWh/year 1824.8644 (275)
Space heating - main system 1 Total CO2 associated with community systems	1014.9242	1.1300	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 Total	-212.6698	0.4595	-97.7181 -532.7074 (283)
Total Primary energy kWh/year			4322.3056 (286)
Target Primary Energy Rate (TPER)			84.7500 (287)

SAP 10 Online 2.22.1 Page 7 of 7



Property Referen		4D	ground floor	fi-1						ssued on D	oto	22/05/2025	
Assessment Refe			2P	ııaı				Prop Type R		2p	ate	22/03/2023	
Property	erence		<u> </u>					Flop Type K	ii.	ZÞ			
SAP Rating					86 B		DER	3.0)4	TER		15.81	
Environmental					98 A		% DER < TER					80.77	
CO ₂ Emissions (t					0.15		DFEE < TE	24	.10	TFEE	:	36.75	
% DPER < TPER	CK				See BREL 61.80		% DFEE < TF		.38	TPEF	,	34.43 84.75	
70 DI ER VII ER					01.00		DI EK	32	.30			04.73	
Assessor Details Client	;	Mr. Chris	stopher Popa							Asse	ssor ID	EH58-00	01
SAP 10 WORKSHEE						7 2022)							
1. Overall dwel Ground f Total floor are Dwelling volume	ling charac	teristics				51.0000					(2b) =		(1b) - (3b
Number of open Number of open Number of chimn Number of chimn Number of flues Number of block Number of inter Number of passi Number of fluel	chimneys flues eys / flues attached t attached t ed chimneys mittent ext ve vents ess gas fir	s attached no solid fu no other he a ract fans	el boiler ater								0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 0 * 10 = 0 * 10 = 0 * 40 = Air change	0.0000 0.0000 0.0000 0.0000 es per hour	(6a) (6b) (6c) (6d) (6e) (6f) (7a) (7b) (7c)
Infiltration du Pressure test Pressure Test M Measured/design Infiltration ra Number of sides	ethod AP50 te	eys, flues	and rans	= (ba)+(bb) + (bc) + (ba) + ((6E) + (6I) +	(bg)+(/a)+(/b)+(/c) =		0.0000		0.0000 Yes Blower Door 1.0000 0.0500	(17)
Shelter factor Infiltration ra	te adjusted	l to includ	e shelter	factor					(20) = 1 - (21)		(19)] = x (20) =	0.7750 0.0388	
Wind speed	Jan 5.1000	Feb 5.0000	Mar 4.9000	Apr 4.4000	May 4.3000	Jun 3.8000	Jul 3.8000	Aug 3.7000	Sep 4.0000	Oct 4.3000	Nov 4.5000		
Wind factor Adj infilt rate		1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Balanced mecha If mechanical v If exhaust air	entilation heat pump u	sing Appen	dix N, (23	covery 8b) = (23a)						0.0417	0.0436	0.0455 0.5000 0.5000 82.8000	(23a) (23b)
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)
Marlowe Externa Shelter Shelter Total net area Fabric heat los Main dwelling Party W Party F	Road Windo Road Door 1 Wall 1 (F ed Wall 2 (ded Wall 3 (of external s, W/K = St fall 1 (S) floor 1 eiling 1	ows paramet (W) (N) (N) (Elements (A x U) (P = Cm / T	er Aum(A, m2) FA) in kJ/	Gross m2 19.6500 19.6500 19.1800	Openings m2 9.7800 2.4500	Net 9 2 9 17 19 58	TArea m2 .7800 .4500 .8700 .2000 .1800 .4800		A x U W/F 8.0397 2.0825 1.7766 2.924U 3.2600 = 18.0834		:-value kJ/m2K	A x K kJ/K 250.0000 3.5088	(27) (26) (29a) (29a) (29a) (31) (33) (32) (32d) (32b)
Point Thermal b					/						(36a) =	0.0000	

