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ENERGY & SUSTAINABILITY REPORT
ROYAL BRUNSWICK PARK

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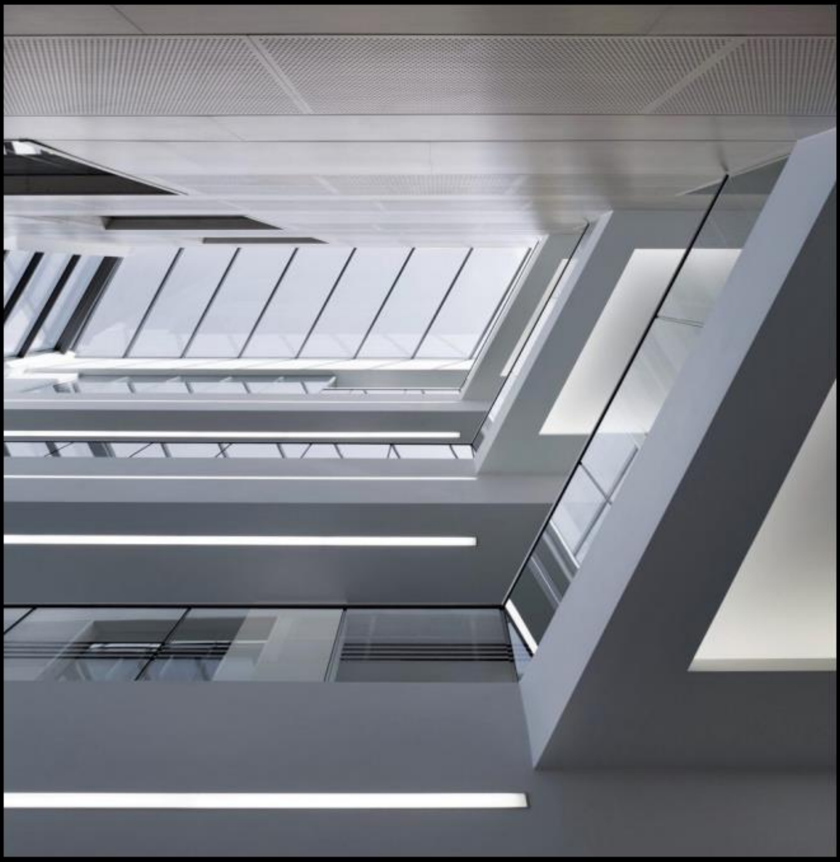
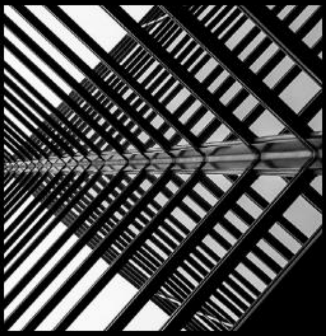




ENERGY & SUSTAINABILITY REPORT

MKPCONSULTANTS
ENGINEERING EXCELLENCE

for the development at Royal Brunswick Park
on behalf of Comer Group

COMER HOMES GROUP

ISSUE REFERENCE	ISSUE DATE	STATUS
P6	Aug 2021	Preliminary Issue

EXECUTIVE SUMMARY

The Energy Strategy has been produced by MKP Consultants Ltd on behalf of Comer Homes Ltd to support a hybrid planning application ('the Application') submitted to the London Borough of Barnet (LBB) for Royal Brunswick Park, North London Business Park, Brunswick Park Road, London, N11 1GN ('the Development').

Proposals are for the phased comprehensive redevelopment of the North London Business Park to deliver a residential-led mixed use development. The detailed element comprises up to 466 residential units in five blocks reaching 9 storeys, the provision of a 5 form entry secondary school, a gymnasium, a multi-use sports pitch and associated changing facilities and improvements to open space and transport infrastructure, including improvements to the access from Brunswick Park Road and; the outline element comprises up to 1,967 additional residential units in buildings ranging from three to twelve storeys, up to 7,148 sqm of non-residential floor space (use Class E) and 20,250sqm of open space. Associated site preparation/enabling work, transport infrastructure and junction work, landscaping and car parking.

By adopting principles of sustainable design, and through the incorporation of efficient, Low- or Zero-Carbon (LZC) technologies, the Applicant successfully delivers London Plan (2021) planning policies:

- 5.2 Minimising carbon dioxide emissions;
- 5.3 Sustainable design and construction;
- 5.4 Retrofitting;
- 5.5 Decentralised energy networks;
- 5.6 Decentralised energy in development proposals;
- 5.7 Renewable energy;
- 5.8 Innovative energy technologies; and
- 5.9 Overheating and cooling.

The Energy Strategy is written in accordance with Energy Assessment Guidance, Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018.) The Applicant is committed to a design approach that aligns with the principles of the energy hierarchy. The Development will achieve a total reduction in regulated CO2 emissions of 52% over the Target Emission Rate (TER) Approved Document Part L (AD L) 2013 through BE LEAN, BE CLEAN and BE GREEN measures and successfully delivers the target 35% minimum on-site reduction in regulated CO2 emissions over AD L 2013 for domestic and non-domestic elements of the Development separately.

SAP10 emission factors are adopted within the Energy Strategy in order to estimate, more accurately, the predicted energy performance and actual carbon emissions associated with the development scheme post-construction. This is in accordance with the recommendations of Energy Assessment Guidance (October 2018).

BE LEAN: Passive design measures have been included and lead to a reduction in regulated CO2 emissions over the AD L 2013 TER and Target Fabric Energy Efficiency (TFEE) standard. A combination of BE LEAN measures including: energy-efficient building fabric; insulation to all heat loss floors, walls and roofs; double-glazed windows; low-energy lighting; and efficient ventilation systems all contribute to an enhancement in energy performance equal to a 52% reduction in regulated CO2 emissions over AD L 2013.

A dynamic simulation model and CIBSE TM59 overheating assessment has been completed in parallel with the Energy Strategy to ensure the BE LEAN design approach adopted within this report successfully mitigates for overheating risk through passive measures (Source: TM59 Overheating Assessment for Brunswick Park, produced by MKP Consultants Ltd, July 2021).

BE CLEAN: The feasibility of supplying decentralised energy to the Development has been assessed in accordance with the heating hierarchy. A site-wide heat network, led by ASHPs and supplemented by high-efficiency gas boilers will serve all domestic units providing a source of decentralised energy to future occupants and users of the Development.

BE GREEN: Opportunities to maximise Low- and Zero-Carbon (LZC) technologies have been assessed and all options reviewed for their practical, financial and technical viability in relation to the Development scheme. ASHPs form a central component of the heat network and are described within this report under the BE CLEAN stage of the energy hierarchy. The GLA's advice is to assess their impact on the energy assessment as a LZC technology under BE GREEN measures. ASHPs will deliver an estimated 40% reduction in regulated CO2 emissions over AD L 2013.

The Development achieves the zero-carbon homes standard in full through a carbon-offset payment which offsets the shortfall in regulated CO2-emissions reduction for the new dwellings. The total CO2 emissions to offset for Royal Brunswick Park, have been calculated as: 44,178 t.CO2/30 years. Based on a carbon price of £95 t.CO2/yr over a 30-year period, this is equivalent to a cash-in-lieu contribution of: £4,196,877.

The results of the energy assessment, based on SAP10 emission factors, and the impact of BE LEAN, BE CLEAN and BE GREEN measures in terms of how the Applicant delivers their commitment to the energy hierarchy, is illustrated in Table 2 and Table 3 below.

Table 1. Domestic carbon emission savings.

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic buildings		
	Regulated domestic carbon dioxide savings	
	Tonnes CO2 per annum	% reduction
Savings from energy demand reduction	328.3	11%
Savings from heat network / CHP	2727.6	89%
Savings from renewable energy	-1,472.6	-48%
Cumulative on site savings	**1584.0**	**52%**
Carbon shortfall	1472.6	-
Cumulative savings for offset payment	**44,178 tonnes CO_2**	
Cash-in-lieu contributions	**£4,196,877**	

Contents

1. INTRODUCTION

This Energy Strategy has been produced by MKP Consultants Ltd on behalf of Comer Homes (‘the Applicant’).

It will set out the climate change mitigation measures incorporated by the Applicant as part of the Development at Royal Brunswick Park, Barnet (‘the Development’) and is written in support of a Hybrid planning application (‘the Application’) submitted to the London Borough of Barnet (LBB).

