Energy Strategy

Godwin and Crowndale Estate, NW1 1PA

Iceni Projects Limited on behalf of
The London Borough of Camden

August 2020

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1. EXECUTIVE SUMMARY

1.1 Iceni Projects Ltd was commissioned by the London Borough of Camden to produce an Energy Strategy for the proposed development at the Godwin and Crowndale Estate.

1.2 This document details the carbon dioxide (CO_2) emissions reduction measures adopted by the proposed development and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme.

1.3 The objective of the proposals is to replace an underused MUGA and area of private car parking with 10 high-quality and sustainable family-sized dwellings along with associated public realm and landscaping improvements to the wider estate.

1.4 The proposed scheme is a pilot for the off-site manufacturing programme. If successful, it is anticipated that the methods, approaches and technical solutions developed for the pilot project will be applied to other development projects within Camden's community investment programme (CIP), forming an off-site manufacturing programme of works. Additionally, the approach could also be scaled up to assist with the development of other larger CIP schemes.

1.5 The energy strategy for the proposed development has been assessed using the Greater London Authority's (GLA) methodology set out in the London Plan and associated documents. This approach is consistent with that required by the London Borough of Camden Local Plan Policy CC1, and therefore represents best practice in meeting the required standards of energy efficiency and carbon dioxide (CO_2) emissions reduction.

1.6 The proposed energy strategy is based upon the principles of the Energy Hierarchy on the basis that it is preferable to reduce carbon dioxide emissions through reduced energy consumption above decarbonisation through alternative energy sources.

1.7 The key measures proposed to minimise carbon dioxide emissions from the proposed development are set out below.

1.8 The proposed 'Be Lean' measures include:

- High levels of building fabric insulation to minimise heat loss
- A balanced proportion of façade glazing to ensure natural daylight provision without increasing overheating risk
- High levels of air tightness to reduce heat loss through infiltration

- The use of accredited construction details to minimise heat loss through thermal bridging
- Low energy LED lighting to minimise artificial lighting energy consumption
- Mechanical ventilation with heat recovery to provide fresh air, with heat recovered from extract air
- A high specification of heating controls to ensure operational efficiency

1.9 The 'Be Green' measures include:

- Employment of highly efficient, air source heat pump (ASHP) systems

1.10 Incorporation of the measures outlined above will deliver savings of 11.14 tCO_2 per year for the proposed dwellings, which equates to a 54.8% improvement over the Part L 2013 baseline. The level of domestic emissions reduction achieved for each stage of the Energy Hierarchy is shown below.

Figure 1.1 Carbon dioxide emissions savings after each stage of the Energy Hierarchy

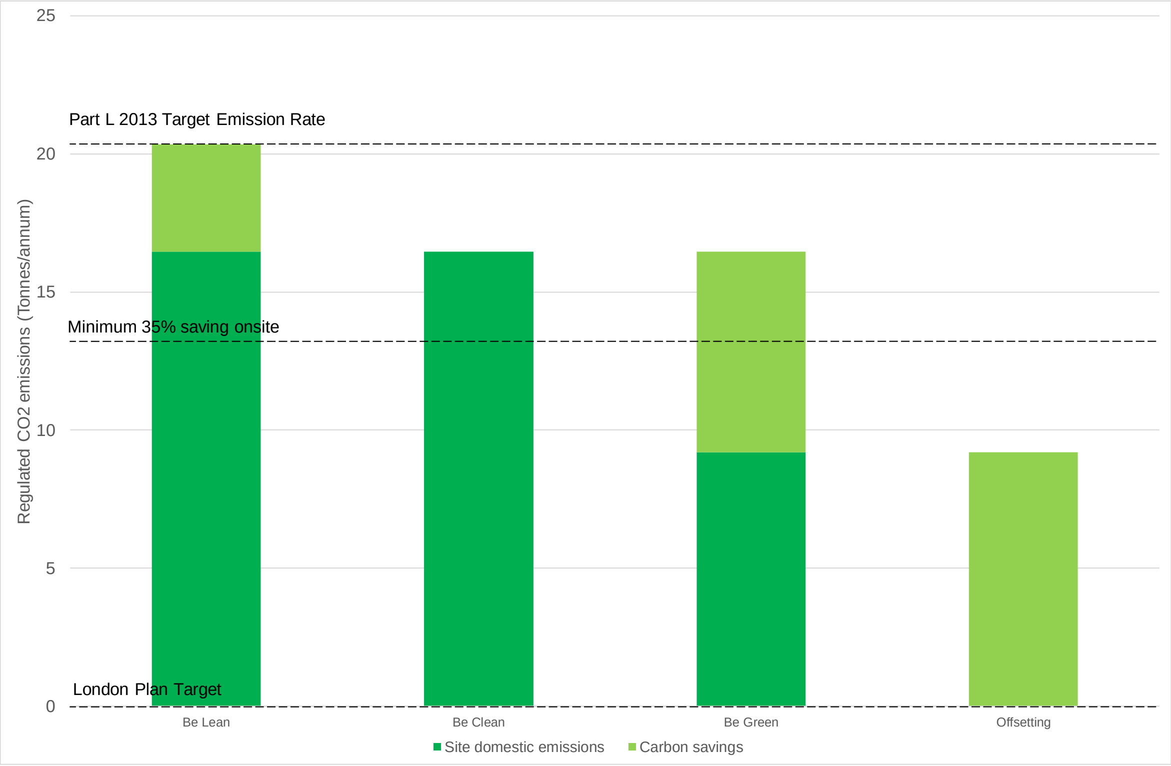


Table 1.1 Carbon dioxide emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions for domestic buildings (Tonnes CO_2 per annum)
Baseline: Part L 2013 of the Building Regulations Compliant Development	20.34
After energy demand reduction	16.45
After renewable energy	9.20

Table 1.2 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Savings from energy demand reduction	3.89	19.1%
Savings from renewable energy	7.25	35.6%
Cumulative on-site savings	11.14	54.8%
Carbon shortfall	9.20	
	(Tonnes CO_2)	
Cumulative savings for offset payment	276	
Cash in-lieu contribution	£26,224	

1.11 Overall, the proposals are therefore in accordance with national, local and regional policy requirements, and will provide a development that seeks to promote these principles in operation.

2. INTRODUCTION

2.1 Iceni Projects Ltd was commissioned by the London Borough of Camden to produce an Energy Strategy for the proposed development at the Godwin and Crowndale Estate.

Report Objective

2.2 This document details the carbon dioxide (CO_2) emissions reduction measures adopted by the proposed development and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme. The Energy Strategy report headlines will provide a framework for the project team to operate consistently within sustainability guidelines set out by the Greater London Authority and the London Borough of Camden.

2.3 The report is structured to meet these guidelines as follows:

- Section 3 discusses the planning context and policies which are relevant to energy;
- Section 4 discusses the development response to the policy drivers for energy; and
- Section 5 summarises the development's design response.

Site and Surroundings

2.4 The application site (Appendix A1) is situated on the Godwin and Crowndale Estate, to the north-west of Chalton Street, approximately 0.3 miles east of Mornington Crescent Underground Station.

2.5 The site currently comprises a car park and Multi-Use Games Area (MUGA) with the southern boundary of the Godwin and Crowndale Estate.

2.6 The site lies adjacent to the pedestrianised continuation of Chalton Street and close to the junction with Charrington Street. Part of the site is currently accessed through the existing open space of Godwin Court, whilst the existing enclosed car parking element of the site is accessed via the Crowndale Court access road.

The Proposed Development

2.7 The scheme proposes the redevelopment of the site to provide a total of 10 new residential dwellings to provide additional social rented units for the Godwin and Crowndale Estate. The single terrace of three storey dwellings each has four bedrooms.

2.8 The project is part of the Council's Community Investment Programme (CIP). The CIP is London Borough of Camden's 15-year plan (2010-2025) to invest money in schools, homes and community facilities. To help deliver the CIP vision, Camden are investigating procurement options for the provision of new housing to meet the housing need within the Borough. Initial studies have identified that modern methods of construction could offer substantial benefits to the Council in meeting this need. Off-site manufacturing in particular has been noted as providing a good fit to the Council's development drivers.

2.9 The proposed scheme is a pilot for the off-site manufacturing programme. If successful, it is anticipated that the methods, approaches and technical solutions developed for the pilot project will be applied to other development projects within the CIP, forming an off-site manufacturing programme of works. Additionally, the approach could also be scaled up to assist with the development of other larger CIP schemes.

2.10 The site was initially identified through a wider assessment of the estate and due it its location, urban context and restricted vehicular access, it was considered a good test for off-site manufacturing approaches to construction, delivering 10 family sized, social rent, car-free homes for the estate.

2.11 The objective of the proposals is to replace an underused MUGA and area of private car parking with 10 high-quality and sustainable family-sized dwellings along with associated public realm and landscaping improvements to the wider estate.

2.12 The images below show elevations of the scheme.

Figure 2.3 Front elevation

Figure 2.4 Rear elevation

2.13 Overall, the proposals would provide the following floor areas and unit mix.

Table 2.1 Development area and unit mix

Residential Unit	Mix	Proposed GIA (m^2)
Unit 1	4 bed 6 persons	137
Unit 2	4 bed 6 persons	113
Unit 3	4 bed 6 persons	113
Unit 4	4 bed 6 persons	113
Unit 5	4 bed 6 persons	113
Unit 6	4 bed 6 persons	113
Unit 7	4 bed 6 persons	113
Unit 8	4 bed 6 persons	113
Unit 9	4 bed 6 persons	113
Unit 10	4 bed 6 persons	117
TOTAL		1,412

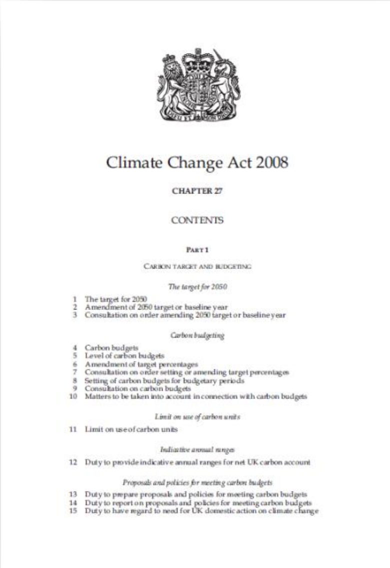
3. PLANNING AND REGULATORY CONTEXT

3.1 Built environment energy efficiency and carbon dioxide emissions are incorporated within policy and regulation at a national, regional and local level, as set out below.

National

Climate Change Act 2008

3.2 On 26th November 2008, the UK Government published the Climate Change Act 2008; the world's first long-term legally binding framework to mitigate against climate change. Within this framework, the Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target set out in the Energy White Paper, to 80% by 2050.


Climate Change Act 2008

CHAPTER 27

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PART 1

CARBON TARGET AND BUDGETING

The target for 2050

1 The target for 2050
2 Amendment of 2050 target or baseline year
3 Consultation on order amending 2050 target or baseline year

Carbon budgeting

4 Carbon budgets
5 Level of carbon budgets
6 Amendment of target percentages
7 Consultation on order setting or amending target percentages
8 Setting of carbon budgets for budgetary periods
9 Consultation on carbon budgets
10 Matters to be taken into account in connection with carbon budgets

Limit on use of carbon units

11 Limit on use of carbon units

Indicative annual ranges

12 Duty to provide indicative annual ranges for net UK carbon account

Proposals and policies for meeting carbon budgets

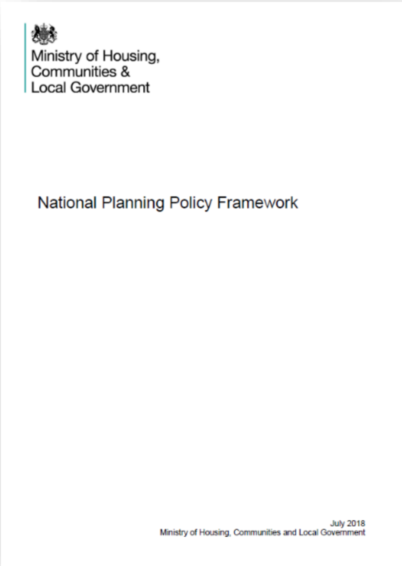
13 Duty to prepare proposals and policies for meeting carbon budgets
14 Duty to report on proposals and policies for meeting carbon budgets
15 Duty to have regard to need for UK domestic action on climate change

3.3 As required under Section 34 of the Climate Change Act, the Fifth Annual Carbon Budget was accepted by the Government in June 2016. This sets out a budget for UK emissions for the period 2028 – 2032.

3.4 Following a commitment in June 2019, the Climate Change Act has been amended to target net zero carbon emissions by 2050.

National Planning Policy Framework

3.5 The Ministry of Housing, Communities & Local Government determines national policies on different aspects of planning and the rules that govern the operation of the system. Accordingly, the National Planning Policy Framework (NPPF), which came into force in March 2012 and was updated in February 2019, aims to strengthen local decision making.


Ministry of Housing, Communities & Local Government

National Planning Policy Framework

July 2018
Ministry of Housing, Communities and Local Government

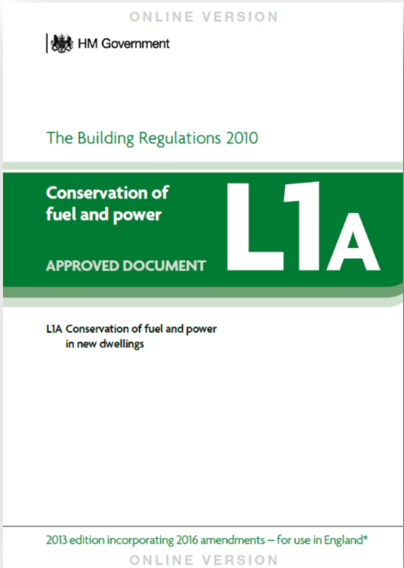
3.6 Paragraphs 10 and 11 of the NPPF confirms that the heart of this document is a "*presumption in favour of sustainable development*", and that development proposals that accord with an up-to-date development plan should be approved without delay.

Building Regulations Part L

3.7 Part L of the Building Regulations relates to the conservation of fuel and power, and applies to both new and existing buildings. The current edition covers the energy efficiency requirements of the building regulations as set out in Part L of Schedule 1 to the Building Regulations. Technical guidance is contained in four Part L Approved Documents and two building services compliance guides.

3.8 The documents of relevance to this scheme include:

- **Approved Document L1A:2013.** This provides the methodology for new build, domestic buildings to meet current energy efficiency standards, including backstop U-values, carbon dioxide emissions calculations and minimising the risk of overheating. Carbon dioxide emissions reductions are prescribed for 'regulated' emissions only, and relate to heating, hot water, lighting, auxiliary and cooling (where specified). Emissions from domestic appliances (cooking, for example) are considered to be unregulated emissions, and are excluded from the analysis.



- **Domestic Building Services Compliance Guide.** This provides minimum building services efficiencies for domestic buildings.