SAP 10 Online 2.22.1 Page 1 of 7



Total fabric h	eat loss								(33) + (36) -	+ (36a) =	21.5922	(37)
Ventilation he													
(38) m	Jan 5.6972	Feb 5.6565	Mar 5.6157	Apr 5.4119	May 5.3711	Jun 5.1673	Jul 5.1673	Aug 5.1266	Sep 5.2489	Oct 5.3711	Nov 5.4527	Dec 5.5342	(38)
Heat transfer	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	
HLP	Jan 0.5351	Feb 0.5343	Mar 0.5335	Apr 0.5295	May 0.5287	Jun 0.5247	Jul 0.5247	Aug 0.5239	Sep 0.5263	Oct 0.5287	Nov 0.5303	Dec 0.5319	(40)
HLP (average) Days in mont	31	28	31	30	31	30	31	31	30	31	30	0.5293 31	
4. Water heati													
Assumed occupa Hot water usag		showers										1.7196	(42)
Hot water usag	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 usag	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)
Average daily	32.2401	31.0678	29.8954 /dav)	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401 85.9708	
-	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot wate	r 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 Energy content Distribution 1	(annual)	129.9721 = 0.15 × (136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886 Total = Si	128.2364 um(45)m =	145.8454 1427.6696	(45)
Water storage	22.1773	19.4958	20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	
Store volume b) If manufa					, ,							110.0000	
Hot water st Volume facto Temperature	r from Tabl	.e 2a	m Table 2 (kwn/litre/d	uay)							0.0152 1.0294 0.6000	(52)
Enter (49) or Total storage	(54) in (55 loss	5)										1.0327	(55)
If cylinder co				30.9817	32.0144	30.9817	32.0144	32.0144	30.9817	32.0144	30.9817	32.0144	
Primary loss	32.0144 23.2624	28.9162 21.0112	32.0144 23.2624	30.9817 22.5120	32.0144 23.2624	30.9817 22.5120	32.0144 23.2624	32.0144 23.2624	30.9817 22.5120	32.0144 23.2624	30.9817 22.5120	32.0144 23.2624	
Combi loss Total heat req	0.0000 uired for w	0.0000 water heati	0.0000 ng calculat	0.0000 ed for each	0.0000 n month	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
WWHRS	203.1257	179.8995	191.7943	170.2568 0.0000	166.1451 0.0000	150.9137	149.8179	155.0920	156.0467	172.5654	181.7300	201.1222	
PV diverter Solar input	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000 0.0000	-0.0000 0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000 0.0000	(63b)
FGHRS Output from w/	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
12Total per ye	203.1257	179.8995	191.7943	170.2568	166.1451	150.9137	149.8179	155.0920 Total pe	156.0467 er year (kW	172.5654 h/year) = Si	181.7300 um(64)m =	201.1222 2078.5094 2079	(64)
Electric showe		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Heat gains from					tal Energy us		antaneous e		wer(s) (kWh		m(64a)m =	0.0000	
	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 ga													
Metabolic gain	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m Lighting gains					85.9785 L9a), also s			85.9785		85.9785			
Appliances gai	ns (calcula	ted in App	endix L, eq	uation L13	or L13a), al	Lso see Tab	le 5						
Cooking gains	(calculated	l in Append	ix L, equat	ion L15 or		see Table	5						(68)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	31.5979 0.0000	31.5979 0.0000		31.5979 0.0000		31.5979 0.0000			
	-68.7828	-68.7828			-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	-68.7828	(71)
Water heating	gains (Tabl 125.5124	.e 5) 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		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]			A	rea	Solar flux		g		FF	Acces	ss	Gains	
				m2	Solar flux Table 6a W/m2	Speci: or '	fic data Table 6b	Specific or Tab	data le 6c	facto Table	or 6d	W	
East			9.7	800	19.6403		0.4000	0	.7000	0.77	00	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 Maan intann													
7. Mean intern Temperature du												21.0000	(95)
Utilisation fa	ctor for ga	ins for li	ving area,	nil,m (see			,Tu 1	Aug	Sen	Oct	Nov	21.0000 Dec	(00)
					131.3514								