It will demonstrate the energy-strategy approach adopted by the Applicant to comply with:

i) National Planning Policy Framework.

ii) The London Plan (Greater London Authority, 2021) planning policies on climate change mitigation measures to:

- Achieve a minimum 35% on-site reduction in CO2 emissions over Approved Document Part L (AD L) 2013, based on SAP10 emission factors, for all major, domestic and
- non-domestic development separately by implementing principles of the energy hierarchy.
- Achieve the zero-carbon homes standard in full and, where this cannot be achieved on site, a commitment to offset the shortfall in CO2 emissions through a carbon-offset payment.
- Evaluate the viability of heat networks in accordance with the following hierarchy:

  1) Connection to an area wide heat network.
  2) Communal heating system:
     - Site-wide heat network
     - Building-level heating system
  3) Individual heating system.

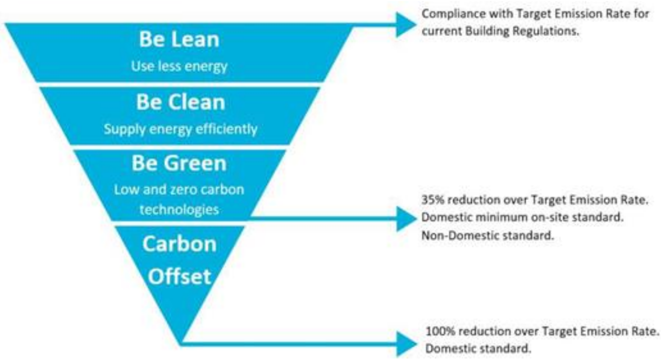
- Reduce the potential for overheating through the incorporation of passive design measures in accordance with the cooling hierarchy.
- Maximise opportunities for the installation of renewable energy technologies.

iii) Energy Assessment Guidance, Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018).

iv) Local planning policy requirements for the LBB set out in Barnet’s Local Plan, Core Strategy (September 2012), Policy CS13: Ensuring the efficient use of natural resources.

This Energy Strategy describes demand-reduction measures, energy-efficiency measures and Low- and Zero-Carbon (LZC) technologies in relation to how the Applicant meets the objectives of the energy hierarchy: BE LEAN, BE CLEAN and BE GREEN.

Figure 1. The energy hierarchy

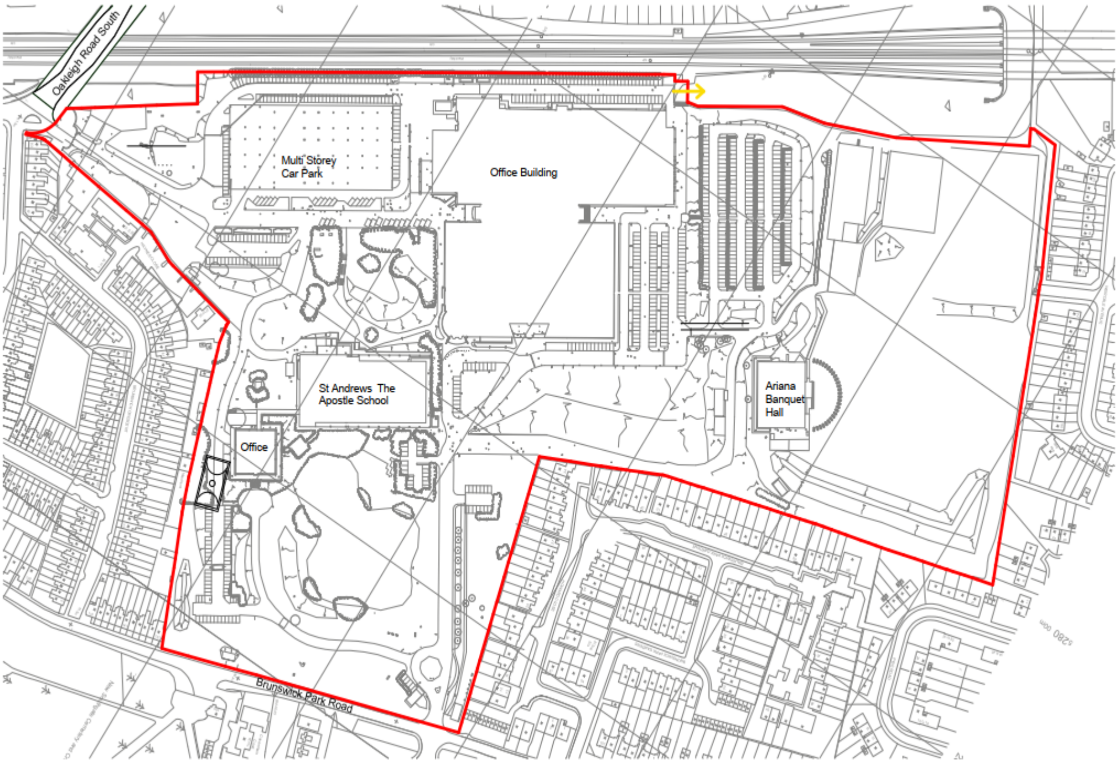


2. THE APPLICATION SITE

The site occupies circa 17 hectares of brownfield land in a predominantly residential area, located to the west of Southgate and to the south of East Barnet. The site is a pre-developed site, with circa 13 hectares of the site being occupied by grasslands, an attenuation lake and unplanned vegetative cover.

The site is located in the London Borough of Barnet, approximately 8 miles to the north-west of Central London. The site lies slightly outside of the circular route prescribed by the A406 North Circular Road.

Figure 2. Brunswick Park, Barnet.



A full planning application is submitted to the LBB for the comprehensive phased redevelopment of existing commercial site comprising phased demolition of existing offices and construction of a mixed use development. The proposed development consists of a mixed use residential development of 2,428 dwellings plus a 5 Form of Entry secondary school (1,050 pupils) at the existing North London Business Park site in the London Borough of Barnet. There is no strategic commercial use planned for the site.
The Detail Planning Area (Phase 1) is proposed to accommodate 461 new residential units, with a mixture of houses, duplexes, and apartments. The Detail Planning Area (Phase 1) will also include the 5th Form of Entry secondary school, which will replace the existing temporary school building on site accommodating the St Andrew the Apostle School.

All associated site works, landscaped areas (including Brunswick Lakeside Park), transport infrastructure and car parking required to support the delivery of the Detail Planning Area (Phase 1) is included in the Detail Planning Application. The Outline Planning Area (Phases 2-5) is proposed to accommodate the balance of the 2,428 residential units proposed for the site.

The Outline Planning Area (Phases 2-5) will also accommodate a small number of non-residential uses. These ancillary uses are intended to compliment and support the planned residential community on the site and include Café/Retail Use, Community Use and Incubator Office Use.

The design framework for all associated site works, landscaped areas (including New Brunswick Park), transport infrastructure and car parking required to support the delivery of the Outline Planning Area (Phases 2-5) is described in Plus Architecture's Parameter Plans and Design Principles Document, which accompanied the Outline Planning Area (Phases 2 to 5).

3. METHODOLOGY

The purpose of the Energy Strategy is to demonstrate the Applicant's commitment to delivering the principles of the energy hierarchy. The Energy Strategy has been assessed against, and presented, to align with the following steps:

The Baseline: The Development's baseline energy demand, the Target Emission Rate (TER), has been calculated to establish the minimum on-site standard for compliance with AD L 2013, based on SAP10 emission factors. The baseline has been calculated using a mains gas heating system.

BE LEAN: The Development's Building Emission Rate (BER) and Dwelling Emission Rate (DER) has been calculated to explain how the Applicant's design specification has led to a reduced energy demand and an improved fabric-energy efficiency. The better the design of the building fabric in terms of, for example, insulation, air tightness and orientation to maximise solar gain, the less energy required to heat the dwellings and so the better the fabric energy efficiency.

BE CLEAN: The potential to provide energy to the Development in an efficient way, by either connecting to a District Heat Network (DHN) or installing a site-wide, low-carbon energy supply, has been assessed and viability concluded.

BE GREEN: Low- and Zero-Carbon (LZC) technologies have been assessed for their suitability and viability in relation to the Development. Solutions have been put forward for the Development and the resulting regulated CO2 emission savings presented.

Carbon Offset: Where it has been demonstrated that the energy target for the Development cannot be met onsite then any shortfall in regulated CO2 emissions reduction has been offset through a cash-in-lieu payment and mechanism agreed in consultation with the Local Planning Authority.

3.1 ASSESSMENT METHODS

At each stage of the energy hierarchy, the estimated energy performance of the Development has been calculated using the following assessment methodologies.