Regional

3.9 Within Greater London, key sustainable development principles for economic, environmental and social improvement are set out below:

The London Plan (March 2016)

3.10 The London Plan is the overall strategic plan for London and includes policies for sustainable development and energy within Chapter 5 (London's response to climate change). Key policies of relevance to this scheme are as follows:

- **Policy 5.2 Minimising Carbon Dioxide Emissions.** This states that development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

  1. Be lean: use less energy
  2. Be clean: supply energy efficiently
  3. Be green: use renewable energy

- **Policy 5.3 Sustainable Design and Construction.** This states that development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

- **Policy 5.6 Decentralised Energy in Development Proposals.** This states that major development proposals should select energy systems in accordance with the following hierarchy:

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

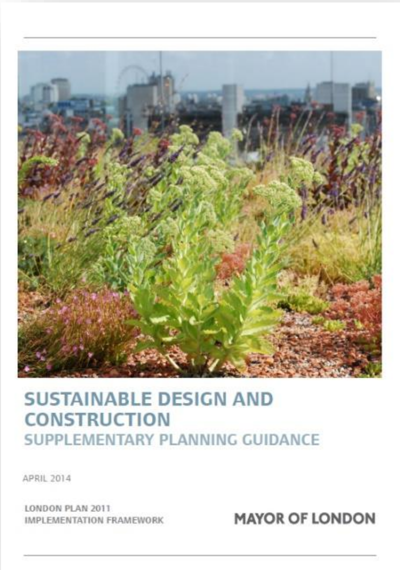
- **Policy 5.7 Renewable Energy.** This states that major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

- **Policy 5.9 Overheating and Cooling.** This states that major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

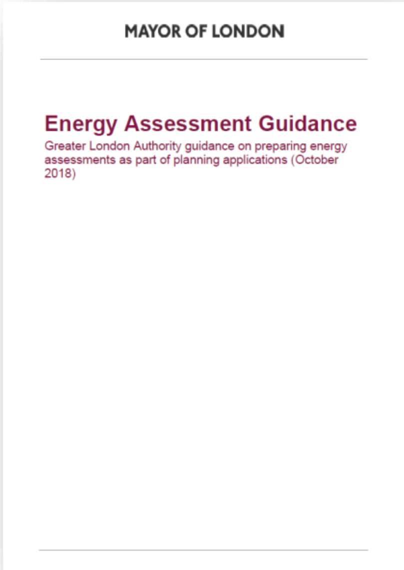
  1. Minimise internal heat generation through energy efficient design
  2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
  3. Manage the heat within the building through exposed internal thermal mass and high ceilings
  4. Passive ventilation
  5. Mechanical ventilation
  6. Active cooling systems (ensuring they are the lowest carbon options).

Sustainable Design and Construction Supplementary Planning Guidance (SPG) (April 2014)

3.11 This document provides guidance on the implementation of London Plan policy 5.3 ‘Sustainable Design and Construction’ as well as a range of policies relating to environmental sustainability. The document contains best practice and priority targets for a wide range of issues related to sustainable design and construction, grouped into three categories: resource management, adapting to climate change and greening the city, and pollution management.



Energy Planning – GLA guidance on preparing energy assessments (October 2018)


MAYOR OF LONDON

Energy Assessment Guidance

Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018)

3.12 The guidance note provides further detail on addressing the London Plan's energy hierarchy through the provision of an energy assessment to accompany planning applications. The document sets out the expected carbon dioxide emissions targets for the following building types:

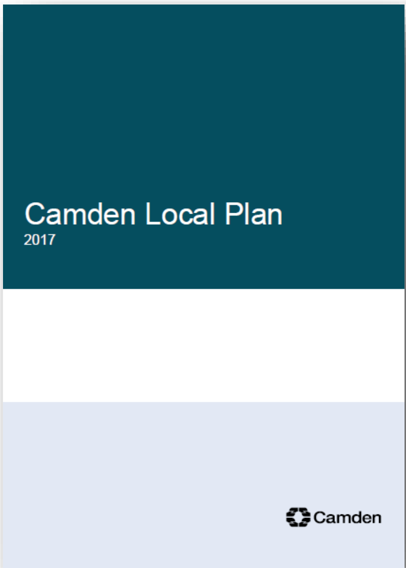
- New build residential buildings are expected to meet a zero-carbon target. This is made up of a minimum 35% reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100%, are to be offset through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

3.13 The latest "Energy Assessment Guidance" (October 2018) states that from January 2019 "planning applicants are encouraged to use the SAP 10 emission factors for applications when estimating CO_2 emission performance against London Plan policies".

Local

3.14 In determining the local context, the London Borough of Camden policy is gained through the Camden Local Plan, adopted in July 2017.

Camden Local Plan (adopted July 2017)



3.15 The Camden Local Plan is the key strategic document in Camden's development plan. It sets out the vision for shaping the future of the Borough and contains policies for guiding planning decisions. Policies of relevance to this project in the context of sustainability and energy are as follows:

- **Policy CC1 (Climate change mitigation)** states that the Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. The Council will:

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

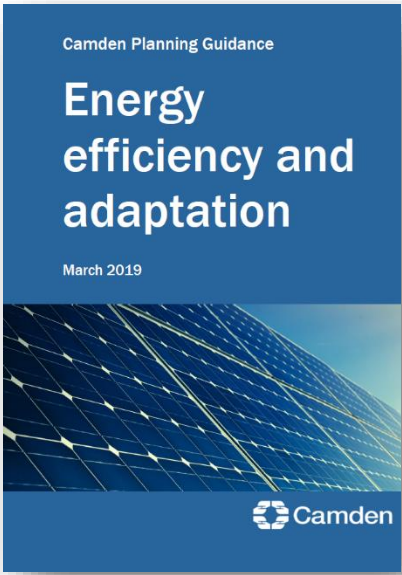
The Council will promote decentralised energy by:

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

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

- **Policy CC2 (Adapting to Climate Change)** states that the Council will promote and measure sustainable design and construction by:
    - Ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation; and
    - Encouraging new build residential development to use the Home Quality Mark and Passivhaus design standards.

Camden Planning Guidance: Energy Efficiency and Adaptation (March 2019)



3.16 This document supports the policies outlines in the Camden Local Plan 2017. This planning guidance document provides information on key energy and resource issues within Camden, and supports Local Plan Policies CC1 (Climate change mitigation) and CC2 (Adapting to climate change).

London Borough of Camden Sustainability Statements in Planning Applications website (accessed April 2020)

3.17 This states that, from January 2020, the Council considers a carbon offset cost of £95 per tonne for 30 years to be appropriate. This would equate to £2,850 per tonne of residual carbon dioxide emitted by the development.

Declaration of a Climate Emergency (April 2019)

3.18 In April 2019, Camden Council declared a Climate Emergency, alongside a commitment to achieve a target of net zero emissions by 2030. In July 2019, Camden held the UK's first Citizens' Assembly on the climate crisis. The Assembly proposals will inform a new Climate Action Plan for Camden, which will be published in 2020.

Other Considerations

The Draft London Plan (December 2017 and updated July 2019)

3.19 Although not formally adopted, it is expected that the updated London Plan will be adopted in 2020. Given the relative weight attributed to this document, there are a number of key policies of relevance to this scheme, as follows:

- **Policy SI2 Minimising Greenhouse Gas Emissions.** This policy extends the zero-carbon requirement to new non-domestic buildings. The policy adds a fourth layer to the energy hierarchy which requires development to monitor, verify and report on energy performance in operation. In addition, development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

- **Policy SI3 Energy Infrastructure.** This policy recognises that combined heat and power installations can have negative effects on London's air quality and shifts the focus of decentralised energy networks to the use of waste or secondary heat sources, where available. The policy also recognises that, compared to increasingly decarbonised electricity generation, gas-fired heat will become comparatively more carbon intensive as the electricity grid is further decarbonised.

- **Policy SI4 Managing Heat Risk.** This policy sets out the standards that should be used to assess and mitigate overheating risk in new developments. CIBSE TM59 should be used for domestic developments and CIBSE TM52 should be used for non-domestic developments. In addition, CIBSE TM49 guidance and datasets should also be used to ensure that all new development is designed for the climate it will experience over its design life.

4. ENERGY ASSESSMENT

4.1 The energy strategy for the proposed development has been assessed using the Greater London Authority's (GLA) methodology set out in the London Plan and associated documents. This approach is consistent with that required by the London Borough of Camden, and therefore represents best practice in meeting the required standards of energy efficiency and carbon dioxide (CO_2) emissions reduction.

4.2 In line with the GLA London Plan Policy 5.2 and Camden policy CC1, the scheme will aim to achieve a minimum 35% carbon dioxide emissions reduction through on-site means. In addition, the residual emissions will be offset to zero via cash in-lieu payment to the London Borough of Camden. The London Borough of Camden's suggested price of £95 per tonne over 30 years will be employed.

4.3 As outlined in Section 3, the October 2018 update to the GLA Guidance on Energy Assessments encourages the use of SAP 10 carbon emission factors from January 2019 onward. This is due to the significant progress in decarbonising the UK electricity grid since the previous update of Part L in April 2014. The SAP 10 carbon emission factors, which are used within this Energy Assessment, are as follows:

- Natural Gas: 0.210 $kgCO_2$/kWh
- Electricity: 0.233 kg/CO_2/kWh

Energy Strategy

4.4 With reference to the policy requirements, guidance and industry best practice detailed in Section 3, a comprehensive energy and carbon dioxide (CO_2) emissions assessment has been carried out for the proposed development. The energy performance of the scheme has been analysed and evaluated to target a high level of CO_2 emissions performance when assessed against Part L 2013 of the Building Regulations and associated policies, accounting for economic, technical and functional feasibility.

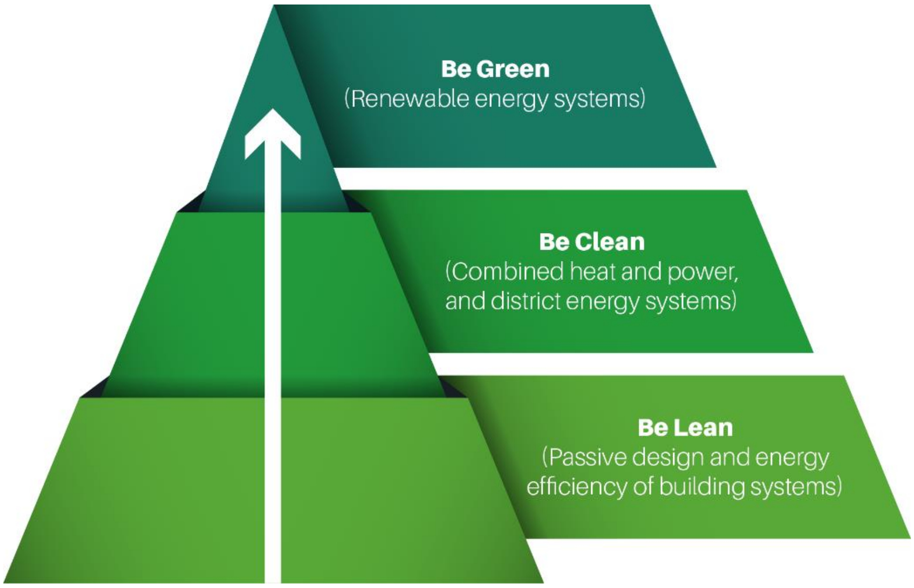
4.5 The proposed energy strategy is based upon the principles of the Energy Hierarchy on the basis that it is preferable to reduce carbon dioxide emissions through reduced energy consumption above decarbonisation through alternative energy sources.

4.6 The tiers of the Energy Hierarchy are:

- Be Lean   Use less energy
- Be Clean   Supply energy efficiently

- Be Green Use renewable energy

Figure 4.1 The Energy Hierarchy



'Be Lean' (Use Less Energy)

4.7 Within the first stage of the energy hierarchy, it is proposed to incorporate high levels of passive and energy efficient design measures in order to reduce the development's energy consumption and associated CO_2 emissions.

4.8 It is technically possible to exceed Building Regulations requirements (Part L 2013) through demand reduction measures alone and it is an expectation that new buildings are able achieve this as a means of demonstrating the extent to which passive design principles have been incorporated into the development, without reliance on renewable energy generation.

4.9 The proposed development includes a wide range of energy efficiency measures, intended to reduce energy demand.

4.10 The massing and orientation of the individual dwellings are constrained by the overall masterplan in terms of delivering the required density, preventing overlooking and ensuring daylight and sunlight provision. Despite this, passive design of the dwellings includes a number of specific energy efficiency features.

4.11 The following U-values are proposed as a means of limiting heat loss through the building fabric.

Table 4.1 Proposed building fabric U-values

Building Fabric Element	Part L1A:2013 backstop U-values (W/m^2K)	Proposed U-values (W/m^2K)
Ground floor	0.25	0.12
External wall	0.30	0.15
Roofs	0.20	0.12
Windows	2.00 (including frame)	1.50 (including frame)
Doors	2.00 (including frame)	1.40 (including frame)

4.12 The glazing will be double glazed, argon filled with a low emissivity coating. Although this has yet to be formally specified, it is expected that window U-values will be 1.5 W/m^2K or better (including frame), with a g-value of 0.63 and light transmission of ~70% to improve natural daylight penetration.

4.13 A high level of air tightness is proposed, where a level equal to or below $3m^3/h/m^2$ shall be targeted, meaning that air infiltration between the internal and the external environment will be largely controlled, and space heating/cooling demand further reduced.

4.14 The other significant means of heat loss from dwellings is due to thermal (or cold) bridging. This is typically a construction detail which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer. Thermal bridges result in an overall reduction in thermal resistance of the building elements and should be designed out where possible to minimise unwanted heat loss. In order to minimise heat loss through thermal bridges, accredited construction details have been assumed, with an equivalent y-value of 0.05 for each dwelling.

4.15 High efficiency plant, equipment and controls are proposed to limit the energy consumed in order to provide the required level of indoor environmental performance and control. Performance efficiency values were tested and improved in energy models to benchmark the resulting predicted CO_2 reduction.

- Low energy LED lighting will be installed throughout the dwellings.
- In order to meet the requirements of the GLA's Energy Planning Guidance document under the 'Be Lean' scenario, space and water heating demand within the residential units is served by individual gas-fired boilers with an efficiency of 89%.

- Residential units are provided with opening windows to mitigate against overheating and to provide outside air during warmer months.

- In order to meet outside air supply requirements during other times of the year, a mechanical ventilation with heat recovery (MVHR) unit will be provided with a specific fan power of approximately 0.59 W/l/s and a heat exchange efficiency of 89%. A summer bypass will be included for use in warmer months.

- Energy usage for each dwelling will be separately metered to ensure that charging for energy is linked to usage.

- Heating will be controlled via the suitable arrangement of plumbing and electrical services.

4.16 Energy modelling of the proposed scheme has been undertaken using the Standard Assessment Procedure (SAP) for one of the proposed units, located in a mid-terrace. This was deemed to be an effective means of assessment, given the high level of similarity between the dwellings. Carbon dioxide emissions results from the test dwelling have then been extrapolated to match the total floor area proposed.

4.17 The carbon dioxide emissions for the residential component, under the ‘Be Lean’ tier of the Energy Hierarchy, and using the SAP 10 carbon emission factors, are shown below. DER and TER worksheets showing the ‘Be Lean’ performance of the sample dwelling modelled are provided in Appendix A2.