SAP 10 Online 2.22.1 Page 2 of 7



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 Th 2 20.4888	20.9416 20.4895	20.9824	20.9982 20.4939	20.9999 20.4946	21.0000 20.4982	21.0000 20.4982	21.0000 20.4990	21.0000 20.4968	20.9974 20.4946	20.9592 20.4931	20.8623 20.4917	
util rest of house 0.9084 MIT 2 20.3597	0.8380 20.4295	0.7285 20.4734	0.5611 20.4924	0.4094 20.4945	0.2758 20.4982	0.1897 20.4982	0.2101 20.4990	0.3501 20.4968	0.5939 20.4925	0.8155 20.4531	0.9229 20.3418	(90)
Living area fraction MIT 20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	fLA = 20.8611	Living area 20.8580	/ (4) = 20.8195	0.7239 20.7186	(92)
Temperature adjustment adjusted MIT 20.7365	20.8002	20.8419	20.8586	20.8604	20.8615	20.8615	20.8617	20.8611	20.8580	20.8195	0.0000 20.7186	
8. Space heating requirem	ent											
Jan Utilisation 0.9150 Useful gains 402.1930 Ext temp. 4.3000	Feb 0.8495 410.6080 4.9000	Mar 0.7446 383.4041 6.5000	Apr 0.5784 322.2595 8.9000	May 0.4264 246.9593 11.7000	Jun 0.2927 167.5532 14.6000	Jul 0.2074 114.0349 16.6000	Aug 0.2287 119.2103 16.4000	Sep 0.3700 181.4668 14.1000	Oct 0.6151 275.6287 10.6000	Nov 0.8303 355.3422 7.1000	Dec 0.9283 394.9110 4.2000	(95)
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	
Space heating kWh 34.4826 Space heating requirement	15.2218 - total pe	5.0644 r year (kW	0.4826 h/year)	0.0258	0.0000	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639 106.8588	
Solar heating kWh 0.0000 Solar heating contribution	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Space heating kWh 34.4826 Space heating requirement	15.2218 after sola:	5.0644 r contribu	0.4826 tion - total	0.0258 L per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	0.7152	11.3025	39.5639 106.8588	(98c)
Space heating per m2									(98c)	/ (4) =	2.0953	(99)
Oh Francis requirements												
9b. Energy requirements Fraction of space heat fr											0.0000	(301)
Fraction of space heat fr Fraction of heat from com Factor for control and ch Factor for charging metho Distribution loss factor Efficiency of secondary/s Space heating:	com community munity Heat arging method (Table 4c (Table 12c)	y system pump-Space od (Table (3)) for wa for commun	e and Water 4c(3)) for s ater heating nity heating	space heati							1.0000 1.0000 1.0000 1.0000 1.5000 0.0000	(302) (303a) (305) (305a) (306)
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 307a 51.7239	$= (98) \times 1$ 22.8327	.00 x 1.00 7.5966	x 1.50 0.7238	0.0387	0.0000	0.0000	0.0000	0.0000	1.0728	16.9537	59.3459	
Space heating requirement 51.7239 Efficiency of secondary/s	22.8327 supplementar			0.0387 (from Tabl	0.0000 e 4a or App	0.0000 endix E)	0.0000	0.0000	1.0728	16.9537	59.3459 0.0000	
Space heating fuel for se 0.0000	condary/supposed 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 requ 203.1257		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 310a 304.6886	$= (64) \times 1$			249.2176	226.3705	224.7268	232.6380	234.0701	258.8482	272.5950	301.6832	
	269.8493		255.3852	249.2176	226.3705	224.7268	232.6380	234.0701	258.8482	272.5950	301.6832	
Cooling System Energy Eff Space coolin 0.0000 Pumps and Fa 9.4129	0.0000 8.5020	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	0.0000 9.4129	0.0000 9.1093	0.0000 9.4129	0.0000 9.1093	0.0000 0.0000 9.4129	(315)
Lighting 17.2533 Electricity generated by				7.0527 ity)	5.7621	6.4337	8.3628	10.8625	14.2521	16.0977	17.7328	(332)
Electricity generated by	-17.3811 wind turbine	es (Append:	ix M) (negat		ty)		-31.9409	-27.0282	-20.8422	-13.0490	-9.8067	
(334a)m 0.0000 Electricity generated by							0.0000	0.0000	0.0000	0.0000		(334a)
(335a)m 0.0000 Electricity generated by					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		(335a)
(333b)m 0.0000 Electricity generated by		0.0000 es (Append				0.0000	0.0000	0.0000	0.0000	0.0000		(333b)
(334b)m 0.0000 Electricity generated by							0.0000	0.0000	0.0000	0.0000		(334b)
(335b)m 0.0000 Annual totals kWh/year	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		(335b)
Space heating fuel - comm Space heating fuel - seco Water heating fuel - comm Efficiency of water heate Electricity used for heat	endary nunity heating er	ng									160.2881 0.0000 3117.7641 0.0000 1.6029	(309) (310) (311) (313)
Space cooling fuel Electricity for pumps and	l fans:										0.0000	(321)
(BalancedWithHeatReco mechanical ventilation Total electricity for the Electricity for lighting	very, Databa fans (SFP : above, kWh	= 0. /year	7125)	1.2500, SFF	= 0.7125)						110.8294 110.8294 139.2442	(331)
Energy saving/generation	technologie:	s (Appendi	ces M ,N and	d Q)							-298.1815	(333)
PV generation Wind generation Hydro-electric generation Electricity generated - M											0.0000	(334) (335a)
Appendix Q - special feat Energy saved or generated Energy used Total delivered energy fo	ures										-0.0000 0.0000 3229.9443	(336) (337)
52												•