3.1.1 DOMESTIC

SAP 2012 methodology has been used to calculate energy demand for seven sample dwellings representing a cross-section of proposed, 1, 2, 3 and 4 bedroom flats included in proposals for Royal Brunswick Park.

Sample SAPs have been completed to reflect the scheme on 2nd August 2021 and reviewed at design freeze to ensure these accurately reflect the fixed scheme. The sample SAPs provide the basis for estimating energy performance pre-planning and to inform viability.

SAP calculates the regulated energy demand associated with hot water, space heating and fixed electrical items. Part L1A is used for the purposes of the new build energy assessment.

The cumulative floor areas for representative, sample dwellings have been used to estimate the TER and DER for new dwellings within the Development proposals.

3.1.2 SAP10 EMISSION FACTORS

In order to more accurately reflect the carbon emissions associated with the expected operation of the proposed Development, and to demonstrate the way in which the Applicant will meet planning policy targets, outputs from the energy assessment in SAP 2012 have been manually converted using SAP10 emission factors. Refer to Appendix for SAP10 worksheets.

4. THE DEVELOPMENT BASELINE

In order to measure the effectiveness of BE LEAN, demand-reduction measures, it is first necessary to calculate the baseline energy demand for the Development and this has been done using SAP 2012 and is based on SAP10 emission factors. This is also referred to as the Target Emission Rate (TER.)

The resulting AD L 2013 TER for Royal Brunswick Park, has been calculated using Part L model designs which have been applied to the Applicant's Development details. The TER, or baseline energy demand, represents the maximum regulated CO2 emissions that are permitted for the Development in order to comply with AD L 2013.

The resulting TER has been calculated as 2,631 t.CO2/yr. To ensure compliance with AD L 2013, regulated CO2 emissions should not exceed this figure.

Refer to Appendix for SAP10 worksheets and Appendix 4 for sample TER and DER worksheets.

5. BE LEAN: REDUCED ENERGY DEMAND

The mixed-use development scheme at Royal Brunswick Park, will achieve a high-quality, sustainable design by integrating the following passive and active design measures to reduce energy demand:

- Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs.
- High-efficiency double-glazed windows throughout.
- Quality of build will be confirmed by achieving good air-tightness results throughout.
- Efficient-building services including high-efficiency ventilation systems.
- Low-energy lighting throughout the buildings.

Throughout the design process, the Applicant has developed a fabric specification that takes into account multiple issues and environmental considerations. These include: building form and massing and its impact on energy efficiency; noise impact; air quality; sunlight and daylight; and the internal overheating of dwellings. The Energy Strategy represents a design approach that achieves a balance and takes into account each of these objectives.

Refer to the BE LEAN design specification in detail in Table 1 below.

Table 2. BE LEAN design specification.

Element	BE LEAN Design Specification
Ground Floor U-Value (W/m^2.K)	0.15
External Wall U-Value (W/m^2.K)	0.18
Party Wall U-Value (W/m^2.K)	0 (fully filled and sealed)
Wall (Adj unheated) U-Value (W/m^2.K)	0.35
Wall (Adj corridor) U-Value (W/m^2.K)	0.20
Roof U-Value (W/m^2.K)	0.13-0.20
Thermal Mass	Defaults
Glazing U-Value (W/m^2.K)	1.4 (double-glazed units)
Glazing G-Value	0.5 0.4 on all floors of south and west-facing facades in B9, B10, B11 as mitigation for overheating.
Door U-Value (W/m^2.K)	1.0
Space Heating	Mains Gas Boilers

	Community Gas Boilers, 89.5% efficiency for domestic units and 91% efficiency for non-domestic units.[1]
Heating Controls	Standard Heating System Controls
Domestic Hot Water	Domestic: from Main Heating System Non-domestic: Electric, instant at point of use
Ventilation	All dwellings will be fitted with energy-efficient ventilation systems System 4: MVHR is specified in all dwellings, Nuaire (MRXBOX) Non-domestic: MVHR with specific fan power 1.5W/l/s; HR efficiency 75%
Cooling	None
Design Air Permeability	Domestic: 4.0
Low Energy Lighting	Domestic: 100% Low-e Non-domestic: LEDs throughout with average power density of 5W/sqm
Thermal Bridging	Bespoke Psi Values The Applicant will carry out a further review of thermal bridging post-planning to minimise heat loss through thermal bridges.

[1] Where development proposals include a communal heat network, a community heating system with gas boilers is assumed for BE LEAN calculations. This is in accordance with Energy Assessment Guidance. Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018.)

5.1 BE LEAN: CARBON EMISSIONS REDUCTION

The Applicant’s design specification and intended demand-reduction measures for the Development have been modelled using the same methodology as before. This allows us to assess the effectiveness of BE LEAN measures as a percentage reduction in CO2 emissions over the baseline for both domestic and non-domestic elements of the Development separately.

Refer to Appendix For SAP10 worksheets sample TER and DER worksheets.

By incorporating sustainable design, the Applicant will reduce regulated CO2 emissions over AD L 2013 elements of the Development. These reductions are illustrated in Table 2 below.

Table 3. BE LEAN regulated CO2 emissions.

	Total regulated emissions	Regulated CO2 emissions savings	Percentage saving
Detailed element:	Tonnes CO_2 per annum		%
ADL 2013 Baseline: Domestic	3056.5		
BE LEAN: Domestic	2727.6	328.9	11%
Total	2315	328.9	11%

5.2 TOTAL ENERGY DEMAND

Total energy demand for the Development is set out in Table 3 below.

Table4. Energy demand for the Development.

Building Use	Energy demand following energy efficiency measures (MWh/year)						
	Space heating	Hot water	Lighting	Auxiliary	Cooling	Unregulated electricity	Unregulated gas
Domestic	5279	5846	860	817	0	0	n/a

The total Part L Fabric Energy Efficiency Standard (FEES) is provided for the residential element of the Development as a whole and set out in Table 4 below.

Table 5: Total energy demand for domestic units.

	Target Fabric Energy Efficiency	Design Fabric Energy Efficiency	Improvement
Residential element:	MWh/year		%
Development total	49.55	43.36	12%

6. BE CLEAN: HEATING INFRASTRUCTURE

Steps have been taken by the Applicant to reduce the energy demand of the Development through BE LEAN measures.

The next step in the energy hierarchy is to consider how the remaining energy demand can be met and whether there is the potential for this to be done through the mechanism of establishing and/or linking up with existing or planned District Heat Network (DHN). This is assessed in line with planning policy 5.6 of the London Plan (2021) and the requirements of Energy Assessment Guidance, Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018.)

To ensure compliance with the energy hierarchy, the potential to supply energy efficiently to the Development and further reduce regulated CO2 emissions through BE CLEAN measures, has been evaluated. This has been done with attention to the following hierarchy for selecting an energy system:

1. Connection to an area wide heat network.
2. Communal heating system:
    - Site-wide heat network
    - Building-level heating system
3. Individual heating system.