Figure 4.3 Domestic carbon dioxide emissions (Be Lean)

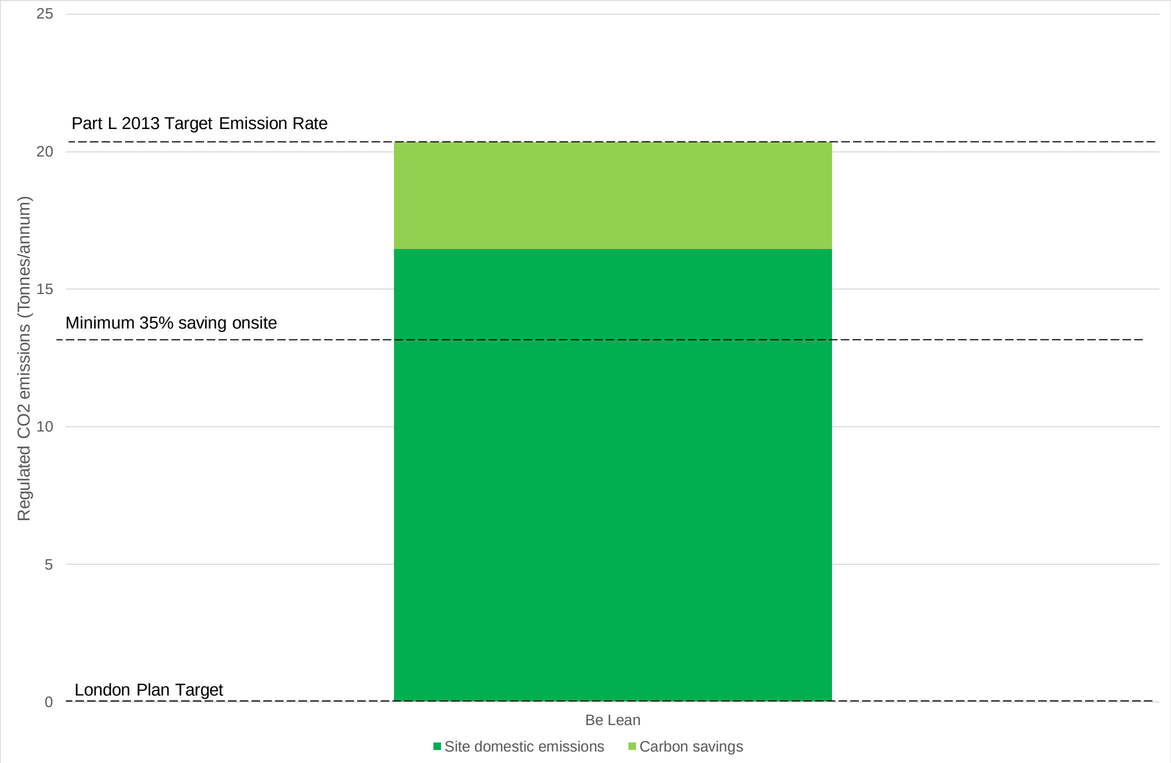


Table 4.2 Domestic carbon dioxide emissions (Be Lean)

TER: Baseline: Part L 2013 Emissions (Tonnes CO_2 per annum)	DER: Proposed 'Be Lean' Emissions (Tonnes CO_2 per annum)	Emissions Savings (Tonnes CO_2 per annum)	Emissions Savings (%)
20.34	16.45	3.89	19.1%

4.18 The above analysis shows that the proposed development achieves a carbon dioxide emissions saving of 19.1% through energy efficiency measures alone, under the 'Be Lean' scenario.

'Be Clean' (Supply Energy Efficiently)

4.19 The potential for the proposed development to incorporate a low carbon heating/cooling system has been reviewed for the scheme, in line with the hierarchy presented in London Plan policy 5.6, copied below.

1. Connection to existing heating or cooling networks;

2. Site wide CHP network; and

3. Communal heating and cooling;

4.20 The London Heat Map is a tool provided by the Mayor of London to identify opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study.

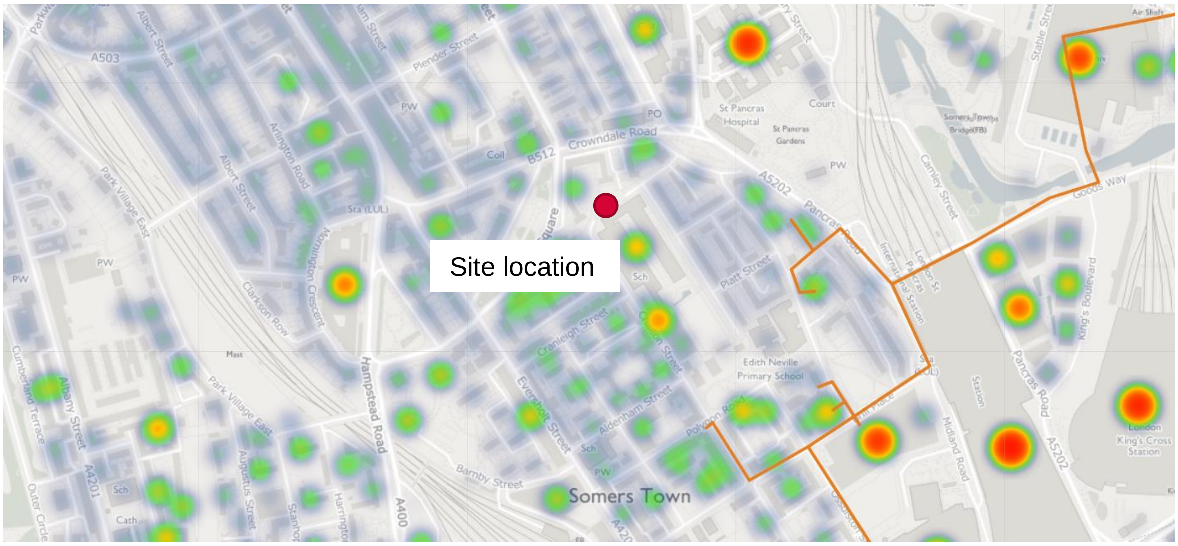
4.21 The image below is an extract from the London Heat Map, showing the area in the vicinity of the site. It illustrates;

- Heat demand (areas of heat demand are shown in red, with areas with a high density of heat demand appearing more opaque and areas of zero heat demand appearing transparent);

- Existing heat networks (shown as red lines); and

- Proposed heat networks (shown as orange lines).

Figure 4.5 Extract from the London heat map



4.22 The extract above indicates that the proposed development site is located within an area of medium heat density. It is located approximately 400m from part of the proposed Euston Road district heat network.

4.23 An extract from the London Borough of Camden Borough Wide Heat Demand and Heat Source Mapping report is shown above. This indicates that there are potential sources of heat in the area, with an existing heat network in the vicinity.

4.24 However, given the relatively small scale of the development and connection costs, it is unlikely that connecting to nearby district heating schemes will be feasible. Approximate costs are likely to be in the region of £1,500 - £2,000 per metre, giving a connection cost of £600,000 - £800,000 for 400m of additional district heating infrastructure. There are also a number of utility constraints on the site, including a gas main and LV cable. Potential diversions are required for combined sewer, water and LV, subject to the adopted construction methodology, which would add to the technical complexity of connection to a district heat network.

4.25 The use of CHP is also considered to be unviable for the proposed site, based on the most up-to-date GLA energy guidance, which looks to move away from the use of natural gas to meet space and water heating demands. It is therefore recommended that an air source heat pump (ASHP) system is employed to service the development. The incorporation of heat pump technology is discussed in greater detail in the 'Be Green' section.

4.26 'Be Clean' carbon dioxide emissions are therefore identical to those set out under the 'Be Lean' scenario.

‘Be Green’ (Utilise Renewable Technologies)

4.27 A full review of potentially applicable renewable technologies has been carried out, considering both the effectiveness and viability of the different technologies. Full details of the assessment and outcomes are provided in Appendix A3.

4.28 Given the site location, lack of viable existing or proposed heat networks, and the emergence of the draft SAP 10 carbon factors, it is proposed that air source heat pump (ASHP) technology is employed to serve the heating and hot water demands of the proposed scheme.

4.29 Highly efficient, individual air source heat pump (ASHP) systems will be employed to serve both the space and water heating demand. Typical manufacturer specifications for the proposed system quote a heating coefficient of performance of 4.35. Whilst the specified system operates quietly, as the design progresses, acoustic measures to further limit the noise generated by the outside unit of the system during operation will be considered.

4.30 Although the placement of rooftop PV panels would provide renewable electricity generation on-site, further reducing development carbon dioxide emissions, the orientation of the site and roofs means that only 50% of the roof space faces south-west. Roofs facing north-east will receive less solar gain. In addition, a significant portion of the site is overshadowed by a large tree to the south. Both of these factors would reduce the output of PV panels considerably, and it is therefore considered that rooftop PV is unsuitable for this development.

Figure 4.6 The site and surrounding tall trees

4.31 The domestic ‘Be Green’ energy analysis was carried out on the same dwellings as detailed above.

4.32 The carbon dioxide emissions for the residential component, under the 'Be Green' tier of the Energy Hierarchy, and using the SAP 10 carbon emission factors, are shown below. DER and TER worksheets showing the 'Be Green' performance of the sample dwelling modelled are provided in Appendix A2.

Figure 4.7 Domestic carbon dioxide emissions (Be Green)

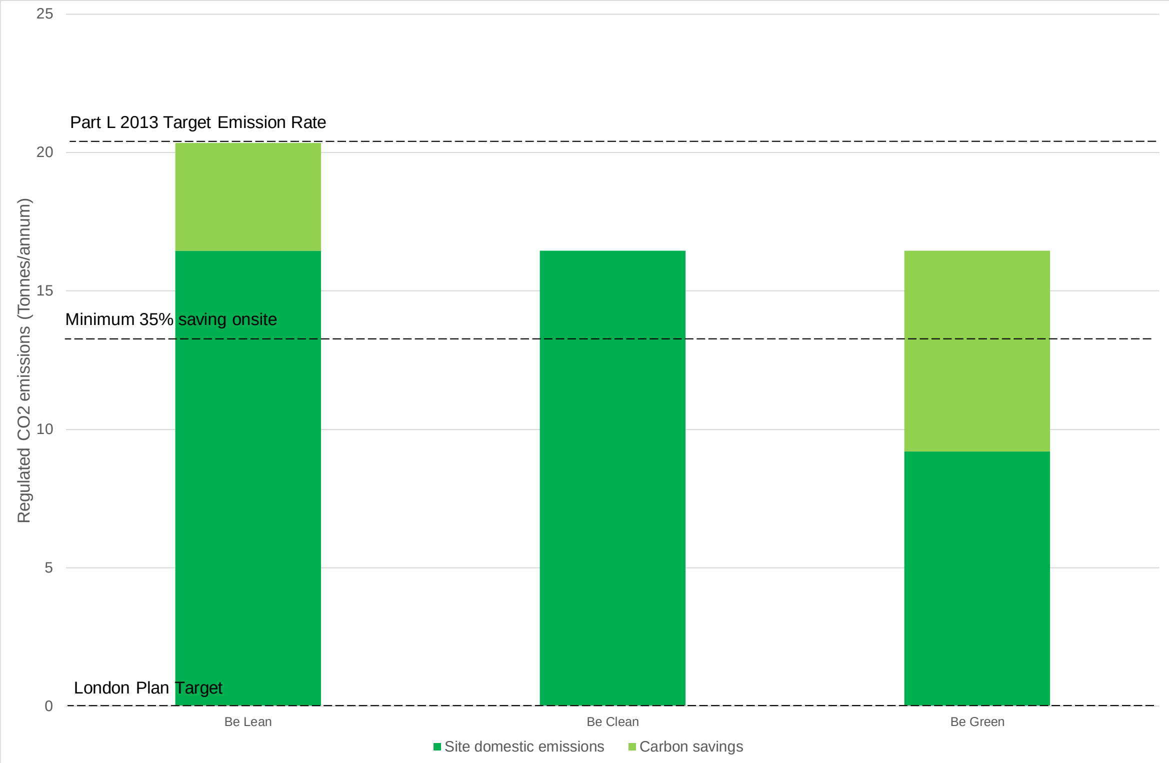


Table 4.3 Domestic carbon dioxide emissions (Be Green)

TER: Baseline: Part L 2013 Emissions (Tonnes CO_2 per annum)	DER: Proposed 'Be Green' Emissions (Tonnes CO_2 per annum)	Cumulative Emissions Savings (Tonnes CO_2 per annum)	Cumulative Emissions Savings (%)
20.34	9.20	11.14	54.8%

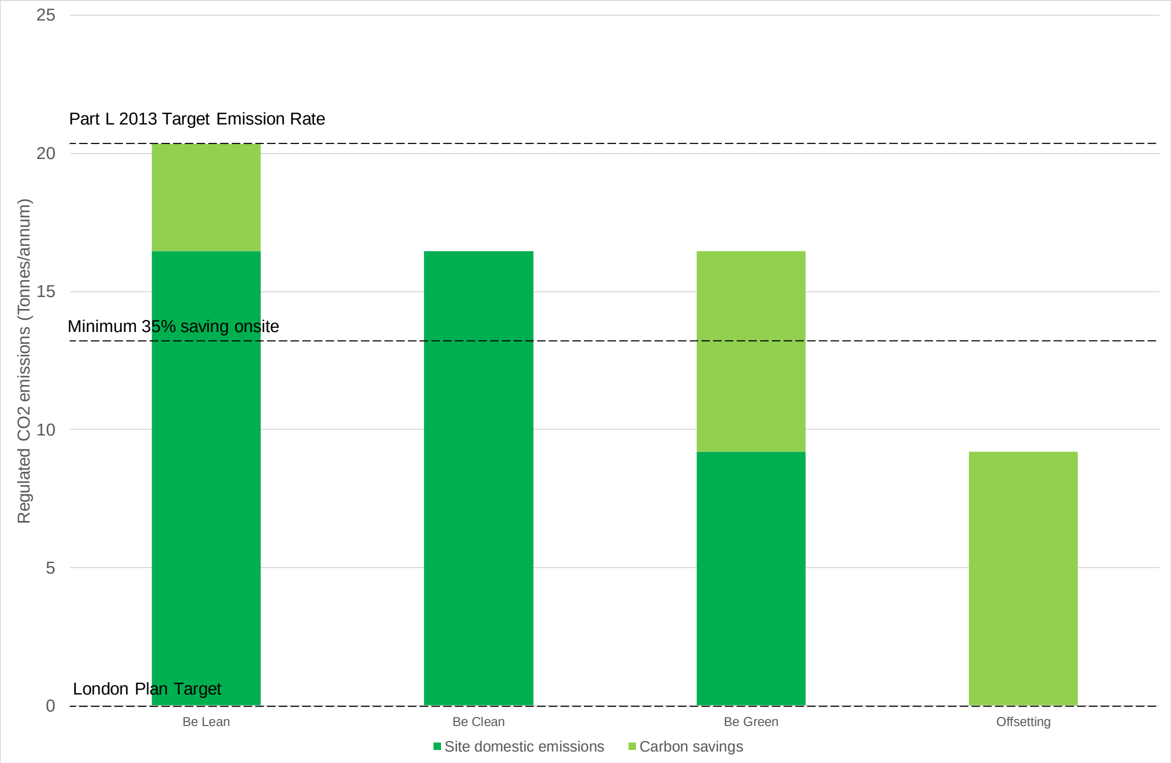
4.33 The above analysis shows that the proposed development achieves a carbon dioxide emissions saving of 54.8% through energy efficiency measures and renewable technologies, under the 'Be Green' scenario.

Carbon Offsetting

4.34 As per the requirements of London Plan policy 5.2, new build residential buildings are expected to meet a zero-carbon target. Where the residential component of a development is unable to meet the zero-carbon target through on-site means alone, the remaining regulated carbon dioxide emissions, to 100%, are to be offset through a cash in lieu contribution to local authorities to be ringfenced to secure delivery of carbon dioxide savings elsewhere.

4.35 Based on the information presented in Table 4.7 above, a total of 276 tonnes of residual carbon dioxide are required to be offset from the residential component over a period of 30 years. Using the Council's proposed carbon dioxide price of £95 per tonne, the 276 tonnes therefore result in an offset cost of £26,224.

Figure 4.9 Carbon dioxide emissions after offsetting



Cooling and Overheating

4.36 The design of both the residential and non-domestic elements has been developed in line with the GLA's recommended 'Cooling Hierarchy' approach, detailed in London Plan policy 5.9 and Camden Local Plan policy CC2. This applies a similar principle to the thorough decision-making process of the Energy Hierarchy, with the aim of reducing CO_2 emissions from cooling and minimising the risk of overheating where no cooling is present:

Minimisation of internal heat generation through energy efficient design

- Heat gain from lighting is kept to a minimum as a result of an energy-efficient lighting design solution.
- The availability of natural light is maximised by optimising the light transmittance of the glass elements of the façade.
- Heat gains from equipment will be minimised through the specification of low energy systems.
- Heat distribution pipework will be fully insulated to prevent unwanted heat loss.
- The scheme will use individual air source heat pumps, which is a low temperature distribution system, leading to lower internal heat gains from distribution pipework.