12b. Carbon dioxide emissions - Community heating scheme

SAP 10 Online 2.22.1 Page 3 of 7



Efficiency of he Space and Water Electrical energ Overall CO2 fact Total CO2 associ Space and water Pumps, fans and Energy for light Energy saving/c PV Unit electric PV Unit electric Total Total CO2, kg/ye EPC Dwelling Car	heating from the state of the s	om Heat pumy distribution in the community state of the community st	on (space ystems		Energy kWh/year 1092.6841 1.6029 110.8294 139.2442 -298.1815 0.0000	kg	factor CO2/kWh 0.1606 0.0000 0.1387 0.1443 0.1331 0.0000	1	Emissions kg CO2/year 300.0000 8.5781 4.6427 0.0486 159.3990 15.3734 20.0972 -39.6916 0.0000 -39.6916 155.1780 3.0400	(367) (372) (386) (373) (376) (378) (379) (380) (383)				
Efficiency of he Space and Water Electrical energ Overall CO2 fact Total CO2 associ Space and water Pumps, fans and Energy for light Energy saving/c PV Unit electric PV Unit electric Total Total Primary er Dwelling Primary	eat source ! heating from y for heat cor for heat cated with heating electric ke cing generation to gity used in city used in city used we hergy kWh/ye	Heat pump om Heat pump distribution to network community sy eep-hot technologies n dwelling ed	ng scheme Don (space ystems									mary energy kWh/year 300.0000 85.1763 49.9480 0.5231 1714.8802 167.6627 213.5774 -444.8499 0.0000 -444.8499 1651.2704 32.3800	(467a) (467) (472) (486) (473) (476) (478) (479) (480) (483)	
SAP 10 WORKSHEET CALCULATION OF T	PFOR New Burners	aild (As De:	signed)	(Version 10	2, February	, 2022)		Area (m2) 51.0000	-	height (m) 2.5000 3d)+(3e)		Volume (m3) 127.5000 127.5000	(4)	· (3b)
	chimneys flues sys / flues attached tr attached ses adjusted Jan 5.1000 1.2750 0.4020	attached to solid fue of solid	o closed 1 boiler ter and fans shelter Mar 4.9000 1.2250 0.3863	fire = (6a)+(6b)- factor Apr 4.4000 1.1000 0.3469	May 4.3000 1.0750 0.3390	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	(20) = 1 - (21) Sep 4.0000	[0.075 x = (18) Oct 4.3000 1.0750 0.3390	0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 0 * 35 = 0 * 40 = 0 * 10 = 0 * 40 = Air change / (5) = 1 x (19)] = x (20) = Nov 4.5000 1.1250 0.3547	0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 es per hour 1.1569 Yes 3lower Door 5.0000 0.4069 3 0.7750 0.3153	(6b) (6c) (6d) (6d) (6e) (6f) (7a) (7b) (7c) (8) (17) (18) (19) (20) (21) (22) (22a) (22b)	
3. Heat losses a Element Main dwelling TER Opac	and heat los	ss paramete:	 r			Net. 2. 9.			A x U W/K	K		0.5686 A x K kJ/K		