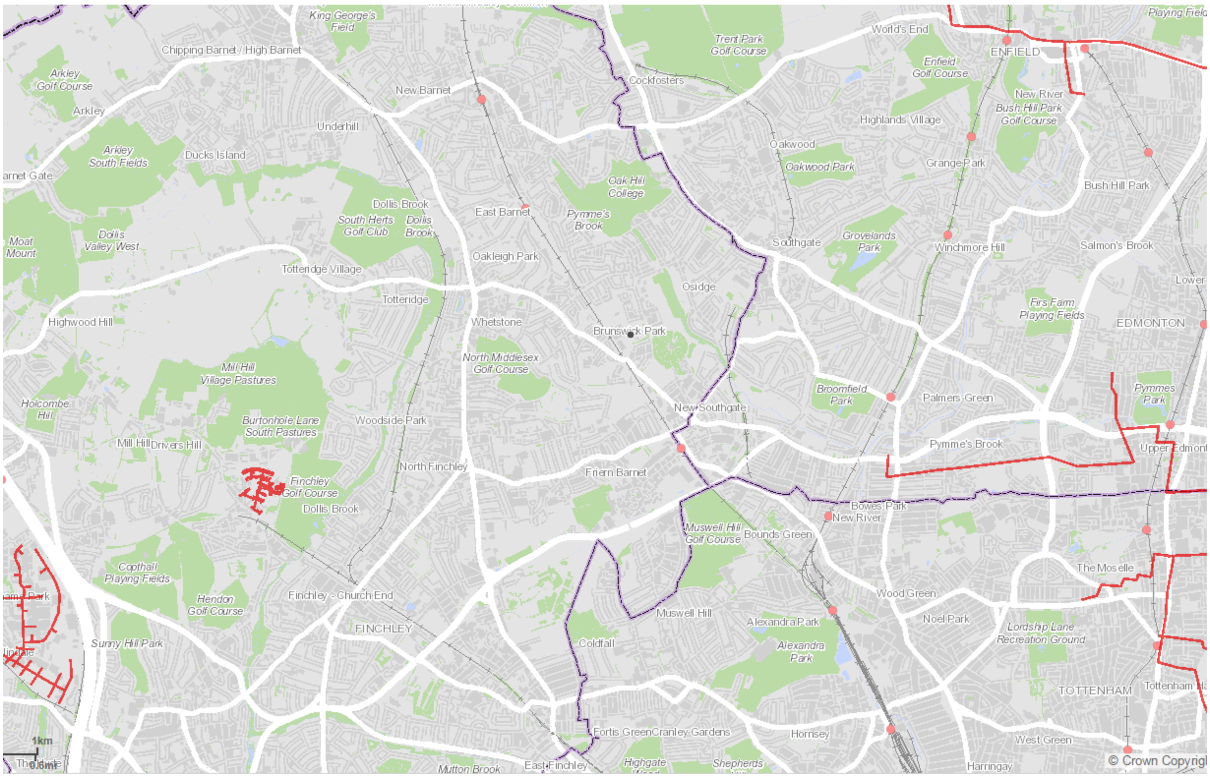
6.1 AREA- WIDE HEAT NETWORK

The London Heat Map has been consulted to establish whether the Development lies within proximity of an existing or proposed area-wide DHN. London Plan policy states that development should seek to connect to existing or planned district energy networks. If it is not possible to link to an existing network, the feasibility of CHP should be considered on a site-wide basis, connecting different uses and/or group of buildings or an individual building.

- The following images contain extracts from the 'London Heat Map' and show:
- The site (black dot in centre of map), current heat networks (shown in red) and proposed networks (none at present)
- Areas of potential heat network opportunity (coloured contour map)

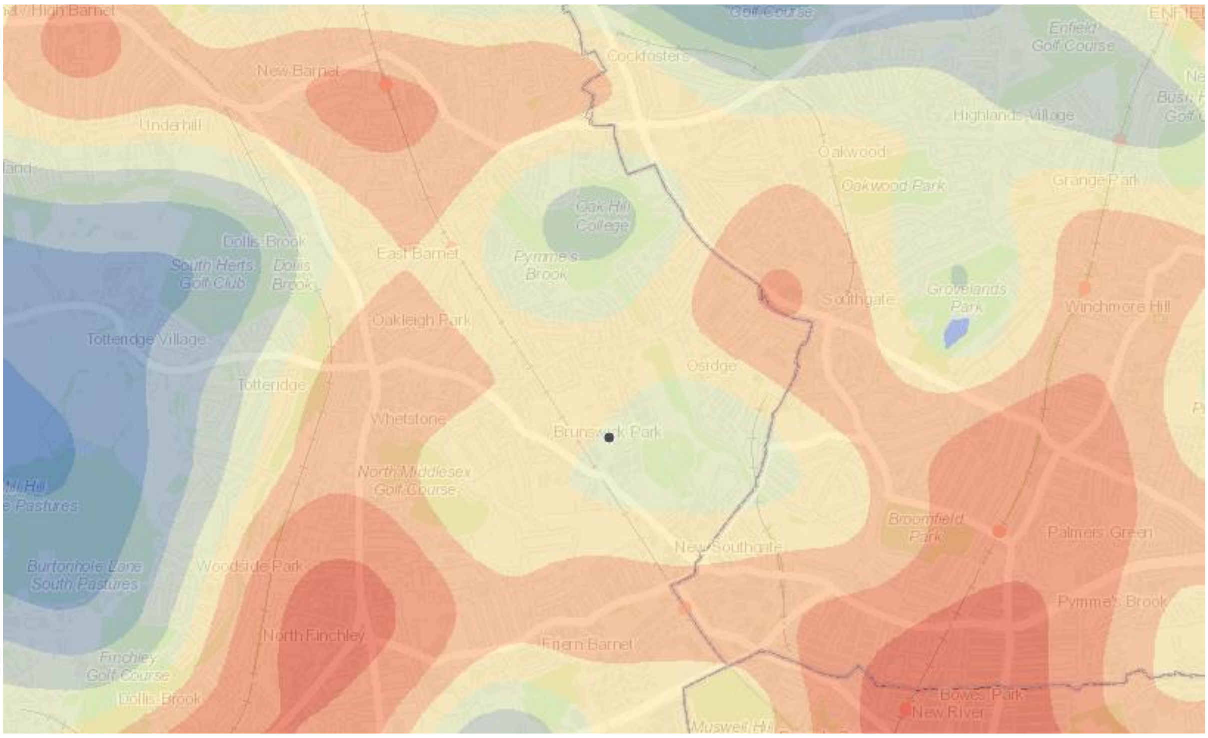
This indicates that the site is not located near to any existing or proposed heat networks. However, it is located close to areas identified as an 'opportunity area' for the implementation of a heat network.

Contact has been made with the local authority and other stakeholders and there are indeed no proposed heat networks that could be extended to connect to the site
Figure 5. London Heat Map showing current heat networks in red:



London Heat Map showing areas of potential opportunity:

From the London Plan Heat Map, it can be clearly demonstrated that the development is not within an area that will be supplied by a district heating network in future. development in areas where an area-wide heat network is not proposed, and which is not within an HNPA.



As Royal Brunswick Park, falls outside a HPA and as there are no plans for an area-wide heat network within close proximity to the Development, the Applicant focuses on a site-wide, communal heating strategy.

The Applicant also focuses on the most suitable site-wide heat network solution for compliance with planning policy targets, whilst adopting SAP10 emission factors. This is in accordance with the GLA’s Energy Assessment Guidance (October, 2018).

6.2 SITE-WIDE HEAT NETWORK

A site-wide heat network, served by a low-carbon generation heat source, will form the central component of the Energy Strategy at Royal Brunswick Park.

A hybrid heat network, led by Air Source Heat Pump (ASHPs) and supplemented by gas- fired boilers, will serve all new dwellings. An ASHP and gas-fired boiler hybrid solution has been selected for its financial, practical and technical feasibility in terms of:

- Space and load requirements of ASHP units on the roofs.
- The positioning of ASHP units inset from the edge of the roof to allow for the appropriate screening for acoustics mitigation/visual improvement.
- Supply and maintenance/replacement cost of ASHP units.
- Cost of energy to the homeowner.
- Carbon emission reductions in SAP10.

Details of this system are set out below.

Table 6. Heat network overview.

Heating Infrastructure	Detail
Heat Demand Met: Air Source Heat Pump (ASHP) Gas Boilers	 80% 20%
ASHP: Heat Pump Efficiency Number of Units Positioning Gas Boiler Efficiency	 COP 3.15 40 Phase 1 91.5%
Heat Losses	20% in line with CIBSE CP1

The site-wide heat network will incorporate ASHP units as the leading heat source. The heat network currently includes 40 Mitsubishi Ecodan CAHV units, roof-mounted at a central location on the roof of Block D in Phase 1. Whilst the energy strategy records a specific make and model of ASHP, it should be noted that the technical specification and exact ASHP selection for the Development may be subject to change pre-construction.

Gas boilers are retained as a supplementary heat source to provide the minimum temperature requirements. The gas boilers will remain within the Energy Centre located at Level 0 along with associated plant for the ASHPs.

To align with Energy Assessment Guidance, Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018) gas boilers will be specified to meet air quality standards and NOx emission limits of <40mgNOx/kWh. Prior to occupation, boiler emissions will be tested to ensure compliance with these limits.

The heat network will be designed in accordance with the District Heating Manual for London and CIBSE Heat Networks Code of Practice (CP1): the focus being to ensure that common design and key principles are adopted in the specification in the early stages. Steps will be taken to:

- Reduce network losses by keeping the length of pipework to a minimum; and

- Insulating pipework to ensure heat loss is minimised with CP1 Best Practice Target of <20% being achieved. 20% heat losses have been assumed for the purposes of the report, however, losses with be designed to be significantly improved upon this. This will be achieved through appropriate use of lagging pipework, minimising lengths of pipework runs, and utilising low temperature water distribution.