Reduction of the amount of heat entering the building in summer

- The building's façades have a limited amount of glazing to mitigate direct solar heat gain while optimising daylight penetration.
- The use of blinds will provide solar shading and glare protection to houses.

Management of the heat within the building through exposed thermal mass and high ceilings

- Generous floor to ceiling heights of 2.7m (ground and first floors) and up to 3.4m (second floor) will allow internal heat to rise and stratify above occupied areas.
- The habitable rooms are distributed across three storeys allowing heat to rise and exit the building due to the stack effect.

Passive ventilation

- Openable windows on multiple aspects will provide a passive ventilation strategy that utilises crossflow ventilation to maximise the potential for natural ventilation within the scheme.
- Trickle ventilation will be provided for ground floor spaces.

Mechanical and active cooling

- Cooling is not proposed.

4.37 An overheating assessment of a sample of the dwellings has been carried out using dynamic thermal modelling. This assessment has employed the guidance set out in CIBSE TM59 to reliably model overheating in residential properties. The overheating assessment made use of the Design Summer Years for London specified in CIBSE TM49 to predict overheating risk for three different weather scenarios.

- DSY1. 1989: a moderately warm summer (current design year for London).
- DSY2. 1976: a year with a prolonged period of sustained warmth.
- DSY3. 2003: a year with a very intense single warm spell.

4.38 To account for the urban heat island effect in the locality of the development, weather data from the London Weather Centre has been employed as the basis for the analysis, as this location most closely matches Camden as an urban location.

4.39 The risk of overheating has been assessed using the guidance contained in CIBSE TM52, which details the limits of thermal comfort.

4.40 Full details of the overheating assessment are provided in Appendix A4, and a summary is given below.

4.41 All dwellings pass the TM59 overheating criteria for the DSY1 weather file. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.

4.42 If overheating was found to be an issue in the future for these dwellings, the following mitigation measures should be explored:

- Retrofitted solar control film to minimise solar gain
- Additional external shading to limit solar gain
- Improved blinds to reduce solar gain
- Increased MVHR flow rates for additional purge ventilation
- Use of free-standing fans in extreme cases

5. SUMMARY AND CONCLUSIONS

5.1 This Energy Strategy provides an overview as to how the proposed development at Godwin and Crowndale Estate contributes to achieve CO_2 emissions reduction and gives an overview of the design proposals that will ensure the development operates in an energy efficient manner over the lifespan of the scheme.

5.2 Section 4 of this statement demonstrates that the siting and design of the proposals support relevant policy relating to energy guidelines set out by the Greater London Authority and the London Borough of Camden.

5.3 The energy assessment has shown that the proposed development will adopt the Mayor of London's 'Energy Hierarchy' and the proposed strategy shall achieve a 54.8% reduction in carbon dioxide emissions through on-site means alone.

5.4 The measures proposed at each level of the Energy Hierarchy are set out below.

5.5 The proposed 'Be Lean' measures include:

- High levels of building fabric insulation to minimise heat loss
- A balanced proportion of façade glazing to ensure natural daylight provision without increasing overheating risk
- High levels of air tightness to reduce heat loss through infiltration
- The use of accredited construction details to minimise heat loss through thermal bridging
- Low energy LED lighting to minimise artificial lighting energy consumption
- Mechanical ventilation with heat recovery to provide fresh air, with heat recovered from extract air
- A high specification of heating controls to ensure operational efficiency

5.6 District and communal heat systems have not been deemed to be appropriate due to the relatively small scale of the development, estimated connection costs and utility constraints.

5.7 The 'Be Green' measures include:

- Employment of highly efficient, individual air source heat pump (ASHP) systems.

5.8 The level of site-wide emissions reduction achieved for each stage of the Energy Hierarchy is shown below.

Figure 5.1 Site-wide regulated carbon dioxide emissions and savings

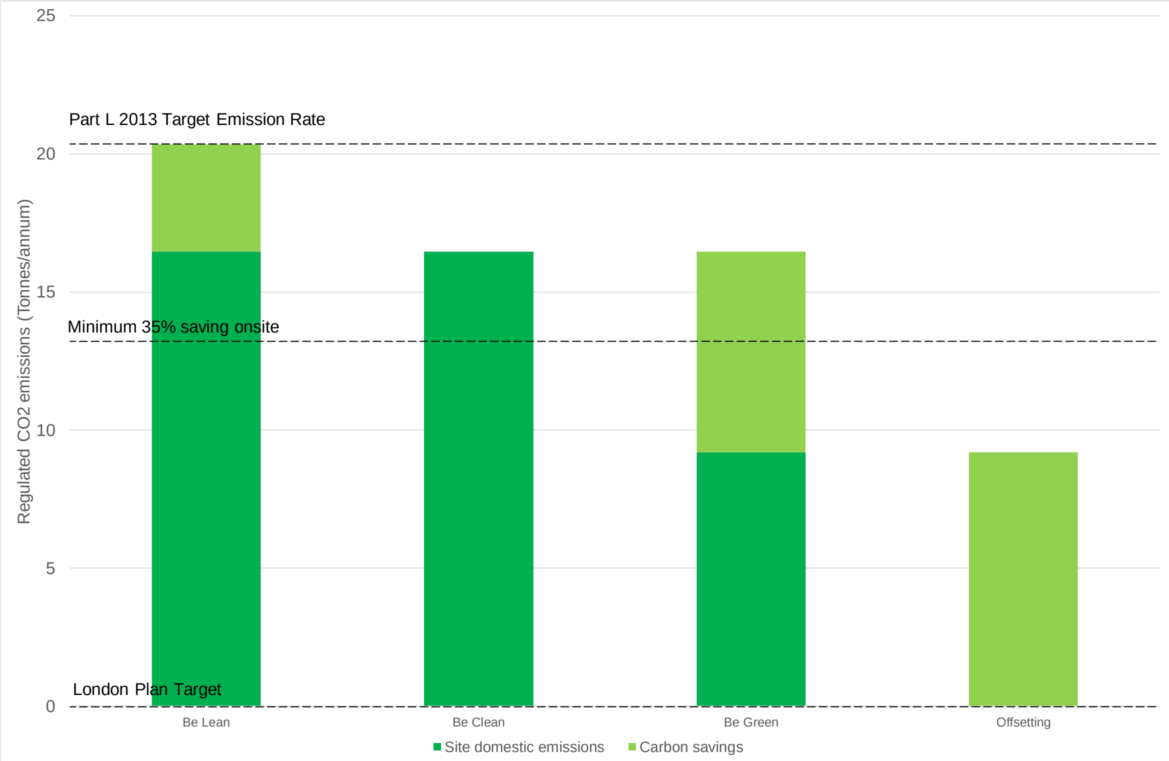


Table 5.1 Site-wide carbon dioxide emissions after each stage of the Energy Hierarchy

	Site-wide carbon dioxide emissions (Tonnes CO_2 per annum)
Baseline: Part L 2013 of the Building Regulations Compliant Development	20.34
After energy demand reduction	16.45
After renewable energy	9.20

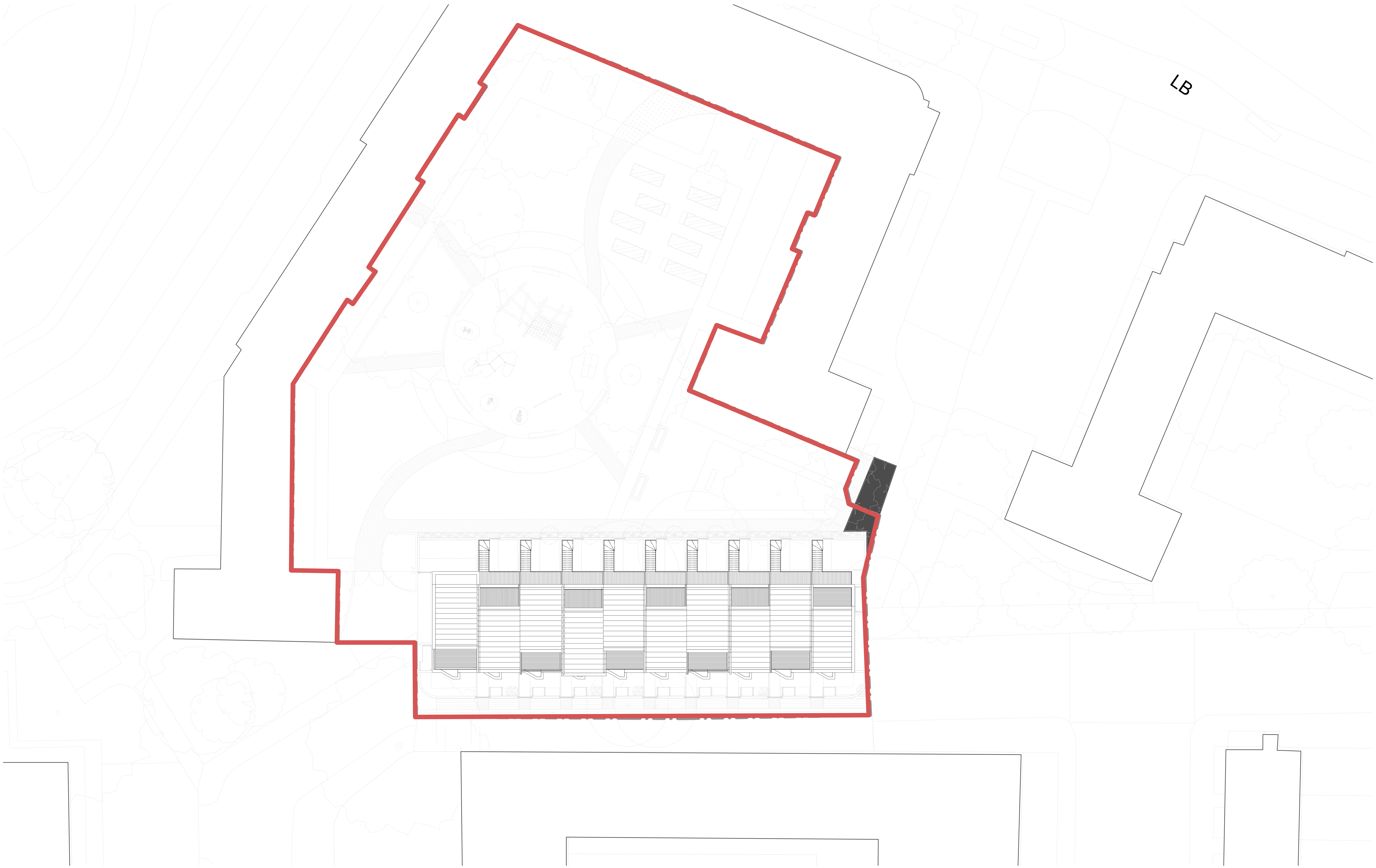
Table 5.2 Site-wide regulated carbon dioxide emissions after each stage of the Energy Hierarchy

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Savings from energy demand reduction	3.89	19.1%
Savings from renewable energy	7.25	35.6%
Cumulative on-site savings	11.14	54.8%
Carbon shortfall	9.20	
	(Tonnes CO_2)	
Cumulative savings for offset payment	276	
Cash in-lieu contribution	£26,224	

5.9 The assessment concludes that the proposals have maximised all available opportunities for on-site regulated carbon emissions reduction. The proposed energy strategy achieves an on-site emissions reduction of 54.8%. 276 tonnes of CO_2 per annum of residential emissions from the development are proposed to be offset through a cash-in-lieu contribution.

5.10 Overall, the proposals for the scheme are in line with the policy requirements of the planning authority for energy statements and will provide a development that seeks to promote these principles in operation.

A1. SITE PLAN



General Notes

1. Drawing indicates design intent only.
2. The contractor is responsible for taking and scheduling all dimensions on site.
3. Do not scale from drawings.
4. Report all discrepancies to the architect before proceeding.

Key Plan / Section

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4m 8m 12m 16m 20m

N

INDICATIVE

Revision Date Description

Client

London Borough of Camden

SURFACE TO AIR

Unit 210, Metropolitan Wharf Building, 70 Wapping Wall, London, E1W 3SS
T +44 (0)203 727 3300 E info@surface-to-air.com
Registered office in England and Wales No: 05302392

Project

Godwin & Crowndale

Drawing Title

Proposed Site Plan

Scale: 1 : 200 @ A1
Status: For Information
Checked By: Checker

Project	Origin	Role	Zones	Level	Type	Class	Number	Suitability	Revision
1674	S2A	A	01	XX	DR	00	100	S3	

01/04/2020 13:01:48

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A2. DER/TER WORKSHEETS

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.4.25

Property Address: House 1 (Boiler) S2A

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.1	(1a)	x	2.7	(2a)	=	105.57	(3a)
First floor	43.3	(1b)	x	2.7	(2b)	=	116.91	(3b)
Second floor	31	(1c)	x	3.4	(2c)	=	105.4	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.4	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	327.88	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

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			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 75.65 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3.38	x	1.4	=	4.725			(26)
Windows Type 1			0.9	x1/[1/(1.5)+ 0.04]		=	1.27			(27)
Windows Type 2			1.5	x1/[1/(1.5)+ 0.04]		=	2.12			(27)
Windows Type 3			2.28	x1/[1/(1.5)+ 0.04]		=	3.23			(27)
Windows Type 4			4.2	x1/[1/(1.5)+ 0.04]		=	5.94			(27)
Windows Type 5			3.7	x1/[1/(1.5)+ 0.04]		=	5.24			(27)
Windows Type 6			3.2	x1/[1/(1.5)+ 0.04]		=	4.53			(27)
Floor Type 1			39.1	x	0.12	=	4.692			(28)
Floor Type 2			4.2	x	0.12	=	0.5039999			(28)
Walls	97.05	22.85	74.2	x	0.15	=	11.13			(29)
Roof	43.3	0	43.3	x	0.12	=	5.2			(30)
Total area of elements, m²			183.65							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 53.81 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 5442.45 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K | 9.28 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 63.09 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	30.76	30.42	30.07	28.35	28	26.28	26.28	25.93	26.97	28	28.69	29.38	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	93.86	93.51	93.17	91.44	91.1	89.37	89.37	89.03	90.06	91.1	91.79	92.48

Average = Sum(39)$_{1\dots12}$ /12= | 91.35 | (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	0.83	0.82	0.82	0.81	0.8	0.79	0.79	0.79	0.79	0.8	0.81	0.82

Average = Sum(40)$_{1\dots12}$ /12= | 0.81 | (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

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Assumed occupancy, N | 2.83 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 101.5 | (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65

Total = Sum(44)$_{1\dots12}$ = | 1218.02 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35

Total = Sum(45)$_{1\dots12}$ = | 1597.02 | (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 0 | (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): | 0 | (48)

Temperature factor from Table 2b | 0 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 0 | (50)

b) If manufacturer’s declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

DER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	49.05	48.62	45.05	46.55	48.62	49.05	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31	

Output from water heater (annual)$_{1…12}$ — 2183.15 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	67.79	59.66	62.43	55.58	53.72	47.13	44.87	50.29	50.86	57.72	61.43	66.06	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	24.63	21.88	17.79	13.47	10.07	8.5	9.19	11.94	16.03	20.35	23.75	25.32	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	(71)

Water heating gains (Table 5)