SAP 10 Online 2.22.1 Page 4 of 7



		(N) l elements	Aum(A, m2)	19.6500 19.1800	2.4500	19	.2000 .1800 .4800	0.1800 0.1800 30) + (32) =	3.09 3.45 = 21.97	2.4			(29a) (29a) (31) (33)
Main dwelling	Wall 1 (S)	uni (A X U)				19	.1800	0.0000	0.00				(32)
Thermal mass p		MP = Cm / 5	FFA) in kJ/ı	m2K								250.0000	(35)
E3 Sil E4 Jam E20 Ex E7 Par E18 Pa E25 St P3 Par P7 Par	ment er lintels l b posed floor ty floor be rty wall be aggered par ty wall - I ty Wall - E ty Wall - E	(normal) tween dwel: tween dwel: ty wall bet ntermediate xposed floo xposed floo	lings (in b. lings tween dwell: e floor bettor (normal) or (invertee	locks of fl ings ween dwelli d)	ngs (in blo	cks of flat	s)	6 5 18 14 14 8 2 2 14 7	ength .9300 .9100 .0000 .3500 .3500 .2200 .7400 .0000	Psi-value 0.0500 0.0500 0.0500 0.3200 0.0700 0.0600 0.0600 0.0000 0.1600 0.2400	Tot. 0.34 0.29 0.90 4.59 1.00 0.49 0.16 0.00 1.12 1.68	65 55 00 20 45 32 44 00 00	(26)
Point Thermal : Total fabric h	bridges	rsi) caicu.	raceu using	Appendix K	,				(33) + (36)	(36a) = + (36a) =	0.0000	
Ventilation he								_				_	
(38)m Heat transfer	Jan 24.4378	Feb 24.3057	Mar 24.1763	Apr 23.5684	May 23.4547	Jun 22.9252	Jul 22.9252	Aug 22.8272	Sep 23.1292	Oct 23.4547	Nov 23.6848	Dec 23.9253	(38)
Average = Sum(57.0073	56.8753	56.7459	56.1380	56.0243	55.4948	55.4948	55.3968	55.6987	56.0243	56.2543	56.4949 56.1375	
HLP	Jan 1.1178	Feb 1.1152	Mar 1.1127	Apr 1.1007	May 1.0985	Jun 1.0881	Jul 1.0881	Aug 1.0862	Sep 1.0921	Oct 1.0985	Nov 1.1030	Dec 1.1077	
HLP (average) Days in mont	31	28	31	30	31	30	31	31	30	31	30	1.1007	
4. Water heati	ng energy r	equirement:	s (kWh/year)									
Assumed occupa Hot water usag		showers 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.7196	
Hot water usag			0.0000 58.9275	56.5709	54.8063	0.0000 52.8496	51.7927	53.0619	0.0000 54.4438	56.5375	58.9427	0.0000	
Hot water usag			29.8954	28.7230	27.5507	26.3783	26.3783	27.5507	28.7230	29.8954	31.0678	32.2401	
Average daily												85.9708	(43)
Daily hot wate		Feb 91.2734	Mar 88.8229	Apr 85.2939	May 82.3570	Jun 79.2279	Jul 78.1710	Aug 80.6126	Sep 83.1668	Oct 86.4329	Nov 90.0104	Dec	(44)
Energy conte Energy content		129.9721	136.5175	116.7631	110.8683	97.4200	94.5411	99.8152	102.5530	117.2886	128.2364 um(45)m =	93.1468 145.8454 1427.6696	(45)
Distribution 1	oss (46)m 22.1773	= 0.15 x (15)m 20.4776	17.5145	16.6302	14.6130	14.1812	14.9723	15.3830	17.5933	19.2355	21.8768	
Water storage Store volume												150.0000	
a) If manufac Temperature Enter (49) or Total storage	factor from (54) in (55	Table 2b	actor is kn	own (kWh/d	ay):							1.3938 0.5400 0.7527	(49)
If cylinder co	23.3325	21.0745 cated sola:	23.3325 r storage	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
Primary loss Combi loss	23.3325 23.2624 0.0000	21.0745 21.0112 0.0000	23.3325 23.2624 0.0000	22.5798 22.5120 0.0000	23.3325 23.2624 0.0000	22.5798 22.5120 0.0000	23.3325 23.2624 0.0000	23.3325 23.2624 0.0000	22.5798 22.5120 0.0000	23.3325 23.2624 0.0000	22.5798 22.5120 0.0000	23.3325 23.2624 0.0000	(59)
Total heat req	uired for w 194.4438	ater heatin 172.0578	ng calculate 183.1124	ed for each 161.8550	month 157.4632	142.5118	141.1360	146.4101	147.6449	163.8835	173.3282	192.4403	(62)
	-0.0000		0.0000	-0.0000	-0.0000	-0.0000	0.0000	-0.0000	-0.0000	0.0000	-0.0000	-0.0000	(63b)
Solar input FGHRS Output from w/	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	194.4438		183.1124	161.8550	157.4632	142.5118	141.1360				173.3282 um(64)m =	1976.2870	
Electric showe		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			0.0000	(64a)
Heat gains from							antaneous e				m(64a)m = 78.7121	0.0000 85.7695	
5. Internal ga Metabolic gain			oa) 										
(66) m	85.9785		85.9785		May 85.9785			Aug 85.9785	Sep 85.9785	Oct 85.9785	Nov 85.9785	Dec 85.9785	(66)
Lighting gains	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 gai Cooking gains	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)
Pumps, fans	31.5979 3.0000	31.5979 3.0000	31.5979 3.0000	31.5979 3.0000	31.5979		31.5979 0.0000	31.5979 0.0000	31.5979 0.0000	31.5979 3.0000	31.5979 3.0000	31.5979 3.0000	
Losses e.g. ev	aporation (-68.7828	negative va -68.7828	alues) (Tab	le 5)	-68.7828			-68.7828		-68.7828	-68.7828	-68.7828	
	116.1770		111.1129	104.0239	99.6500	95.0911	92.3533	94.7103	97.4616	102.5193	109.3223	115.2816	(72)
Total internal		402.2651	386.8545	373.9739	356.5218	341.6166	329.7184	330.5207	339.7393	353.5886	373.4698	386.7755	(73)
6. Solar gains													