The heat network will be designed to align with the future-proofing standards of CIBSE Heat Networks Code of Practice (CP1) as follows:

- Allowance for future expansion, e.g. design in valved and capped tees.
- Allowance for future changes in network operating temperature and the impact on pipework sizes, heat exchangers etc.
- Allowance for future low carbon heat sources.

Any future external, larger heat network system will be able to adapt to the site at the end of the central energy plant life. Or it may function in tandem based on future viability. The Energy Centre is positioned close to the Development boundary allowing a network to expand in the future, subject to viability.

6.3 PHASING AND LAYOUT

The construction of a site-wide heat network will be phased according to the phasing of the Development. As aforementioned, the total 40 ASHPs for the scheme will be located on the roof of Block D in Phase 1 as centralised plant

6.4 BE CLEAN CARBON EMISSIONS REDUCTION

The Applicant will provide a sustainable, hybrid heat network as a centralised and site-wide solution for the space heating and hot water of all new dwellings within the Development proposals.

Further to the advice of the GLA, ASHPs are accounted for under the Be Green calculation and described in Section 7 of the Energy Strategy. There are therefore no reductions recorded for BE CLEAN measures.

Table 7. BE CLEAN regulated CO2 emissions.

	Total regulated emissions	**Regulated CO_2 emissions savings**	**Percentage saving**
Detailed element:	**Tonnes CO2 per annum**		**%**
ADL 2013 Baseline: Domestic	3056.5		
BE LEAN: Domestic	2727.6	328.9	11%
BE CLEAN: Domestic	0	0	0%
Total	**2727.6**	**328.9**	**11%**

7. BE GREEN: LOW- AND ZERO-CARBON TECHNOLOGIES

In line with planning policy of the London Plan (2021) and Energy Assessment Guidance, Greater London Authority guidance on preparing energy assessments as part of planning applications (October 2018), the Applicant seeks to maximise opportunities for incorporating Low- and Zero-Carbon (LZC) technologies as part of their Energy Strategy for the Development.

In accordance with the energy hierarchy, the Applicant has adopted BE LEAN and BE CLEAN measures as a priority for the scheme and demonstrates a 10% reduction in regulated CO2 emissions over the AD L 2013 baseline, using SAP10 emission factors, for domestic and non-domestic areas.

LZC technologies have been assessed for their viability as a component of a complementary heating and cooling strategy for the Development. A detailed review of LZC technologies is provided in Appendix 5. The viability of Solar PV as a LZC option is set out in Appendix 5.

The Applicant's adopted strategy for LZC technologies are an integral component of the engineered solution for the Development scheme's heat network.

7.1 AIR SOURCE HEAT PUMPS

ASHPs will be adopted as the LZC technology for Brunswick Park, and provide the leading heat source in a hybrid heat network solution serving all domestic units as a source of decentralised energy to future occupants and users of the Development.

An ASHP system has been specified comprising Mitsubishi CAHV units which are connected to form a multiple unit system. The hybrid system plant requirements. Details of this system are set out overleaf.

Table 8. Heat network overview.

Heating Infrastructure	Detail
Heat Demand Met: Air Source Heat Pump (ASHP) Gas Boilers	 80% 20%
ASHP: Heat Pump Efficiency Number of Units Positioning Gas Boiler Efficiency	 COP 3.15 40 Block D 91.5%
Heat Losses	20% in line with CIBSE CP1
Heat pump total capacity (kWth)	1680

The CAHV units included within the design of a heat network are capable of providing water flow temperatures of up to 70 degC without boost heaters however Mitsubishi have confirmed that the optimum temperature range for the units at 50degC to 60degC. There is one size unit capable of generating 42kW, each unit is: 1710 H × 1978 W × 759 D

The total annual heat consumption estimated for the development is presented in the table below and is estimated to be 4,809,673kWh.

Predicted Annual Heat Demand	Predicted Annual Heat Demand
Total Heat Consumption by Development (kWh)	4,809,673
Heat Production by ASHPs (kWh) @ 80%	3,847,738
Heat production by Gas Boilers (kWh) @20%	961,934
Consumption by Gas boiler at n=91.5% (kWh)	1,051,294

To maximise the efficiency of the Air Source Heat Pumps, a lower set point temperature has been utilised. The heat pumps will work in association with the communal gas boilers. The ASHP system prefers lower temperatures with smaller temperature differential. The proposed hydraulic arrangement considers the use of ASHP units to pre-heat the return temperature of the district heating system before entering the gas fired boilers.

Given that the nominal variable return temperature is expected from the secondary system. The SCOP of the ASHP has been based on raising the return temperature to the worst-case design value for the purpose of this assessment.

Manufacturer datasheets showing performance under these conditions have been provided within Appendix 11. Calculations are based on BS EN14511 testing methods, which includes defrost.

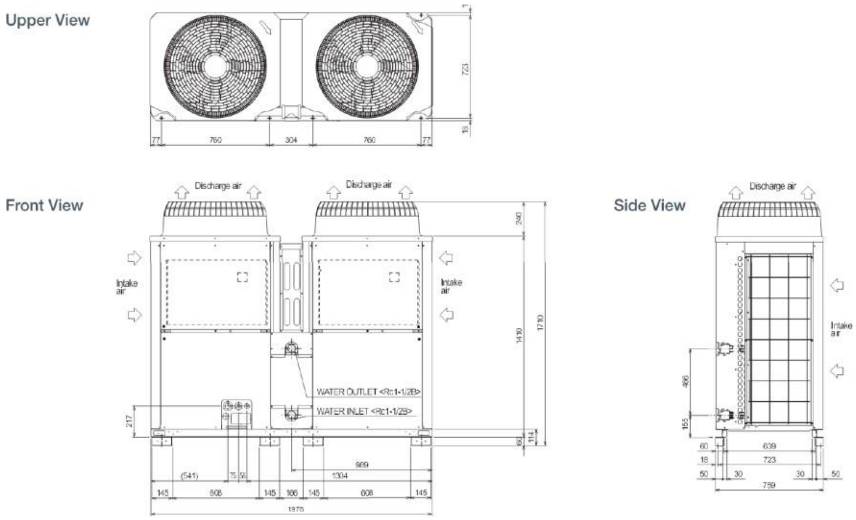
With the exception of the communal gas boiler system, no additional technology is required for hot water top-up.

The heating system has been designed in accordance with Code of Practice and industry standards including:

- Heat Networks Code of Practice for the UK, CP1 2015
- Danish Standards DS439 Code of Practice

The table below highlights the proposed district heating network operating temperature for LTHW system.

Service:	Parameter:
Air Source Heat Pump Set Points	50° C Flow (Variable) Nominal variable return
LTHW Primary Flow & Return Temperatures	75°CFlow 50°C Return (Variable)
LTHW Secondary Flow & Return Temperatures	70°C Flow Nominal Variable Return 22-25°C



In addition to the roof area required for the installation of ASHP units, associated plant and buffer vessels will be installed.

Manufacturers information on the heating system has been provided within the appendices providing details of efficiency under test conditions.

Whilst the energy strategy records a specific make and model of ASHP, it should be noted that the technical specification and exact ASHP selected for the Development may be subject to change pre-construction.

The approved Air Source Heat Pumps will be implemented and if there are any changes to specification or layouts, this shall be agreed in writing with the Local Planning Authority.

Where the Air Source Heat Pump does not achieve expected performance proposed within the Application, the applicant will take the necessary steps to resolve this.

7.2 BE GREEN CARBON EMISSIONS REDUCTION

The cumulative impact of Be Green measures for Royal Brunswick Park, is illustrated in Table 8 below.

Table 9. BE GREEN regulated CO2 emissions.

	Total regulated emissions	**Regulated CO_2 emissions savings**	**Percentage saving**
Detailed element:	**Tonnes CO2 per annum**		**%**
ADL 2013 Baseline: Domestic	3,056.5		
BE LEAN: Domestic	2,727.6	328.9	11
BE CLEAN: Domestic	2,727.6	0	
BE GREEN: Domestic	1,472.6	1255.1	41
Total	**1472.6**	**1584**	**52%**

8. SITE-WIDE RESULTS

By adopting principles of sustainable design, and through the incorporation of efficient, LZC technologies, the Applicant demonstrates their commitment to London Plan (2021) planning policies.

The Applicant is committed to a design approach that aligns with the principles of the energy hierarchy and will achieve a total reduction in regulated CO2 emissions of 52% over the Target Emission Rate (TER) Approved Document Part L (AD L) 2013 through BE LEAN, BE CLEAN and BE GREEN measures, through the adoption of SAP10 emission factors, and successfully delivers the target 35% minimum on-site reduction in regulated CO2 emissions over AD L 2013 for domestic and non-domestic elements of the Development separately.