(72)m=	91.12	88.78	83.91	77.2	72.2	65.46	60.32	67.6	70.64	77.58	85.31	88.79	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	467.61	465.38	449.2	422.78	394.97	368.4	351.75	358.92	373.27	399.92	430.48	453.77	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast	0.9x	0.77	x	0.9	x	36.79	x	0.63	x	0.8	=	11.57	(77)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.8	=	19.28	(77)
Southeast	0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.8	=	29.3	(77)
Southeast	0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.8	=	53.97	(77)
Southeast	0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.8	=	19.7	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.8	=	32.84	(77)
Southeast	0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.8	=	49.91	(77)
Southeast	0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.8	=	91.94	(77)
Southeast	0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.8	=	26.96	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.8	=	44.93	(77)
Southeast	0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.8	=	68.29	(77)
Southeast	0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.8	=	125.79	(77)
Southeast	0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.8	=	33.4	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.8	=	55.67	(77)
Southeast	0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.8	=	84.61	(77)
Southeast	0.9x	0.77	x	4.2	x	106.25	x	0.63	x	0.8	=	155.87	(77)
Southeast	0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.8	=	37.41	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.63	x	0.8	=	62.35	(77)
Southeast	0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.8	=	94.77	(77)
Southeast	0.9x	0.77	x	4.2	x	119.01	x	0.63	x	0.8	=	174.58	(77)
Southeast	0.9x	0.77	x	0.9	x	118.15	x	0.63	x	0.8	=	37.14	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.8	=	61.9	(77)
Southeast	0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.8	=	94.09	(77)
Southeast	0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.8	=	173.32	(77)
Southeast	0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.8	=	35.81	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.8	=	59.68	(77)
Southeast	0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.8	=	90.71	(77)
Southeast	0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.8	=	167.1	(77)
Southeast	0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.8	=	32.81	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.8	=	54.69	(77)
Southeast	0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.8	=	83.13	(77)
Southeast	0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.8	=	153.13	(77)
Southeast	0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.8	=	29.19	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.8	=	48.65	(77)
Southeast	0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.8	=	73.94	(77)
Southeast	0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.8	=	136.21	(77)
Southeast	0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.8	=	21.77	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.63	x	0.8	=	36.29	(77)
Southeast	0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.8	=	55.16	(77)

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Southeast	0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.8	=	101.61	(77)
Southeast	0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.8	=	13.85	(77)
Southeast	0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.8	=	23.09	(77)
Southeast	0.9x	0.77	x	2.28	x	44.07	x	0.63	x	0.8	=	35.1	(77)
Southeast	0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.8	=	64.65	(77)
Southeast	0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.8	=	9.9	(77)
Southeast	0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.8	=	16.5	(77)
Southeast	0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.8	=	25.08	(77)
Southeast	0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.8	=	46.19	(77)
Northwest	0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.8	=	29.16	(81)
Northwest	0.9x	0.77	x	3.2	x	11.28	x	0.63	x	0.8	=	12.61	(81)
Northwest	0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.8	=	59.36	(81)
Northwest	0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.8	=	25.67	(81)
Northwest	0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.8	=	106.95	(81)
Northwest	0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.8	=	46.25	(81)
Northwest	0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.8	=	175.64	(81)
Northwest	0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.8	=	75.95	(81)
Northwest	0.9x	0.77	x	3.7	x	91.35	x	0.63	x	0.8	=	236.09	(81)
Northwest	0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.8	=	102.09	(81)
Northwest	0.9x	0.77	x	3.7	x	97.38	x	0.63	x	0.8	=	251.7	(81)
Northwest	0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.8	=	108.84	(81)
Northwest	0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.8	=	235.46	(81)
Northwest	0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.8	=	101.82	(81)
Northwest	0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.8	=	187.71	(81)
Northwest	0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.8	=	81.17	(81)
Northwest	0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.8	=	130.32	(81)
Northwest	0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.8	=	56.35	(81)
Northwest	0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.8	=	72.54	(81)
Northwest	0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.8	=	31.37	(81)
Northwest	0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.8	=	36.69	(81)
Northwest	0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.8	=	15.87	(81)
Northwest	0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.8	=	23.82	(81)
Northwest	0.9x	0.77	x	3.2	x	9.21	x	0.63	x	0.8	=	10.3	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	155.89	279.41	419.16	581.13	707.3	726.99	690.58	592.66	474.66	318.75	189.25	131.77	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	623.5	744.8	868.36	1003.92	1102.28	1095.4	1042.33	951.58	847.93	718.67	619.73	585.54	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

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(86)m=	1	1	0.98	0.91	0.73	0.52	0.38	0.43	0.71	0.96	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	20.17	20.33	20.56	20.83	20.97	21	21	21	20.98	20.77	20.42	20.15	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.23	20.23	20.23	20.25	20.25	20.26	20.26	20.27	20.26	20.25	20.25	20.24	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.97	0.88	0.69	0.46	0.31	0.36	0.64	0.94	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.1	19.34	19.68	20.05	20.22	20.26	20.26	20.27	20.24	19.99	19.48	19.08	(90)

fLA = Living area ÷ (4) = 0.22 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19.34	19.56	19.87	20.23	20.39	20.43	20.43	20.43	20.41	20.16	19.69	19.32	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.34	19.56	19.87	20.23	20.39	20.43	20.43	20.43	20.41	20.16	19.69	19.32	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.97	0.88	0.69	0.47	0.33	0.38	0.66	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	621.91	738.72	842.75	887.5	765.68	519.08	342.05	358.54	555.48	674.52	615.33	584.52	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1411.87	1370.79	1245.93	1035.83	791.38	520.73	342.15	358.8	568.21	871.17	1155.73	1398.07	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	587.73	424.75	299.96	106.8	19.12	0	0	0	0	146.3	389.09	605.28	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2579.04 (98)

Space heating requirement in kWh/m²/year 22.74 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		89	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	587.73	424.75	299.96	106.8	19.12	0	0	0	0	146.3	389.09	605.28	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	660.37	477.25	337.03	120	21.48	0	0	0	0	164.39	437.18	680.09	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 2897.79 (211)

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Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31

Efficiency of water heater 89 (216)

(217)m=	89	89	89	89	89	89	89	89	89	89	89	89	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	243.3	214.43	225.16	201.5	195.09	171.82	164.62	183.51	185.54	209.25	221.32	237.43

Total = Sum(219a)$_{1...12}$ = 2452.98 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		2897.79	
Water heating fuel used		2452.98	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	295.01		(230a)
central heating pump:	120		(230c)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		415.01	(231)
Electricity for lighting		435.02	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	625.92	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	529.84	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1155.77	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	215.39	(267)
Electricity for lighting	(232) x	0.519	=	225.77	(268)
Total CO2, kg/year		sum of (265)…(271) =		1596.93	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		14.08	(273)
EI rating (section 14)				86	(274)

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TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP 2012

Software Version: Version: 1.0.4.25

Property Address: House 1 (Boiler) S2A

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.1	(1a)	x	2.7	(2a)	=	105.57	(3a)
First floor	43.3	(1b)	x	2.7	(2b)	=	116.91	(3b)
Second floor	31	(1c)	x	3.4	(2c)	=	105.4	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.4	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	327.88	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

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			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.37	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.4	0.4	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.36	0.37

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3.38	x	1.2	=	4.05			(26)
Windows Type 1			0.9	x1/[1/(1.4)+ 0.04]		=	1.19			(27)
Windows Type 2			1.5	x1/[1/(1.4)+ 0.04]		=	1.99			(27)
Windows Type 3			2.28	x1/[1/(1.4)+ 0.04]		=	3.02			(27)
Windows Type 4			4.2	x1/[1/(1.4)+ 0.04]		=	5.57			(27)
Windows Type 5			3.7	x1/[1/(1.4)+ 0.04]		=	4.91			(27)
Windows Type 6			3.2	x1/[1/(1.4)+ 0.04]		=	4.24			(27)
Floor Type 1			39.1	x	0.13	=	5.083			(28)
Floor Type 2			4.2	x	0.13	=	0.5459999			(28)
Walls	97.05	22.85	74.2	x	0.18	=	13.36			(29)
Roof	43.3	0	43.3	x	0.13	=	5.63			(30)
Total area of elements, m²			183.65							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 54.49 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 5442.45 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K — 4.64 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss — (33) + (36) = 59.13 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	62.89	62.55	62.22	60.65	60.35	58.98	58.98	58.73	59.51	60.35	60.95	61.57	(38)

Heat transfer coefficient, W/K — (39)m = (37) + (38)m

(39)m=	122.02	121.68	121.35	119.77	119.48	118.11	118.11	117.86	118.64	119.48	120.07	120.7	

Average = $Sum(39)_{1...12}$ /12= 119.77 (39)

Heat loss parameter (HLP), W/m²K — (40)m = (39)m ÷ (4)

(40)m=	1.08	1.07	1.07	1.06	1.05	1.04	1.04	1.04	1.05	1.05	1.06	1.06	

Average = $Sum(40)_{1...12}$ /12= 1.06 (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

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Assumed occupancy, N — 2.83 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 101.5 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65	

Total = $Sum(44)_{1...12}$ = 1218.02 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35	

Total = $Sum(45)_{1...12}$ = 1597.02 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 0 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0 (48)

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = 0 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0 (51)

If community heating see section 4.3

Volume factor from Table 2a — 0 (52)

Temperature factor from Table 2b — 0 (53)

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Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0		(54)
Enter (50) or (54) in (55)		0		(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	49.05	48.62	45.05	46.55	48.62	49.05	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31	

Output from water heater (annual)$_{1...12}$ 2183.15 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	67.79	59.66	62.43	55.58	53.72	47.13	44.87	50.29	50.86	57.72	61.43	66.06	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	24.79	22.02	17.91	13.56	10.13	8.56	9.24	12.02	16.13	20.48	23.9	25.48	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	(71)

Water heating gains (Table 5)

(72)m=	91.12	88.78	83.91	77.2	72.2	65.46	60.32	67.6	70.64	77.58	85.31	88.79	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	460.77	458.52	442.32	415.87	388.04	361.46	344.81	352	366.38	393.05	423.63	446.93	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast	0.9x	0.77	x	0.9	x	36.79	x	0.63	x	0.7	=	10.12	(77)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.7	=	16.87	(77)
Southeast	0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.7	=	25.64	(77)
Southeast	0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.7	=	47.23	(77)
Southeast	0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.7	=	17.24	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.7	=	28.73	(77)
Southeast	0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.7	=	43.67	(77)
Southeast	0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.7	=	80.45	(77)
Southeast	0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.7	=	23.59	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.7	=	39.31	(77)
Southeast	0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.7	=	59.75	(77)
Southeast	0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.7	=	110.07	(77)
Southeast	0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.7	=	29.22	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.7	=	48.71	(77)
Southeast	0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.7	=	74.04	(77)
Southeast	0.9x	0.77	x	4.2	x	106.25	x	0.63	x	0.7	=	136.38	(77)
Southeast	0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.7	=	32.73	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.63	x	0.7	=	54.56	(77)
Southeast	0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.7	=	82.93	(77)
Southeast	0.9x	0.77	x	4.2	x	119.01	x	0.63	x	0.7	=	152.76	(77)
Southeast	0.9x	0.77	x	0.9	x	118.15	x	0.63	x	0.7	=	32.5	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.7	=	54.16	(77)
Southeast	0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.7	=	82.33	(77)
Southeast	0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.7	=	151.65	(77)
Southeast	0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.7	=	31.33	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.7	=	52.22	(77)
Southeast	0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.7	=	79.37	(77)
Southeast	0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.7	=	146.21	(77)
Southeast	0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.7	=	28.71	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.7	=	47.85	(77)
Southeast	0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.7	=	72.74	(77)
Southeast	0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.7	=	133.99	(77)
Southeast	0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.7	=	25.54	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.7	=	42.57	(77)
Southeast	0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.7	=	64.7	(77)
Southeast	0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.7	=	119.18	(77)
Southeast	0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.7	=	19.05	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.63	x	0.7	=	31.75	(77)
Southeast	0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.7	=	48.27	(77)

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Southeast	0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.7	=	88.91	(77)
Southeast	0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.7	=	12.12	(77)
Southeast	0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.7	=	20.2	(77)
Southeast	0.9x	0.77	x	2.28	x	44.07	x	0.63	x	0.7	=	30.71	(77)
Southeast	0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.7	=	56.57	(77)
Southeast	0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.7	=	8.66	(77)
Southeast	0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.7	=	14.43	(77)
Southeast	0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.7	=	21.94	(77)
Southeast	0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.7	=	40.42	(77)
Northwest	0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.7	=	25.52	(81)
Northwest	0.9x	0.77	x	3.2	x	11.28	x	0.63	x	0.7	=	11.03	(81)
Northwest	0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.7	=	51.94	(81)
Northwest	0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.7	=	22.46	(81)
Northwest	0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.7	=	93.58	(81)
Northwest	0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.7	=	40.47	(81)
Northwest	0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.7	=	153.68	(81)
Northwest	0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.7	=	66.46	(81)
Northwest	0.9x	0.77	x	3.7	x	91.35	x	0.63	x	0.7	=	206.58	(81)
Northwest	0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.7	=	89.33	(81)
Northwest	0.9x	0.77	x	3.7	x	97.38	x	0.63	x	0.7	=	220.24	(81)
Northwest	0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.7	=	95.24	(81)
Northwest	0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.7	=	206.03	(81)
Northwest	0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.7	=	89.09	(81)
Northwest	0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.7	=	164.25	(81)
Northwest	0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.7	=	71.03	(81)
Northwest	0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.7	=	114.03	(81)
Northwest	0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.7	=	49.31	(81)
Northwest	0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.7	=	63.47	(81)
Northwest	0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.7	=	27.45	(81)
Northwest	0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.7	=	32.11	(81)
Northwest	0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.7	=	13.88	(81)
Northwest	0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.7	=	20.84	(81)
Northwest	0.9x	0.77	x	3.2	x	9.21	x	0.63	x	0.7	=	9.01	(81)

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Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	136.4	244.49	366.77	508.49	618.89	636.12	604.25	518.57	415.32	278.9	165.59	115.3	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	597.18	703.01	809.08	924.36	1006.93	997.58	949.07	870.57	781.7	671.96	589.22	562.24	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

(86)m=	1	1	0.99	0.97	0.88	0.71	0.54	0.6	0.86	0.98	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.79	19.94	20.2	20.53	20.81	20.96	20.99	20.99	20.88	20.51	20.09	19.77	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.02	20.02	20.03	20.04	20.04	20.05	20.05	20.05	20.05	20.04	20.03	20.03	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.95	0.84	0.62	0.43	0.49	0.8	0.97	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.4	18.62	18.99	19.48	19.85	20.02	20.05	20.04	19.94	19.45	18.84	18.37	(90)

fLA = Living area ÷ (4) = 0.22 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	18.71	18.92	19.26	19.71	20.07	20.23	20.26	20.26	20.15	19.69	19.12	18.68	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.71	18.92	19.26	19.71	20.07	20.23	20.26	20.26	20.15	19.69	19.12	18.68	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.98	0.95	0.84	0.64	0.45	0.51	0.81	0.97	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	595.89	699.28	796.7	875.64	846.37	638.8	428.78	448.07	630.42	651.81	586.38	561.35	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1758.04	1705.59	1548.3	1295.18	999.69	665.11	432.04	454.43	718.17	1086.19	1443.58	1747.83	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	864.64	676.24	559.19	302.07	114.07	0	0	0	0	323.18	617.18	882.74	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4339.31 (98)

Space heating requirement in kWh/m²/year 38.27 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.4	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	864.64	676.24	559.19	302.07	114.07	0	0	0	0	323.18	617.18	882.74	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	925.74	724.03	598.7	323.41	122.13	0	0	0	0	346.02	660.79	945.12	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 4645.94 (211)

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Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

216.54	190.84	200.39	179.34	173.63	152.92	146.51	163.33	165.13	186.23	196.98	211.31

Efficiency of water heater 80.3 (216)

(217)m=	88.18	87.96	87.5	86.35	84.02	80.3	80.3	80.3	80.3	86.43	87.73	88.26

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	245.56	216.95	229.03	207.68	206.65	190.44	182.46	203.4	205.64	215.48	224.53	239.43

Total = Sum(219a)$_{1...12}$ = 2567.24 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4645.94	
Water heating fuel used		2567.24	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75	(231)
Electricity for lighting		437.82	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	1003.52	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	554.52	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1558.05	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	227.23	(268)
Total CO2, kg/year			sum of (265)…(271) =		1824.2	(272)

TER = 16.09 (273)

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DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.4.25