SAP 10 Online 2.22.1 Page 5 of 7



[Jan]				rea m2	Solar flux Table 6a W/m2	Speci or	g fic data Table 6b	Specific or Tab		Acce facto Table	or	Gains W	
East			9.7		19.6403		0.6300		.7000	0.77	00	58.7027	(76)
Solar gains Total gains	58.7027 452.9845	114.8349 517.1000	189.1167 575.9713	275.8155 649.7894	338.0222 694.5441	346.0259 687.6425	329.4308 659.1492	282.9762 613.4969	219.9506 559.6899	136.2613 489.8499	73.1954 446.6652	48.2742 435.0497	
7. Mean inter													
Temperature d						h1 (C)						21.0000	(85)
tau	Jan 62.1265	Feb 62.2707	Mar 62.4127	Apr 63.0886	May 63.2167	Jun 63.8198	Jul 63.8198	Aug 63.9327	Sep 63.5861	Oct 63.2167	Nov 62.9581	Dec 62.6900	
alpha util living a	5.1418 rea 0.9884	5.1514 0.9764	5.1608 0.9464	5.2059 0.8569	5.2144 0.6999	5.2547 0.5086	5.2547 0.3692	5.2622 0.4130	5.2391 0.6535	5.2144 0.9023	5.1972 0.9759	5.1793 0.9904	(96)
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 util rest of	20.4411 house 0.9866	0.9728	0.9385	20.4496	20.4507 0.6677	20.4559	20.4559	20.4569 0.3651	20.4539 0.6100	20.4507	20.4485	20.4461	
MIT 2 Living area f	19.4405	19.6366	19.9131	20.2293	20.3945	20.4488	20.4551	20.4554	20.4274	20.1993 Living area	19.7766	19.4133 0.7239	(90)
MIT Temperature a adjusted MIT	19.7976 djustment 19.7976	19.9945	20.2745	20.5992	20.7792	20.8395	20.8483	20.8474	20.8133	20.5629	20.1312	19.7673 0.0000 19.7673	
adjusted MII	19.7970	19.9943	20.2743	20.3992	20.7792	20.0393	20.0403	20.0474	20.6133	20.3029	20.1312	19.7073	(93)
8. Space heat	ing require												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation Useful gains Ext temp.	0.9840 445.7500 4.3000	0.9695 501.3030 4.9000	0.9358 538.9876 6.5000	0.8433 547.9740 8.9000	0.6872 477.3024 11.7000	0.4967 341.5206 14.6000	0.3566 235.0742 16.6000	0.3996 245.1539 16.4000	0.6389 357.6059 14.1000	0.8885 435.2366 10.6000	0.9688 432.7263 7.1000	0.9866 429.2350 4.2000	(95)
Heat loss rat		858.5045	781.6456	656.7681	508.6551	346.2584	235.7575	246.3701	373.9240	558.1629	733.0601	879.4703	
Space heating Space heating	325.6672	240.0394 t - total pe	180.5376 er vear (kW	78.3318 h/vear)	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750 1490.5750	(98a)
Solar heating	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 Space heating	kWh	on - total p 240.0394		Wh/year) 78.3318	23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	0.0000	(98c)
Space heating Space heating	requirement) / (4) =	1490.5750 29.2270	
9a. Energy re	quirements ·	- Individua	l heating s	ystems, inc	luding micro	-CHP							
Fraction of s	pace heat f	rom seconda:	ry/suppleme									0.0000	,