The way in which the Applicant achieves the CO2 emissions reduction for domestic and non- domestic elements of the Development, at each stage of the energy hierarchy, is summarised here. Results are provided for both SAP10 emission factors and SAP2012 emission factors for comparison purposes.

8.1 DOMESTIC

The regulated CO2 emissions at each stage of the energy hierarchy and percentage savings for domestic buildings using SAP10 emission factors and SAP2012 emission factors are set out in Tables 9-12 below.

Table 10. Domestic, regulated CO2-emission savings, SAP10 emission factors.

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic buildings		
	Regulated domestic carbon dioxide savings	
	Tonnes CO2 per annum	% reduction
Savings from energy demand reduction	328.9	11%
Savings from heat network	0	0%
Savings from renewable energy	1255.1	41%
Cumulative on site savings	**1584**	**52%**
Carbon shortfall	1257.5	-
Cumulative savings for offset payment	**44,177.7 tonnes CO_2**	
Cash-in-lieu contributions	**£4,196,877**	

Table 11. Domestic, regulated CO2-emission savings, SAP2012 emission factors.

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic buildings		
	Regulated domestic carbon dioxide savings	
	Tonnes CO2 per annum	% reduction
Savings from energy demand reduction	160.8	5%
Savings from heat network	0	0%
Savings from renewable energy	555	16.15%
Cumulative on site savings	**715**	**21%**
Carbon shortfall	2720.1	-
Cumulative savings for offset payment	**81,603 tonnes CO_2**	
Cash-in-lieu contributions	**£7,752,241**	

8.2 WHOE SITE TOTAL (DOMESTIC)

Table 112. Site-wide regulated CO_2 emissions and savings, SAP10 emission factors.

Carbon dioxide emissions after each stage of the Energy Hierarchy for site			
	Total regulated emissions	CO_2 savings	Percentage savings
	Tonnes CO_2 per annum		%
Part L 2013 Baseline	3,0256.5	-	-
Be Lean	2727.6	329	11%
Be Clean	2727.6	0	0%
Be Green	1,472.6	1255	41%
Total		1584	52%
		CO_2 savings offset Tonnes CO_2	
Offset		44,4178	

Table 13. Site-wide regulated CO2 emissions and savings, SAP2012 emission factors.

Carbon dioxide emissions after each stage of the Energy Hierarchy for site			
	Total regulated emissions	CO_2 savings	Percentage savings
	Tonnes CO_2 per annum		%
Part L 2013 Baseline	3,435.2	-	-
Be Lean	3,274.4	160.8	5%
Be Clean	3,274.4	0	0%
Be Green	2,720.1	554.2	16%
Total		715	21%
		CO_2 savings offset Tonnes CO_2	
Offset		81,603	

The Development achieves the zero-carbon homes standard in full through a carbon-offset payment which offsets the shortfall in regulated CO2-emissions reduction for the new dwellings. The total CO2 emissions to offset for Brunswick Park, have been calculated as: 44,177.7 t.CO2/30 years. Based on a carbon price of £95 t.CO2/yr over a 30-year period, this is equivalent to a cash-in-lieu contribution of: £4,196,877.

The Mayor’s Housing Standard’s Viability Assessment assumes a carbon offset price of £95 per tonne of carbon dioxide for a period of 30 years which is referred to in: Energy Assessment Guidance, Greater

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

9. CONCULSIONS AND RECOMMENDATIONS

The Applicant demonstrates their commitment to delivering climate-change mitigation measures at Brunswick Park and aligns their design approach with the principles of the energy hierarchy.

The Development will achieve a total reduction in regulated CO2 emissions of 52% over the Target Emission Rate (TER) Approved Document Part L (AD L) 2013 through BE LEAN, BE CLEAN and BE GREEN measures and successfully delivers the target 35% minimum on- site reduction in regulated CO2 emissions over AD L 2013 for domestic elements of the Development.

SAP10 emission factors are adopted within the Energy Strategy in order to estimate, more accurately, the predicted energy performance and actual carbon emissions associated with the development scheme post-construction. This is in accordance with the recommendations of Energy Assessment Guidance (October 2018).

BE LEAN: Passive design measures have been included and lead to a reduction in regulated CO2 emissions over the AD L 2013 TER and Target Fabric Energy Efficiency (TFEE) standard. A combination of BE LEAN measures including: energy-efficient building fabric; insulation to all heat loss floors, walls and roofs; double-glazed windows; low-energy lighting; and efficient ventilation systems all contribute to an enhancement in energy performance equal to a 12% reduction in regulated CO2 emissions over AD L 2013.

A dynamic simulation model and CIBSE TM59 overheating assessment has been completed in parallel with the Energy Strategy to ensure the BE LEAN design approach adopted within this report successfully mitigates for overheating risk through passive and mechanical measures (Source: Overheating Assessment for Brunswick Park, July 2021).

BE CLEAN: The feasibility of supplying decentralised energy to the Development has been assessed in accordance with the heating hierarchy. A site-wide heat network, led by ASHPs and supplemented by high-efficiency gas boilers will serve all domestic units and, providing a source of decentralised energy to future occupants and users of the Development.

BE GREEN: Opportunities to maximise Low- and Zero-Carbon (LZC) technologies have been assessed and all options reviewed for their practical, financial and technical viability in relation to the Development scheme. ASHPs form a central component of the heat network and are described within this report under the BE CLEAN stage of the energy hierarchy. The GLA’s advice is to assess their impact on the energy assessment as a LZC technology under BE GREEN measures. ASHPs will deliver an estimated 41% reduction in regulated CO2 emissions over AD L 2013.

This reduction in emissions through renewable technology is in excess of the 20% reduction required from renewables, and as ASHPs are defined as an LZC, no further reductions are required.

PV has been investigated for its viability, but as the roof areas will be utilised for other measures such as amenity space, multiple ASHPs to serve the heating and hot water, green roofs to contribute towards urban greening as well as surface water run-off management and noise attenuation measures, it has been concluded that there is no viable roof area available for the installation of Solar PV.

The Development achieves the zero-carbon homes standard in full through a carbon-offset payment which offsets the shortfall in regulated CO2-emissions reduction for the new dwellings. The total CO2 emissions to offset for Brunswick Park, have been calculated as: 44,178 t.CO2/30 years. Based on a carbon price of £95 t.CO2/yr over a 30-year period, this is equivalent to a cash-in-lieu contribution of: £4,196,877.

9.1 TRANSITION TO OPERATIONAL ZERO CARBON BY 2030

Royal Brunswick Park has been designed with consideration to the Comer Group long-term vision to achieve operational zero carbon in their new developments by 2030. The following measures within the adopted Energy Strategy contribute towards this vision:

- A fabric-first approach is being taken by Comer Homes to demonstrate how demand for energy is being reduced over and above the Part L Building Regulations baseline.
- A communal heat network solution is being adopted which includes a hybrid heat pump/communal gas boiler arrangement. Heat pumps are a leading technology in the decarbonisation of heat networks.
- An important aspect of being able to plan towards a target for operational zero carbon is the ability for a Development to adopt and use new technologies. One of the benefits of a hybrid heat pump/communal gas model at Royal Brunswick Park is that
- an energy centre/plant space is retained for gas boilers and future-proofs the scheme for transition across to new LZC technologies as these come on stream.
- Sustainable design and heat infrastructure are important stages in developing well-performing, energy-efficient homes. The performance of a new home, in terms of operational carbon emission savings, is also influenced by how an occupier then uses their property, i.e. their demand for space heating and electricity. Smart technologies continue to evolve and offer occupants the potential for greater control over energy consumption.

The current Energy Strategy therefore demonstrates compliance with current planning policy whilst also building in capacity for future decarbonisation through the replacement of plant with new and tested LZC technologies.