Property Address: House 1 (ASHP) S2A

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.1	(1a)	x	2.7	(2a)	=	105.57	(3a)
First floor	43.3	(1b)	x	2.7	(2b)	=	116.91	(3b)
Second floor	31	(1c)	x	3.4	(2c)	=	105.4	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.4	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	327.88	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 75.65 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.28	0.28	0.28	0.26	0.26	0.24	0.24	0.24	0.25	0.26	0.27	0.27	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3.38	x	1.4	=	4.725			(26)
Windows Type 1			0.9	x1/[1/(1.5)+ 0.04]		=	1.27			(27)
Windows Type 2			1.5	x1/[1/(1.5)+ 0.04]		=	2.12			(27)
Windows Type 3			2.28	x1/[1/(1.5)+ 0.04]		=	3.23			(27)
Windows Type 4			4.2	x1/[1/(1.5)+ 0.04]		=	5.94			(27)
Windows Type 5			3.7	x1/[1/(1.5)+ 0.04]		=	5.24			(27)
Windows Type 6			3.2	x1/[1/(1.5)+ 0.04]		=	4.53			(27)
Floor Type 1			39.1	x	0.12	=	4.692			(28)
Floor Type 2			4.2	x	0.12	=	0.5039999			(28)
Walls	97.05	22.85	74.2	x	0.15	=	11.13			(29)
Roof	43.3	0	43.3	x	0.12	=	5.2			(30)
Total area of elements, m²			183.65							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 53.81 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 5442.45 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

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can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K | 9.28 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 63.09 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	30.76	30.42	30.07	28.35	28	26.28	26.28	25.93	26.97	28	28.69	29.38	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	93.86	93.51	93.17	91.44	91.1	89.37	89.37	89.03	90.06	91.1	91.79	92.48	

Average = $Sum(39)_{1...12}$ /12= | 91.35 | (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	0.83	0.82	0.82	0.81	0.8	0.79	0.79	0.79	0.79	0.8	0.81	0.82	

Average = $Sum(40)_{1...12}$ /12= | 0.81 | (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

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Assumed occupancy, N | 2.83 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 101.5 | (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65

Total = $Sum(44)_{1...12}$ = | 1218.02 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35

Total = $Sum(45)_{1...12}$ = | 1597.02 | (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 150 | (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 1.91 | (48)

Temperature factor from Table 2b | 0.54 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 1.03 | (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

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Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		1.03	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	31.97	28.88	31.97	30.94	31.97	30.94	31.97	31.97	30.94	31.97	30.94	31.97	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	31.97	28.88	31.97	30.94	31.97	30.94	31.97	31.97	30.94	31.97	30.94	31.97	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	220.81	194.71	204.67	183.74	180.24	138.81	131.93	146.68	147.02	190.51	201.12	215.59	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	220.81	194.71	204.67	183.74	180.24	0	0	0	0	190.51	201.12	215.59	

Output from water heater (annual)$_{1...12}$ — 1591.38 (64)

Output immersion

(64)m=	0	0	0	0	0	138.81	131.93	146.68	147.02	0	0	0	

Output from immersion (annual)$_{1...12}$ — 564.444408369204 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	99.24	88.06	93.88	86.08	85.75	60.62	58.82	63.72	63.35	89.17	91.86	97.51	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	24.63	21.88	17.79	13.47	10.07	8.5	9.19	11.94	16.03	20.35	23.75	25.32	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	(71)

Water heating gains (Table 5)

(72)m=	133.39	131.05	126.18	119.56	115.26	84.2	79.05	85.64	87.98	119.85	127.58	131.06	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	499.88	497.65	481.47	455.15	428.03	377.14	360.49	366.97	380.62	432.19	462.75	486.04	(73)

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DER WorkSheet: New dwelling design stage

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast	0.9x	0.77	x	0.9	x	36.79	x	0.63	x	0.8	=	11.57	(77)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.8	=	19.28	(77)
Southeast	0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.8	=	29.3	(77)
Southeast	0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.8	=	53.97	(77)
Southeast	0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.8	=	19.7	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.8	=	32.84	(77)
Southeast	0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.8	=	49.91	(77)
Southeast	0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.8	=	91.94	(77)
Southeast	0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.8	=	26.96	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.8	=	44.93	(77)
Southeast	0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.8	=	68.29	(77)
Southeast	0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.8	=	125.79	(77)
Southeast	0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.8	=	33.4	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.8	=	55.67	(77)
Southeast	0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.8	=	84.61	(77)
Southeast	0.9x	0.77	x	4.2	x	106.25	x	0.63	x	0.8	=	155.87	(77)
Southeast	0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.8	=	37.41	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.63	x	0.8	=	62.35	(77)
Southeast	0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.8	=	94.77	(77)
Southeast	0.9x	0.77	x	4.2	x	119.01	x	0.63	x	0.8	=	174.58	(77)
Southeast	0.9x	0.77	x	0.9	x	118.15	x	0.63	x	0.8	=	37.14	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.8	=	61.9	(77)
Southeast	0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.8	=	94.09	(77)
Southeast	0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.8	=	173.32	(77)
Southeast	0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.8	=	35.81	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.8	=	59.68	(77)
Southeast	0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.8	=	90.71	(77)
Southeast	0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.8	=	167.1	(77)
Southeast	0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.8	=	32.81	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.8	=	54.69	(77)
Southeast	0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.8	=	83.13	(77)
Southeast	0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.8	=	153.13	(77)
Southeast	0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.8	=	29.19	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.8	=	48.65	(77)
Southeast	0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.8	=	73.94	(77)
Southeast	0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.8	=	136.21	(77)

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Southeast	0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.8	=	21.77	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.63	x	0.8	=	36.29	(77)
Southeast	0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.8	=	55.16	(77)
Southeast	0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.8	=	101.61	(77)
Southeast	0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.8	=	13.85	(77)
Southeast	0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.8	=	23.09	(77)
Southeast	0.9x	0.77	x	2.28	x	44.07	x	0.63	x	0.8	=	35.1	(77)
Southeast	0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.8	=	64.65	(77)
Southeast	0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.8	=	9.9	(77)
Southeast	0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.8	=	16.5	(77)
Southeast	0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.8	=	25.08	(77)
Southeast	0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.8	=	46.19	(77)
Northwest	0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.8	=	29.16	(81)
Northwest	0.9x	0.77	x	3.2	x	11.28	x	0.63	x	0.8	=	12.61	(81)
Northwest	0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.8	=	59.36	(81)
Northwest	0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.8	=	25.67	(81)
Northwest	0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.8	=	106.95	(81)
Northwest	0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.8	=	46.25	(81)
Northwest	0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.8	=	175.64	(81)
Northwest	0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.8	=	75.95	(81)
Northwest	0.9x	0.77	x	3.7	x	91.35	x	0.63	x	0.8	=	236.09	(81)
Northwest	0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.8	=	102.09	(81)
Northwest	0.9x	0.77	x	3.7	x	97.38	x	0.63	x	0.8	=	251.7	(81)
Northwest	0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.8	=	108.84	(81)
Northwest	0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.8	=	235.46	(81)
Northwest	0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.8	=	101.82	(81)
Northwest	0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.8	=	187.71	(81)
Northwest	0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.8	=	81.17	(81)
Northwest	0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.8	=	130.32	(81)
Northwest	0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.8	=	56.35	(81)
Northwest	0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.8	=	72.54	(81)
Northwest	0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.8	=	31.37	(81)
Northwest	0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.8	=	36.69	(81)
Northwest	0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.8	=	15.87	(81)
Northwest	0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.8	=	23.82	(81)
Northwest	0.9x	0.77	x	3.2	x	9.21	x	0.63	x	0.8	=	10.3	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	155.89	279.41	419.16	581.13	707.3	726.99	690.58	592.66	474.66	318.75	189.25	131.77	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	655.77	777.07	900.63	1036.28	1135.33	1104.13	1051.07	959.62	855.27	750.94	652	617.81	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

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(86)m=	1	0.99	0.98	0.9	0.72	0.52	0.37	0.43	0.7	0.95	0.99	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	20.2	20.35	20.59	20.84	20.97	21	21	21	20.98	20.79	20.44	20.18	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.23	20.23	20.23	20.25	20.25	20.26	20.26	20.27	20.26	20.25	20.25	20.24	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.97	0.87	0.67	0.46	0.31	0.36	0.64	0.93	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.15	19.38	19.71	20.07	20.22	20.26	20.26	20.27	20.24	20.02	19.52	19.12	(90)

fLA = Living area ÷ (4) = 0.22 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19.38	19.6	19.91	20.25	20.39	20.43	20.43	20.43	20.41	20.19	19.73	19.36	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.38	19.6	19.91	20.25	20.39	20.43	20.43	20.43	20.41	20.19	19.73	19.36	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.97	0.87	0.68	0.47	0.33	0.37	0.65	0.93	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	653.56	769.19	869.36	902.94	769.47	519.17	342.05	358.55	556.08	696.09	645.95	616.36	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1415.49	1374.24	1248.97	1037.48	791.76	520.74	342.15	358.81	568.26	873.56	1159.04	1401.65	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	566.87	406.6	282.43	96.87	16.59	0	0	0	0	132.04	369.42	584.26	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2455.07 (98)

Space heating requirement in kWh/m²/year 21.65 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		190.24	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	566.87	406.6	282.43	96.87	16.59	0	0	0	0	132.04	369.42	584.26	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	297.97	213.72	148.45	50.92	8.72	0	0	0	0	69.4	194.18	307.11	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 1290.48 (211)

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Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...5,10...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

220.81	194.71	204.67	183.74	180.24	0	0	0	0	190.51	201.12	215.59

Efficiency of water heater 270.94 (216)

(217)m=	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94	270.94

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	81.5	71.86	75.54	67.81	66.53	0	0	0	0	70.31	74.23	79.57

Total = Sum(219a)$_{1...12}$ = 587.36 (219)

Water heating requirement (immersion)

0	0	0	0	0	138.81	131.93	146.68	147.02	0	0	0

Efficiency of water heater (Immersion) 100 (216)

(217)m=	0	0	0	0	0	100	100	100	100	0	0	0

(217)

Fuel for water heating (Immersion), kWh/month
(219)m = [(64)m + (218) m] x 100 ÷ (217)m

(219)m=	0	0	0	0	0	138.81	131.93	146.68	147.02	0	0	0

Total = Sum(219a)$_{1...12}$ = 564.44 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		1290.48	
Water heating fuel used		587.36	
Water heating fuel used (Immersion)		564.44	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	295.01		(230a)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		295.01	(231)
Electricity for lighting		435.02	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.519 =	669.76	(261)
Space heating (secondary)	(215) x	0.519 =	0	(263)
Water heating	(219) x	0.519 =	304.84	(264)
Water heating (Immersion)	(219) x	0.519 =	292.95	(264)
Space and water heating	(261) + (262) + (263) + (264) =		1267.54	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519 =	153.11	(267)
Electricity for lighting	(232) x	0.519 =	225.77	(268)
Energy saving/generation technologies				
Total CO2, kg/year		sum of (265)…(271) =	1646.43	(272)

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Dwelling CO2 Emission Rate	(272) ÷ (4) =	14.52	(273)
EI rating (section 14)		86	(274)

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TER WorkSheet: New dwelling design stage

User Details:			
Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.25

Property Address: House 1 (ASHP) S2A

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.1	(1a)	x	2.7	(2a)	=	105.57	(3a)
First floor	43.3	(1b)	x	2.7	(2b)	=	116.91	(3b)
Second floor	31	(1c)	x	3.4	(2c)	=	105.4	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	113.4	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	327.88	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							4	x 10 =	40	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

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			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40	÷ (5) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.37	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.4	0.4	0.39	0.35	0.34	0.3	0.3	0.29	0.32	0.34	0.36	0.37

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)

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3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			3.38	x	1.2	=	4.05			(26)
Windows Type 1			0.9	x1/[1/(1.4)+ 0.04]		=	1.19			(27)
Windows Type 2			1.5	x1/[1/(1.4)+ 0.04]		=	1.99			(27)
Windows Type 3			2.28	x1/[1/(1.4)+ 0.04]		=	3.02			(27)
Windows Type 4			4.2	x1/[1/(1.4)+ 0.04]		=	5.57			(27)
Windows Type 5			3.7	x1/[1/(1.4)+ 0.04]		=	4.91			(27)
Windows Type 6			3.2	x1/[1/(1.4)+ 0.04]		=	4.24			(27)
Floor Type 1			39.1	x	0.13	=	5.083			(28)
Floor Type 2			4.2	x	0.13	=	0.5459999			(28)
Walls	97.05	22.85	74.2	x	0.18	=	13.36			(29)
Roof	43.3	0	43.3	x	0.13	=	5.63			(30)
Total area of elements, m²			183.65							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 54.49 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 5442.45 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f

can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K | 4.64 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 59.13 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	62.89	62.55	62.22	60.65	60.35	58.98	58.98	58.73	59.51	60.35	60.95	61.57	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	122.02	121.68	121.35	119.77	119.48	118.11	118.11	117.86	118.64	119.48	120.07	120.7	

Average = Sum(39)1…12 /12= | 119.77 | (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	1.08	1.07	1.07	1.06	1.05	1.04	1.04	1.04	1.05	1.05	1.06	1.06

Average = Sum(40)1…12 /12= | 1.06 | (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N | 2.83 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 101.5 | (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	111.65	107.59	103.53	99.47	95.41	91.35	91.35	95.41	99.47	103.53	107.59	111.65

Total = Sum(44)1…12 = | 1218.02 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	165.58	144.81	149.44	130.28	125.01	107.87	99.96	114.71	116.08	135.27	147.66	160.35

Total = Sum(45)1…12 = | 1597.02 | (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

(46)m=	24.84	21.72	22.42	19.54	18.75	16.18	14.99	17.21	17.41	20.29	22.15	24.05	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 150 | (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 1.39 | (48)

Temperature factor from Table 2b | 0.54 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 0.75 | (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 0 | (52)

Temperature factor from Table 2b | 0 | (53)

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Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0.75	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	212.17	186.9	196.03	175.37	171.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	212.17	186.9	196.03	175.37	171.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95	

Output from water heater (annual)$_{1…12}$ | 2145.64 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	92.33	81.82	86.96	79.39	78.84	71.94	70.51	75.42	74.67	82.25	85.17	90.59	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	24.79	22.02	17.91	13.56	10.13	8.56	9.24	12.02	16.13	20.48	23.9	25.48	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	276.35	279.22	271.99	256.61	237.19	218.94	206.74	203.88	211.1	226.49	245.91	264.16	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	37.17	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	-113.35	(71)

Water heating gains (Table 5)