Efficiency of Efficiency of Efficiency of	main space	heating sys	stem 2 (in	%)								92.3000 0.0000 0.0000	(207)
Space heating	Jan requirement	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating	325.6672 efficiency	240.0394 (main heat:	ing system		23.3264	0.0000	0.0000	0.0000	0.0000	91.4572	216.2403	334.9750	
Space heating		92.3000 heating sys 260.0644		92.3000 84.8665	92.3000 25.2724	0.0000	0.0000	0.0000	0.0000	92.3000 99.0869	92.3000 234.2799	92.3000 362.9199	
Space heating					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Space heating	fuel (main 0.0000	0.0000	stem 2) 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Space heating	fuel (secon 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												
Efficiency of		172.0578 er 84.8066	183.1124 84.0280	161.8550 82.5278	157.4632 80.8574	142.5118 79.8000	141.1360 79.8000	146.4101 79.8000	147.6449 79.8000	163.8835 82.8060	173.3282 84.5570	192.4403	(216)
Fuel for wate	r heating,			196.1217	194.7419	178.5862	176.8621	183.4713	185.0186	197.9126	204.9839	85.2902 225.6300	
Space cooling (221)m	fuel requi: 0.0000	rement 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 Lighting Electricity g	7.3041 15.8911 reperated by	6.5973 12.7485 PVs (Append	7.3041 11.4786 dix M) (neg	7.0685 8.4097	7.3041 6.4959	7.0685 5.3072	7.3041 5.9258	7.3041 7.7025	7.0685 10.0048	7.3041 13.1269	7.0685 14.8268	7.3041 16.3328	
(233a)m Electricity g	-11.4110 renerated by	-17.1730 wind turbin	-26.3354 nes (Append	-31.6653 ix M) (nega	-35.9911 tive quantit	(y)			-26.4446	-20.5310	-12.9298	-9.7441	
(234a)m Electricity g	0.0000 enerated by	0.0000 hydro-elect	0.0000 tric genera	0.0000 tors (Appen	0.0000 dix M) (nega	0.0000 ative quant		0.0000	0.0000	0.0000	0.0000		(234a)
(235a)m Electricity u (235c)m	0.0000 used or net (0.0000 electricity 0.0000	0.0000 generated 1 0.0000	0.0000 by micro-CH 0.0000	0.0000 P (Appendix 0.0000	0.0000 N) (negati 0.0000	0.0000 ve if net g 0.0000		0.0000	0.0000	0.0000	0.0000	(235a) (235c)
Electricity g (233b)m	enerated by -3.5238	PVs (Append	dix M) (nega -15.5498	ative quant -23.9454	ity) -32.2402	-32.5917			-19.4206	-11.0755	-4.7606	-2.7700	
Electricity g (234b)m Electricity g	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)
(235b)m Electricity u	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 generation)	0.0000	0.0000	0.0000		(235b)
(235d)m Annual totals	0.0000 kWh/year	0.0000	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000		(235d)
Space heating Space heating												1614.9242 0.0000	