(72)m=	124.1	121.76	116.89	110.27	105.97	99.92	94.78	101.36	103.71	110.56	118.29	121.76	(72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	493.75	491.5	475.29	448.94	421.8	395.92	379.27	385.77	399.44	426.03	456.61	479.91	(73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast	0.9x	0.77	x	0.9	x	36.79	x	0.63	x	0.7	=	10.12	(77)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.63	x	0.7	=	16.87	(77)
Southeast	0.9x	0.77	x	2.28	x	36.79	x	0.63	x	0.7	=	25.64	(77)
Southeast	0.9x	0.77	x	4.2	x	36.79	x	0.63	x	0.7	=	47.23	(77)
Southeast	0.9x	0.77	x	0.9	x	62.67	x	0.63	x	0.7	=	17.24	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.63	x	0.7	=	28.73	(77)
Southeast	0.9x	0.77	x	2.28	x	62.67	x	0.63	x	0.7	=	43.67	(77)
Southeast	0.9x	0.77	x	4.2	x	62.67	x	0.63	x	0.7	=	80.45	(77)
Southeast	0.9x	0.77	x	0.9	x	85.75	x	0.63	x	0.7	=	23.59	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.63	x	0.7	=	39.31	(77)
Southeast	0.9x	0.77	x	2.28	x	85.75	x	0.63	x	0.7	=	59.75	(77)
Southeast	0.9x	0.77	x	4.2	x	85.75	x	0.63	x	0.7	=	110.07	(77)
Southeast	0.9x	0.77	x	0.9	x	106.25	x	0.63	x	0.7	=	29.22	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.63	x	0.7	=	48.71	(77)
Southeast	0.9x	0.77	x	2.28	x	106.25	x	0.63	x	0.7	=	74.04	(77)
Southeast	0.9x	0.77	x	4.2	x	106.25	x	0.63	x	0.7	=	136.38	(77)
Southeast	0.9x	0.77	x	0.9	x	119.01	x	0.63	x	0.7	=	32.73	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.63	x	0.7	=	54.56	(77)
Southeast	0.9x	0.77	x	2.28	x	119.01	x	0.63	x	0.7	=	82.93	(77)
Southeast	0.9x	0.77	x	4.2	x	119.01	x	0.63	x	0.7	=	152.76	(77)
Southeast	0.9x	0.77	x	0.9	x	118.15	x	0.63	x	0.7	=	32.5	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.63	x	0.7	=	54.16	(77)
Southeast	0.9x	0.77	x	2.28	x	118.15	x	0.63	x	0.7	=	82.33	(77)
Southeast	0.9x	0.77	x	4.2	x	118.15	x	0.63	x	0.7	=	151.65	(77)
Southeast	0.9x	0.77	x	0.9	x	113.91	x	0.63	x	0.7	=	31.33	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.63	x	0.7	=	52.22	(77)
Southeast	0.9x	0.77	x	2.28	x	113.91	x	0.63	x	0.7	=	79.37	(77)
Southeast	0.9x	0.77	x	4.2	x	113.91	x	0.63	x	0.7	=	146.21	(77)
Southeast	0.9x	0.77	x	0.9	x	104.39	x	0.63	x	0.7	=	28.71	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.63	x	0.7	=	47.85	(77)
Southeast	0.9x	0.77	x	2.28	x	104.39	x	0.63	x	0.7	=	72.74	(77)
Southeast	0.9x	0.77	x	4.2	x	104.39	x	0.63	x	0.7	=	133.99	(77)
Southeast	0.9x	0.77	x	0.9	x	92.85	x	0.63	x	0.7	=	25.54	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.63	x	0.7	=	42.57	(77)
Southeast	0.9x	0.77	x	2.28	x	92.85	x	0.63	x	0.7	=	64.7	(77)
Southeast	0.9x	0.77	x	4.2	x	92.85	x	0.63	x	0.7	=	119.18	(77)
Southeast	0.9x	0.77	x	0.9	x	69.27	x	0.63	x	0.7	=	19.05	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.63	x	0.7	=	31.75	(77)
Southeast	0.9x	0.77	x	2.28	x	69.27	x	0.63	x	0.7	=	48.27	(77)

Southeast 0.9x	0.77	x	4.2	x	69.27	x	0.63	x	0.7	=	88.91	(77)
Southeast 0.9x	0.77	x	0.9	x	44.07	x	0.63	x	0.7	=	12.12	(77)
Southeast 0.9x	0.77	x	1.5	x	44.07	x	0.63	x	0.7	=	20.2	(77)
Southeast 0.9x	0.77	x	2.28	x	44.07	x	0.63	x	0.7	=	30.71	(77)
Southeast 0.9x	0.77	x	4.2	x	44.07	x	0.63	x	0.7	=	56.57	(77)
Southeast 0.9x	0.77	x	0.9	x	31.49	x	0.63	x	0.7	=	8.66	(77)
Southeast 0.9x	0.77	x	1.5	x	31.49	x	0.63	x	0.7	=	14.43	(77)
Southeast 0.9x	0.77	x	2.28	x	31.49	x	0.63	x	0.7	=	21.94	(77)
Southeast 0.9x	0.77	x	4.2	x	31.49	x	0.63	x	0.7	=	40.42	(77)
Northwest 0.9x	0.77	x	3.7	x	11.28	x	0.63	x	0.7	=	25.52	(81)
Northwest 0.9x	0.77	x	3.2	x	11.28	x	0.63	x	0.7	=	11.03	(81)
Northwest 0.9x	0.77	x	3.7	x	22.97	x	0.63	x	0.7	=	51.94	(81)
Northwest 0.9x	0.77	x	3.2	x	22.97	x	0.63	x	0.7	=	22.46	(81)
Northwest 0.9x	0.77	x	3.7	x	41.38	x	0.63	x	0.7	=	93.58	(81)
Northwest 0.9x	0.77	x	3.2	x	41.38	x	0.63	x	0.7	=	40.47	(81)
Northwest 0.9x	0.77	x	3.7	x	67.96	x	0.63	x	0.7	=	153.68	(81)
Northwest 0.9x	0.77	x	3.2	x	67.96	x	0.63	x	0.7	=	66.46	(81)
Northwest 0.9x	0.77	x	3.7	x	91.35	x	0.63	x	0.7	=	206.58	(81)
Northwest 0.9x	0.77	x	3.2	x	91.35	x	0.63	x	0.7	=	89.33	(81)
Northwest 0.9x	0.77	x	3.7	x	97.38	x	0.63	x	0.7	=	220.24	(81)
Northwest 0.9x	0.77	x	3.2	x	97.38	x	0.63	x	0.7	=	95.24	(81)
Northwest 0.9x	0.77	x	3.7	x	91.1	x	0.63	x	0.7	=	206.03	(81)
Northwest 0.9x	0.77	x	3.2	x	91.1	x	0.63	x	0.7	=	89.09	(81)
Northwest 0.9x	0.77	x	3.7	x	72.63	x	0.63	x	0.7	=	164.25	(81)
Northwest 0.9x	0.77	x	3.2	x	72.63	x	0.63	x	0.7	=	71.03	(81)
Northwest 0.9x	0.77	x	3.7	x	50.42	x	0.63	x	0.7	=	114.03	(81)
Northwest 0.9x	0.77	x	3.2	x	50.42	x	0.63	x	0.7	=	49.31	(81)
Northwest 0.9x	0.77	x	3.7	x	28.07	x	0.63	x	0.7	=	63.47	(81)
Northwest 0.9x	0.77	x	3.2	x	28.07	x	0.63	x	0.7	=	27.45	(81)
Northwest 0.9x	0.77	x	3.7	x	14.2	x	0.63	x	0.7	=	32.11	(81)
Northwest 0.9x	0.77	x	3.2	x	14.2	x	0.63	x	0.7	=	13.88	(81)
Northwest 0.9x	0.77	x	3.7	x	9.21	x	0.63	x	0.7	=	20.84	(81)
Northwest 0.9x	0.77	x	3.2	x	9.21	x	0.63	x	0.7	=	9.01	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	136.4	244.49	366.77	508.49	618.89	636.12	604.25	518.57	415.32	278.9	165.59	115.3	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	630.15	735.99	842.06	957.43	1040.69	1032.04	983.52	904.34	814.77	704.94	622.2	595.21	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

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(86)m=	1	1	0.99	0.96	0.87	0.69	0.52	0.58	0.85	0.98	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.82	19.97	20.22	20.55	20.83	20.96	20.99	20.99	20.89	20.53	20.12	19.79	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	20.02	20.02	20.03	20.04	20.04	20.05	20.05	20.05	20.05	20.04	20.03	20.03	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.95	0.82	0.6	0.41	0.47	0.78	0.97	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.44	18.66	19.03	19.51	19.87	20.02	20.05	20.05	19.96	19.49	18.88	18.41	(90)

fLA = Living area ÷ (4) = 0.22 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	18.74	18.95	19.29	19.74	20.08	20.24	20.26	20.26	20.17	19.72	19.16	18.72	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.74	18.95	19.29	19.74	20.08	20.24	20.26	20.26	20.17	19.72	19.16	18.72	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.98	0.94	0.83	0.62	0.44	0.5	0.79	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	628.42	731.22	826.93	900.56	860.66	642.51	429.35	449.2	641.69	679.66	618.39	593.99	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1762.59	1710.07	1552.57	1298.67	1001.59	665.57	432.11	454.57	719.63	1090.09	1448.02	1752.36	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	843.82	657.79	539.87	286.64	104.85	0	0	0	0	305.36	597.33	861.82	

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Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4197.5 (98)

Space heating requirement in kWh/m²/year 37.01 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	843.82	657.79	539.87	286.64	104.85	0	0	0	0	305.36	597.33	861.82	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	902.49	703.52	577.4	306.57	112.14	0	0	0	0	326.59	638.86	921.73	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 4489.3 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
								Total (kWh/year) =Sum(215)$_{1...5,10...12}$=					0	(215)

Water heating

Output from water heater (calculated above)

	212.17	186.9	196.03	175.37	171.6	152.96	146.55	161.3	161.17	181.87	192.75	206.95		
Efficiency of water heater													79.8	(216)
(217)m=	88.13	87.89	87.38	86.12	83.55	79.8	79.8	79.8	79.8	86.19	87.63	88.21		(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	240.76	212.65	224.35	203.65	205.4	191.68	183.65	202.13	201.96	211.02	219.96	234.61		
								Total = Sum(219a)$_{1...12}$ =					2531.81	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4489.3	
Water heating fuel used		2531.81	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	75	(231)
Electricity for lighting		437.82	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	969.69	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	546.87	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1516.56	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	227.23	(268)
Total CO2, kg/year		sum of (265)…(271) =		1782.71	(272)

TER =	23.08	(273)

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A3. RENEWABLE ENERGY FEASIBILITY ASSESSMENT

A3.1 In line with GLA London Plan requirements, a feasibility assessment of potential renewable energy technologies has been undertaken, and the results from this are presented below.

Technology	Appraisal	Included in Development?
Biomass	This technology is not considered a practical solution to reducing CO_2 emissions, in the view of limited storage space for the combustible material, accessibility of the site for regular deliveries of the material, associated carbon emissions of this technology which are not normally accounted for within energy modelling, and local air quality issues arising from the combustion of biomass material.	✗
Air source heat pump	This technology is deemed appropriate to provide both space and water heating to the proposed dwellings. Full details of the proposed system efficiencies and associated carbon dioxide savings are provided in Section 4.	✓
Ground source heat pump	This technology is not deemed appropriate as heat is already due to be provided to the scheme by air source heat pump systems.	✗
Photovoltaics (PV)	The orientation of the site and roofs means that only 50% of the roof space faces south-west. Roofs facing north-east will receive less solar gain. In addition, a significant portion of the site is overshadowed by a large tree to the south. Both of these factors would reduce the output of PV panels considerably, and it is therefore considered that rooftop PV is unsuitable for this development.	✗

Solar thermal hot water (STHW)	As stated above, the development roofs are not considered suitable for solar technology due to orientation and overshading issues. This technology is therefore rejected.	✘
Wind turbines	This technology is rejected on the basis of its potential impact on visual amenity and relatively low efficiency from unpredictable, turbulent wind conditions in urban locations.	✘

A4. DOMESTIC OVERHEATING ASSESSMENT

Introduction

A4.1 Policies 5.9 of the London Plan and CC2 of the Camden Local Plan seek to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

A4.2 In order to reduce overheating and reliance on air conditioning, the design of the proposed scheme at Godwin and Crowndale Estate has followed the Cooling Hierarchy detailed in Policy 5.9:

1. Minimise internal heat generation through energy efficient design;
2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and walls;
3. Manage the heat within the building through exposed internal thermal mass and high ceilings;
4. Passive ventilation;
5. Mechanical ventilation;
6. Active cooling systems.

Cooling Hierarchy

A4.3 The methods used to minimise overheating and excessive heat generation in line with the cooling hierarchy are outlined below.

Minimisation of internal heat generation through energy efficient design

- Heat gain from lighting is kept to a minimum as a result of an energy-efficient lighting design solution.
- The availability of natural light is maximised by optimising the light transmittance of the glass elements of the façade.
- Heat gains from equipment will be minimised through the specification of low energy systems.
- Heat distribution pipework will be fully insulated to prevent unwanted heat loss.
- The scheme will use individual air source heat pumps, which is a low temperature distribution system, leading to lower internal heat gains from distribution pipework.

Reduction of the amount of heat entering the building in summer

- The building's façades have a limited amount of glazing to mitigate direct solar heat gain while optimising daylight penetration.

- The use of blinds will provide solar shading and glare protection to houses.

Management of the heat within the building through exposed thermal mass and high ceilings

- Generous floor to ceiling heights of 2.7m (ground and first floors) and up to 3.4m (second floor) will allow internal heat to rise and stratify above occupied areas.

- The habitable rooms are distributed across three storeys allowing heat to rise and exit the building due to the stack effect.

Passive ventilation

- Openable windows on multiple aspects will provide a passive ventilation strategy that utilises crossflow ventilation to maximise the potential for natural ventilation within the scheme.

- Trickle ventilation will be provided for ground floor spaces.

Mechanical and active cooling

- Cooling is not proposed.

Overheating Criteria

A4.4 TM59:2017 is a design methodology for the assessment of overheating risk in homes, published by the Chartered Institution of Building Services Engineers (CIBSE), in April 2017.

A4.5 This is a standardised approach to predict overheating risk for residential building designs using dynamic thermal analysis. It provides a baseline which includes specific weather files, defined internal gains and a set of profiles that represent reasonable usage patterns for a home suitable for evaluating overheating risk. In addition, defined thresholds to provide a pass / fail result are clearly provided as detailed below.

A4.6 Compliance is based on passing both of the following two criteria:

1. For living rooms, kitchen and bedrooms: the number of hours during which the temperature difference between the inside and outside is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours.
2. For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 22:00 to 07:00 shall not exceed 26°C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, therefore 33 or more hours above 26°C will be recorded as a fail).

A4.7 Both criteria (1) and (2) above should be met for all relevant rooms.

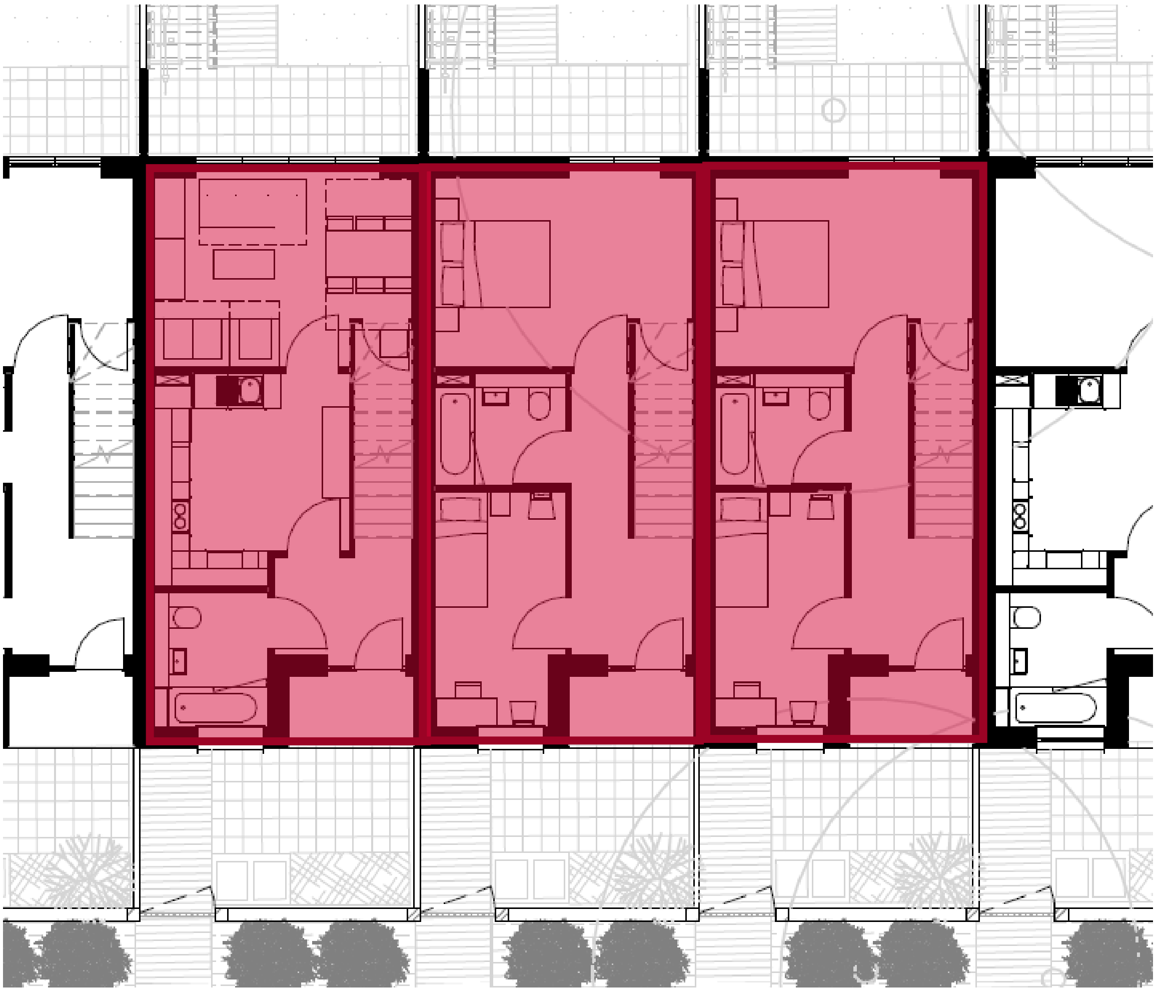
Methodology

A4.8 The TM59 methodology provides a baseline and guidance for a domestic overheating risk assessment. In line with this methodology, this section includes model inputs used to assess overheating risks to the proposed sample dwellings of the proposed development at Godwin and Crowndale Estate.

A4.9 Three dwellings were selected for this overheating risk assessment, due to the differences in internal layouts, with some dwellings having bedrooms on the ground floor.

A4.10 The images below show the locations of the tested dwellings.

Figure A4.1 Locations of tested dwellings



A4.11 The model was created in EDSL TAS to simulate the internal conditions in each of the occupied spaces highlighted in the above images. The geometry was modelled based on planning submission issue drawings from Surface To Air Architects.

A4.12 The weather files used for simulation have been based on the guidance contained within CIBSE TM49:2014 (Design Summer Years for London) as follows:

- Design summer year weather file for the London Weather Centre, based on an urban location for 1989 (DSY1), has been used on the simulations as required by TM49 methodology. The CIBSE DSY1 represents a moderately warm summer.

- Design summer year weather file for the London Weather Centre, based on an urban location for 1976 (DSY2), has been used on the simulations as required by TM49 methodology. The CIBSE DSY2 represents summer with a long period of persistent warmth.

- Design summer year weather file for the London Weather Centre, based on an urban location for 2003 (DSY3), has been used on the simulations as required by TM49 methodology. The CIBSE DSY3 represents a summer with a single intense warm spell.

A4.13 The building fabric parameters have been based on the same level of performance as that detailed in the energy strategy. A summary of the thermal envelope values used in the assessment is shown in Table A4.1.

A4.14 In line with the TM59 methodology, the following internal gains and time periods have been employed for this analysis.

Table A4.1 Occupancy heat gains

Room	Sensible heat gain (W/person)	Latent heat gain (W/person)	Occupancy period
Kitchen/Living Room	75	55	Full gains from 9am-10pm
Bedroom	52.5	38.5	70% gains from 11pm to 8am; 100% gains from 8am to 9am and from 10pm to 11pm; 50% gains from 9am to 10pm.

Table A4.2 Equipment heat gains

Room	Heat gain (W)	Occupancy period
Kitchen/Living Room	450 W 200 W 110 W 85 W	6pm to 8pm 8pm to 10pm 9am to 6pm and 10pm to 12pm All other times
Bedroom	80 W 10 W	9am to 11pm All other times

A4.15 A lighting gain of 2 W/m^2 has been applied from 7pm to 11pm to all occupiable rooms.

A4.16 Passive ventilation was modelled based on information provided by Surface To Air as part of the planning submission documentation. The openable window proportions for each dwelling are shown below.

Figure A4.2 Window open areas (front elevation)

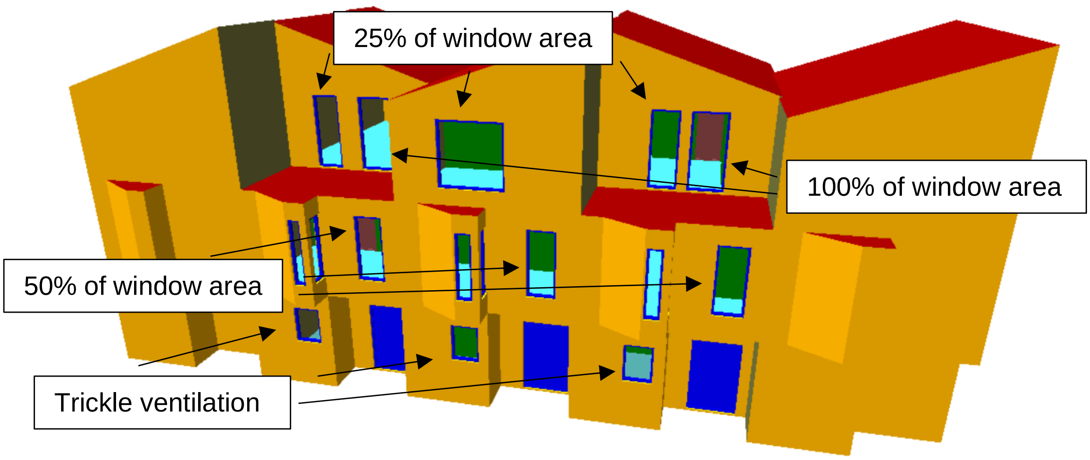
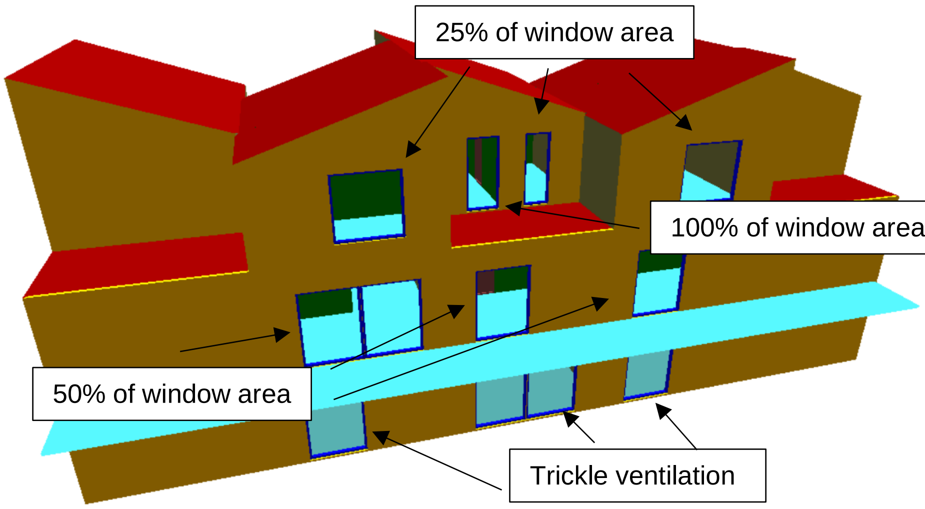


Figure A4.3 Window open areas (rear elevation)



A4.17 Due to the height of the floors tested, it was assumed that windows on the first and second floors could be opened throughout the day without any security concerns. Ground floor spaces were assumed to be ventilated through trickle ventilation only.

A4.18 The TM59 methodology states that internal blinds can be included for the analysis only if specifically included in the design, provided in the base build and explained within associated home user guide. In addition, blinds should not be used if they clash with the opening of windows. The proposed overheating mitigation strategy includes the use of internal blinds with full details to be provided by Surface To Air Architects.

A4.19 An infiltration rate of 0.15 air changes per hour has been used for all dwellings, and has been derived from CIBSE Guide A (2015) for a dwelling with an air permeability of $3m^3/hr$ per m^2 @ 50Pa for low rise and high-rise dwellings.

A4.20 Background mechanical ventilation will be provided by MVHR units as required by Part F of the Building Regulations. The ventilation rate included in the model is 1.5 air changes per hour for all rooms.

A4.21 As stated above mechanical cooling is not proposed for the residential elements of the scheme.

Results

A4.22 The table below shows the results of the simulation incorporating the inputs described above.

Table A4.3 DSY1 Results

Room	Criterion 1		Criterion 2		Result
	Max. Exceedable Hours	Hours Exceeded	Max. Exceedable Night Hours	Night Hours Exceeded	Pass/Fail
Dwelling 1, Bedroom 1	110	2	32	3	Pass
Dwelling 1, Bedroom 2	110	0	32	5	Pass
Dwelling 1, Bedroom 3	110	1	32	3	Pass
Dwelling 1, Bedroom 4	110	0	32	4	Pass
Dwelling 2, Bedroom 1	110	12	32	3	Pass
Dwelling 2, Bedroom 2	110	7	32	5	Pass
Dwelling 2, Bedroom 3	110	11	32	5	Pass
Dwelling 2, Bedroom 4	110	12	32	5	Pass
Dwelling 3, Bedroom 1	110	12	32	8	Pass

Dwelling 3, Bedroom 2	110	19	32	6	Pass
Dwelling 3, Bedroom 3	110	24	32	7	Pass
Dwelling 3, Bedroom 4	110	13	32	6	Pass
Dwelling 1, Kitchen	59	1	N/A	N/A	Pass
Dwelling 2, Kitchen	59	12	N/A	N/A	Pass
Dwelling 3, Kitchen	59	17	N/A	N/A	Pass
Dwelling 1, Living Room	59	2	N/A	N/A	Pass
Dwelling 2, Living Room	59	16	N/A	N/A	Pass
Dwelling 3, Living Room	59	17	N/A	N/A	Pass

Table A4.4 DSY2 Results

Room	Criterion 1		Criterion 2		Result
	Max. Exceedable Hours	**Hours Exceeded**	**Max. Exceedable Night Hours**	**Night Hours Exceeded**	**Pass/Fail**
Dwelling 1, Bedroom 1	110	20	32	22	Pass

Dwelling 1, Bedroom 2	110	29	32	31	Pass
Dwelling 1, Bedroom 3	110	17	32	23	Pass
Dwelling 1, Bedroom 4	110	29	32	28	Pass
Dwelling 2, Bedroom 1	110	33	32	27	Pass
Dwelling 2, Bedroom 2	110	37	32	25	Pass
Dwelling 2, Bedroom 3	110	33	32	27	Pass
Dwelling 2, Bedroom 4	110	38	32	22	Pass
Dwelling 3, Bedroom 1	110	38	32	33	Fail
Dwelling 3, Bedroom 2	110	60	32	23	Pass
Dwelling 3, Bedroom 3	110	69	32	28	Pass
Dwelling 3, Bedroom 4	110	41	32	23	Pass
Dwelling 1, Kitchen	59	24	N/A	N/A	Pass
Dwelling 2, Kitchen	59	35	N/A	N/A	Pass

Dwelling 3, Kitchen	59	45	N/A	N/A	Pass
Dwelling 1, Living Room	59	29	N/A	N/A	Pass
Dwelling 2, Living Room	59	39	N/A	N/A	Pass
Dwelling 3, Living Room	59	48	N/A	N/A	Pass

Table A4.5 DSY3 Results

Room	**Criterion 1**		**Criterion 2**		**Result**
	Max. Exceedable Hours	**Hours Exceeded**	**Max. Exceedable Night Hours**	**Night Hours Exceeded**	**Pass/Fail**
Dwelling 1, Bedroom 1	110	22	32	19	Pass
Dwelling 1, Bedroom 2	110	26	32	22	Pass
Dwelling 1, Bedroom 3	110	17	32	20	Pass
Dwelling 1, Bedroom 4	110	24	32	19	Pass
Dwelling 2, Bedroom 1	110	43	32	18	Pass
Dwelling 2, Bedroom 2	110	39	32	19	Pass

Dwelling 2, Bedroom 3	110	44	32	24	Pass
Dwelling 2, Bedroom 4	110	46	32	19	Pass
Dwelling 3, Bedroom 1	110	49	32	30	Pass
Dwelling 3, Bedroom 2	110	74	32	20	Pass
Dwelling 3, Bedroom 3	110	76	32	24	Pass
Dwelling 3, Bedroom 4	110	51	32	21	Pass
Dwelling 1, Kitchen	59	20	N/A	N/A	Pass
Dwelling 2, Kitchen	59	36	N/A	N/A	Pass
Dwelling 3, Kitchen	59	57	N/A	N/A	Pass
Dwelling 1, Living Room	59	31	N/A	N/A	Pass
Dwelling 2, Living Room	59	52	N/A	N/A	Pass
Dwelling 3, Living Room	59	63	N/A	N/A	Fail

5.11 It can be concluded that all dwellings pass the TM59 overheating criteria for the DSY1 weather file. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.

A4.1 The building design and building services design have maximised all available measures to minimise heat generation within the dwellings, to reduce the amount of heat entering the building, and to passively and mechanically ventilate the dwellings in line with the cooling hierarchy in Policy 5.9 of the London Plan.

Conclusion

A4.2 This study has shown how the proposed development at Godwin and Crowndale Estate has been designed to minimise the risk of overheating. The strategy has followed the cooling hierarchy in Policy 5.9 of the London Plan and Camden Local Plan Policy CC2.

A4.3 TM59:2017 has been adopted for this overheating study as it is the recommended methodology for the assessment of overheating risk in dwellings.

A4.4 The new methodology aims to produce a test that encourages good design that is comfortable within sensible limits, without being so stringent that it over-promotes the use of mechanical cooling.

A4.5 Three dwellings were chosen for this overheating assessment, to represent the range of different layouts present in the development.

A4.6 A dynamic thermal model was created in EDSL TAS to simulate the internal conditions in each of the occupied spaces within the selected sample dwellings.

A4.7 The modelling incorporated inputs provided within the TM59 methodology guidance and information provided by Surface To Air Architects.

A4.8 The building design and building services design have maximised all available measures to minimise heat generation within the dwellings, to reduce the amount of heat entering the building, and to passively and mechanically ventilate the dwellings in line with the cooling hierarchy in Policy 5.9 of the London Plan.

A4.9 The results were then compared to the CIBSE TM59 overheating criteria for the three weather files specified in CIBSE TM49. It can be concluded that all dwellings pass the TM59 overheating criteria for the DSY1 weather files. For the DSY2 scenario, a single bedroom is predicted to fail by a single hour. For the DSY3 scenario, a single living room is predicted to fail by four hours. These failures are considered to be marginal and not of a significant nature.

A4.10 If overheating was found to be an issue in future for these dwellings, the following mitigation measures should be explored:

- Retrofitted solar control film to minimise solar gain
- Additional external shading to limit solar gain
- Improved blinds to reduce solar gain
- Increased MVHR flow rates for additional purge ventilation
- Use of free-standing fans in extreme cases

A5. GENERAL NOTES

A5.1 The report is based on information available at the time of the writing and discussions with the client during any project meetings. Where any data supplied by the client or from other sources have been used it has been assumed that the information is correct. No responsibility can be accepted by Iceni Projects Ltd for inaccuracies in the data supplied by any other party.

A5.2 The review of planning policy and other requirements does not constitute a detailed review. Its purpose is as a guide to provide the context for the development and to determine the likely requirements of the Local Authority.

A5.3 No site visits have been carried out, unless otherwise specified.

A5.4 This report is prepared and written in the context of an agreed scope of work and should not be used in a different context. Furthermore, new information, improved practices and changes in guidance may necessitate a re-interpretation of the report in whole or in part after its original submission.

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