SAP 10 Online 2.22.1 Page 6 of 7



Space heating fuel - secondary			0.0000 (215)
Efficiency of water heater			79.8000
Water heating fuel used Space cooling fuel			2392.3301 (219) 0.0000 (221)
space costing fact			0.0000 (221)
Electricity for pumps and fans:			
Total electricity for the above, kWh/year			86.0000 (231) 128.2505 (232)
Electricity for lighting (calculated in Appendix L)			128.2505 (232)
Energy saving/generation technologies (Appendices M , N and Q)			
PV generation Wind generation			-504.1606 (233) 0.0000 (234)
Hydro-electric generation (Appendix N)			0.0000 (234) 0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)			0.0000 (235)
Appendix Q - special features			
Energy saved or generated Energy used			-0.0000 (236) 0.0000 (237)
Total delivered energy for all uses			3717.3443 (238)
**			
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP			
	Energy	Emission factor	Emissions
	kWh/year		
Space heating - main system 1 Total CO2 associated with community systems	1614.9242	0.2100	339.1341 (261) 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 Total	-212.6698	0.1252	-26.6231 -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			
		imary energy factor	Primary energy
		kg CO2/kWh	kWh/year
Space heating - main system 1	1614.9242	1.1300	
Total CO2 associated with community systems Water heating (other fuel)	2392.3301	1.1300	0.0000 (473) 2703.3330 (278)
Space and water heating	2392.3301	1.1300	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 Total Primary energy kWh/year			-532.7074 (283) 4322.3056 (286)
Target Primary Energy Rate (TPER)			84.7500 (287)

SAP 10 Online 2.22.1 Page 7 of 7