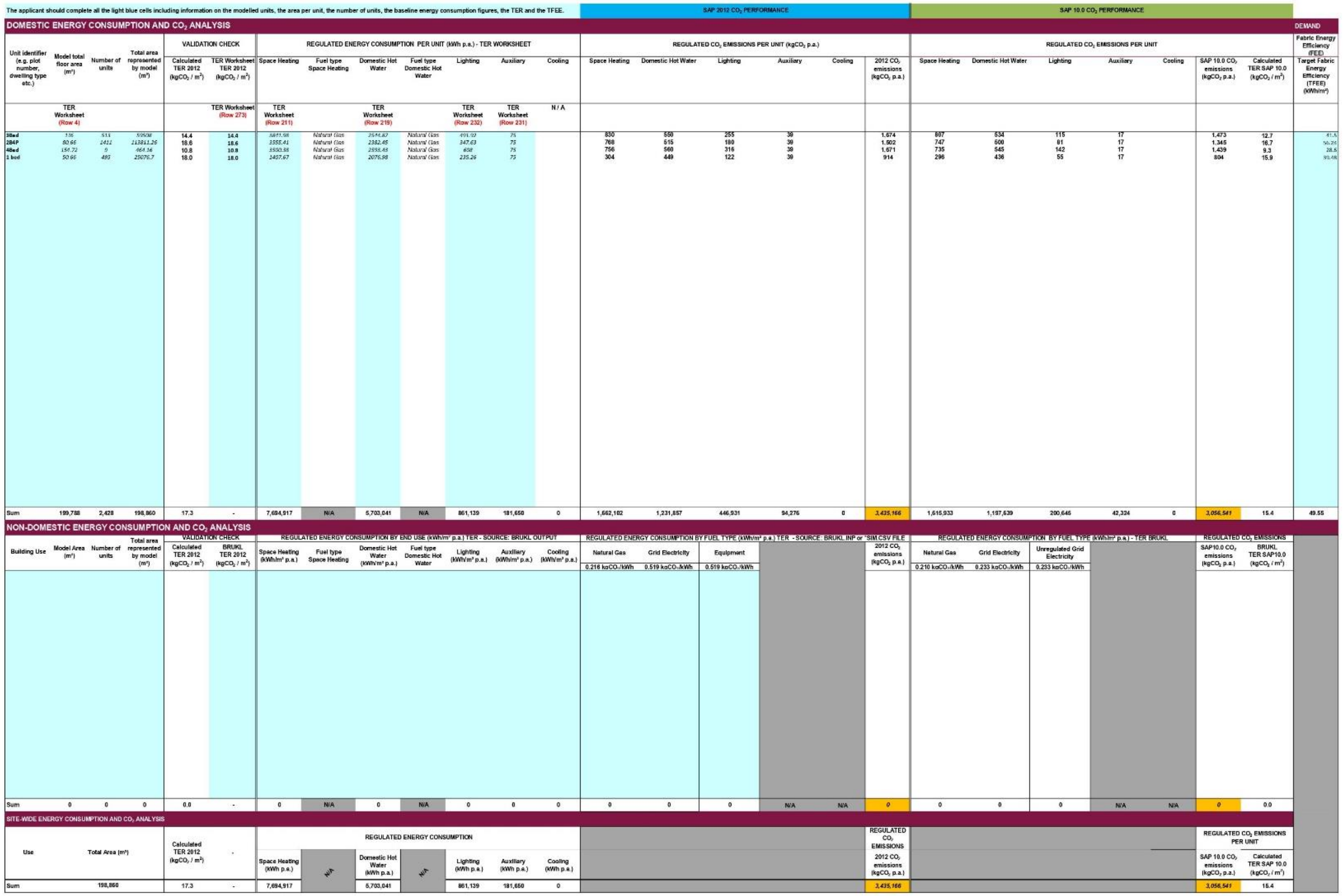
10. APPENDICES

10.1 APPENDIX 1: LIST OF ABBREVIATIONS

AD L 2013	Approved Document Part L of Buildings Regulations 2013
ASHP	Air Source Heat Pump
BER	Building Emission Rate
CHP	Combined Heat & Power
DER	Dwelling Emission Rate
DHN	District Heat Network
DHW	Domestic Hot Water
ESCO	Energy Services Company
FEES	Fabric Energy Efficiency Standard
GSHP	Ground Source Heat Pump
LPA	Local Planning Authority
PV	Photovoltaics
SAP	Standard Assessment Procedure
SBEM	Simplified Building Energy Model
TER	Target Emission Rate

10.2 APPENDIX 2: ENERGY ASSESSMENT RESULTS.

SAP10 Worksheets, Baseline.
Domestic.



The applicant should complete all the light blue cells including information on the modelled units, the area per unit, the number of units, the baseline energy consumption figures, the TER and the TFEE.

DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS

				VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - TER WORKSHEET							SAP 2012 CO_2 PERFORMANCE: REGULATED CO_2 EMISSIONS PER UNIT (kgCO₂ p.a.)						SAP 10.0 CO_2 PERFORMANCE: REGULATED CO_2 EMISSIONS PER UNIT							DEMAND: Fabric Energy Efficiency (FEE)
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	Number of units	Total area represented by model (m²)	Calculated TER 2012 (kgCO₂ / m²)	TER Worksheet TER 2012 (kgCO₂ / m²)	Space Heating	Fuel type Space Heating	Domestic Hot Water	Fuel type Domestic Hot Water	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	2012 CO₂ emissions (kgCO₂ p.a.)	Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	SAP 10.0 CO₂ emissions (kgCO₂ p.a.)	Calculated TER SAP 10.0 (kgCO₂ / m²)	Target Fabric Energy Efficiency (TFEE) (kWh/m²)
	TER Worksheet (Row 4)				TER Worksheet (Row 273)	TER Worksheet (Row 211)		TER Worksheet (Row 219)		TER Worksheet (Row 232)	TER Worksheet (Row 231)	N / A														
3Bed	116	513	59508	14.4	14.4	3841.98	Natural Gas	2544.87	Natural Gas	491.92	75		830	550	255	39		1,674	807	534	115	17		1,473	12.7	41.5
2B4P	80.66	1411	113811.26	18.6	18.6	3555.41	Natural Gas	2382.45	Natural Gas	347.63	75		768	515	180	39		1,502	747	500	81	17		1,345	16.7	56.24
4Bed	154.72	9	464.16	10.8	10.8	3500.38	Natural Gas	2593.43	Natural Gas	608	75		756	560	316	39		1,671	735	545	142	17		1,439	9.3	28.5
1 bed	50.66	495	25076.7	18.0	18.0	1407.67	Natural Gas	2076.98	Natural Gas	235.26	75		304	449	122	39		914	296	436	55	17		804	15.9	50.48
Sum	199,788	2,428	198,860	17.3	-	7,694,917	N/A	5,703,041	N/A	861,139	181,650	0	1,662,102	1,231,857	446,931	94,276	0	3,435,166	1,615,933	1,197,639	200,645	42,324	0	3,056,541	15.4	49.55

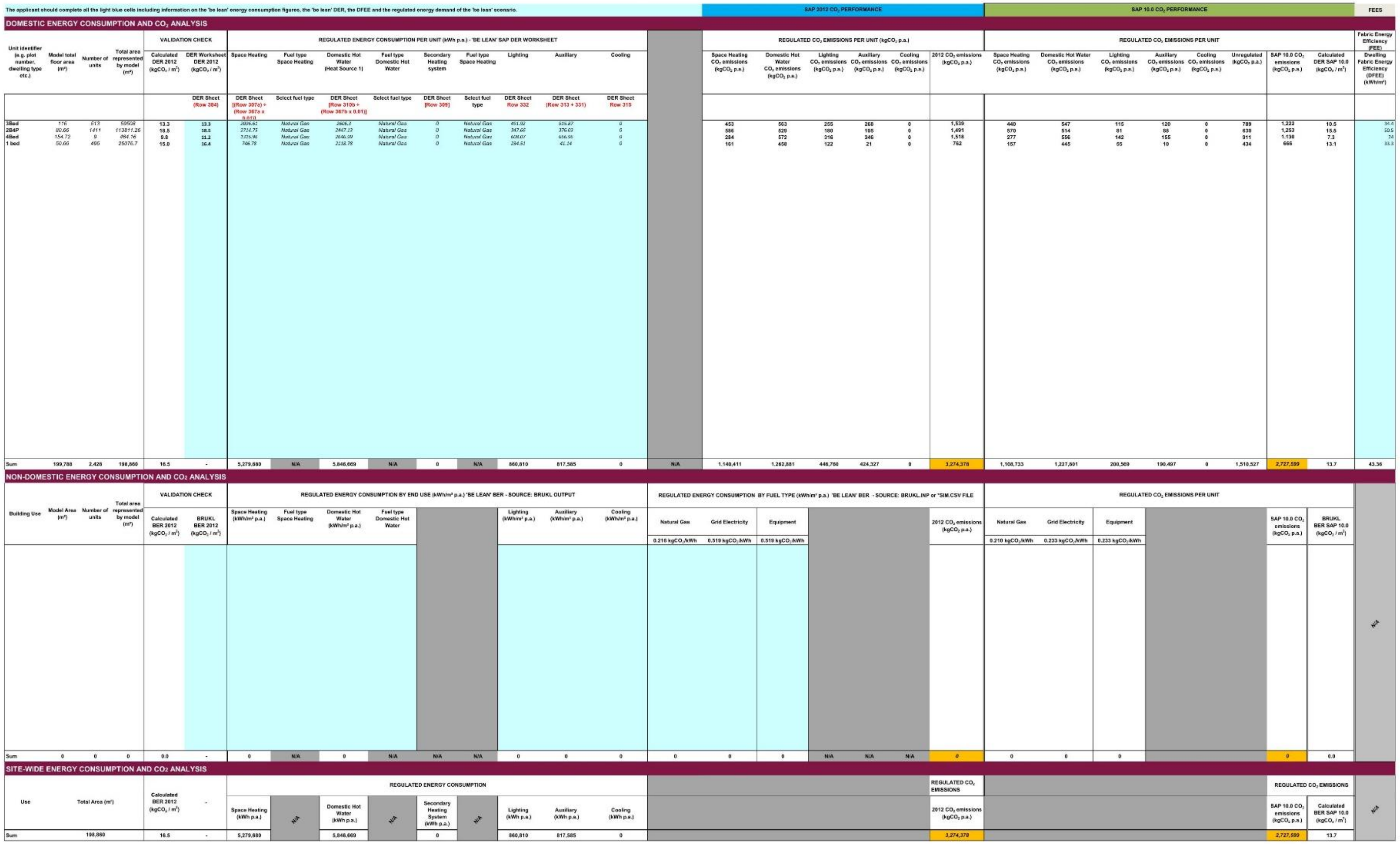
NON-DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS

				VALIDATION CHECK		REGULATED ENERGY CONSUMPTION BY END USE (kWh/m² p.a.) TER - SOURCE: BRUKL OUTPUT							REGULATED ENERGY CONSUMPTION BY FUEL TYPE (kWh/m² p.a.) TER - SOURCE: BRUKL.INP or *SIM.CSV FILE						REGULATED ENERGY CONSUMPTION BY FUEL TYPE (kWh/m² p.a.) - TER BRUKL					REGULATED CO₂ EMISSIONS	
Building Use	Model Area (m²)	Number of units	Total area represented by model (m²)	Calculated TER 2012 (kgCO₂ / m²)	BRUKL TER 2012 (kgCO₂ / m²)	Space Heating (kWh/m² p.a.)	Fuel type Space Heating	Domestic Hot Water (kWh/m² p.a.)	Fuel type Domestic Hot Water	Lighting (kWh/m² p.a.)	Auxiliary (kWh/m² p.a.)	Cooling (kWh/m² p.a.)	Natural Gas	Grid Electricity	Equipment			2012 CO₂ emissions (kgCO₂ p.a.)	Natural Gas	Grid Electricity	Unregulated Grid Electricity			SAP10.0 CO₂ emissions (kgCO₂ p.a.)	BRUKL TER SAP10.0 (kgCO₂ / m²)
													0.216 kgCO₂/kWh	0.519 kgCO₂/kWh	0.519 kgCO₂/kWh				0.210 kgCO₂/kWh	0.233 kgCO₂/kWh	0.233 kgCO₂/kWh				
Sum	0	0	0	0.0	-	0	N/A	0	N/A	0	0	0	0	0	0	N/A	N/A	0	0	0	0	N/A	N/A	0	0.0

SITE-WIDE ENERGY CONSUMPTION AND CO_2 ANALYSIS

				REGULATED ENERGY CONSUMPTION							REGULATED CO₂ EMISSIONS	REGULATED CO₂ EMISSIONS PER UNIT	
Use	Total Area (m²)	Calculated TER 2012 (kgCO₂ / m²)	-	Space Heating (kWh p.a.)	N/A	Domestic Hot Water (kWh p.a.)	N/A	Lighting (kWh p.a.)	Auxiliary (kWh p.a.)	Cooling (kWh p.a.)	2012 CO₂ emissions (kgCO₂ p.a.)	SAP 10.0 CO₂ emissions (kgCO₂ p.a.)	Calculated TER SAP 10.0 (kgCO₂ / m²)
Sum	198,860	17.3	-	7,694,917		5,703,041		861,139	181,650	0	3,435,166	3,056,541	15.4

SAP10 Worksheets, BE LEAN.
Domestic.



The applicant should complete all the light blue cells including information on the 'be lean' energy consumption figures, the 'be lean' DER, the DFEE and the regulated energy demand of the 'be lean' scenario.

DOMESTIC ENERGY CONSUMPTION AND CO$_2$ ANALYSIS

Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m^2)	Number of units	Total area represented by model (m^2)	VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET									
				Calculated DER 2012 (kgCO$_2$ / m^2)	DER Worksheet DER 2012 (kgCO$_2$ / m^2)	Space Heating	Fuel type Space Heating	Domestic Hot Water (Heat Source 1)	Fuel type Domestic Hot Water	Secondary Heating system	Fuel type Space Heating	Lighting	Auxiliary	Cooling	
					DER Sheet (Row 384)	DER Sheet [(Row 307a) + (Row 367a x 0.01)]	Select fuel type	DER Sheet [Row 310b + (Row 367b x 0.01)]	Select fuel type	DER Sheet [Row 309]	Select fuel type	DER Sheet Row 332	DER Sheet (Row 313 + 331)	DER Sheet Row 315	
3Bed	116	513	59508	13.3	13.3	2095.62	Natural Gas	2606.3	Natural Gas	0	Natural Gas	491.92	515.87	0	
2B4P	80.66	1411	113811.26	18.5	18.5	2714.75	Natural Gas	2447.13	Natural Gas	0	Natural Gas	347.66	376.03	0	
4Bed	154.72	9	484.16	9.8	11.2	1315.96	Natural Gas	2646.99	Natural Gas	0	Natural Gas	608.07	666.95	0	
1 bed	50.66	495	25076.7	15.0	16.4	746.78	Natural Gas	2118.78	Natural Gas	0	Natural Gas	234.51	41.14	0	
Sum	199,788	2,428	198,860	16.5	-	5,279,880	N/A	5,846,669	N/A	0	N/A	860,810	817,585	0	N/A

Unit identifier (e.g. plot number, dwelling type etc.)	SAP 2012 CO$_2$ PERFORMANCE						SAP 10.0 CO$_2$ PERFORMANCE								FEES
	REGULATED CO$_2$ EMISSIONS PER UNIT (kgCO$_2$ p.a.)						REGULATED CO$_2$ EMISSIONS PER UNIT								Fabric Energy Efficiency (FEE)
	Space Heating CO$_2$ emissions (kgCO$_2$ p.a.)	Domestic Hot Water CO$_2$ emissions (kgCO$_2$ p.a.)	Lighting CO$_2$ emissions (kgCO$_2$ p.a.)	Auxiliary CO$_2$ emissions (kgCO$_2$ p.a.)	Cooling CO$_2$ emissions (kgCO$_2$ p.a.)	2012 CO$_2$ emissions (kgCO$_2$ p.a.)	Space Heating CO$_2$ emissions (kgCO$_2$ p.a.)	Domestic Hot Water CO$_2$ emissions (kgCO$_2$ p.a.)	Lighting CO$_2$ emissions (kgCO$_2$ p.a.)	Auxiliary CO$_2$ emissions (kgCO$_2$ p.a.)	Cooling CO$_2$ emissions (kgCO$_2$ p.a.)	Unregulated (kgCO$_2$ p.a.)	SAP 10.0 CO$_2$ emissions (kgCO$_2$ p.a.)	Calculated DER SAP 10.0 (kgCO$_2$ / m^2)	Dwelling Fabric Energy Efficiency (DFEE) (kWh/m^2)
3Bed	453	563	255	268	0	1,539	440	547	115	120	0	789	1,222	10.5	34.4
2B4P	586	529	180	195	0	1,491	570	514	81	88	0	630	1,253	15.5	50.5
4Bed	284	572	316	346	0	1,518	277	556	142	155	0	911	1,130	7.3	74
1 bed	161	458	122	21	0	762	157	445	55	10	0	434	666	13.1	33.3
Sum	1,140,411	1,262,881	446,760	424,327	0	3,274,378	1,108,733	1,227,801	200,569	190,497	0	1,510,527	2,727,599	13.7	43.36

NON-DOMESTIC ENERGY CONSUMPTION AND CO$_2$ ANALYSIS

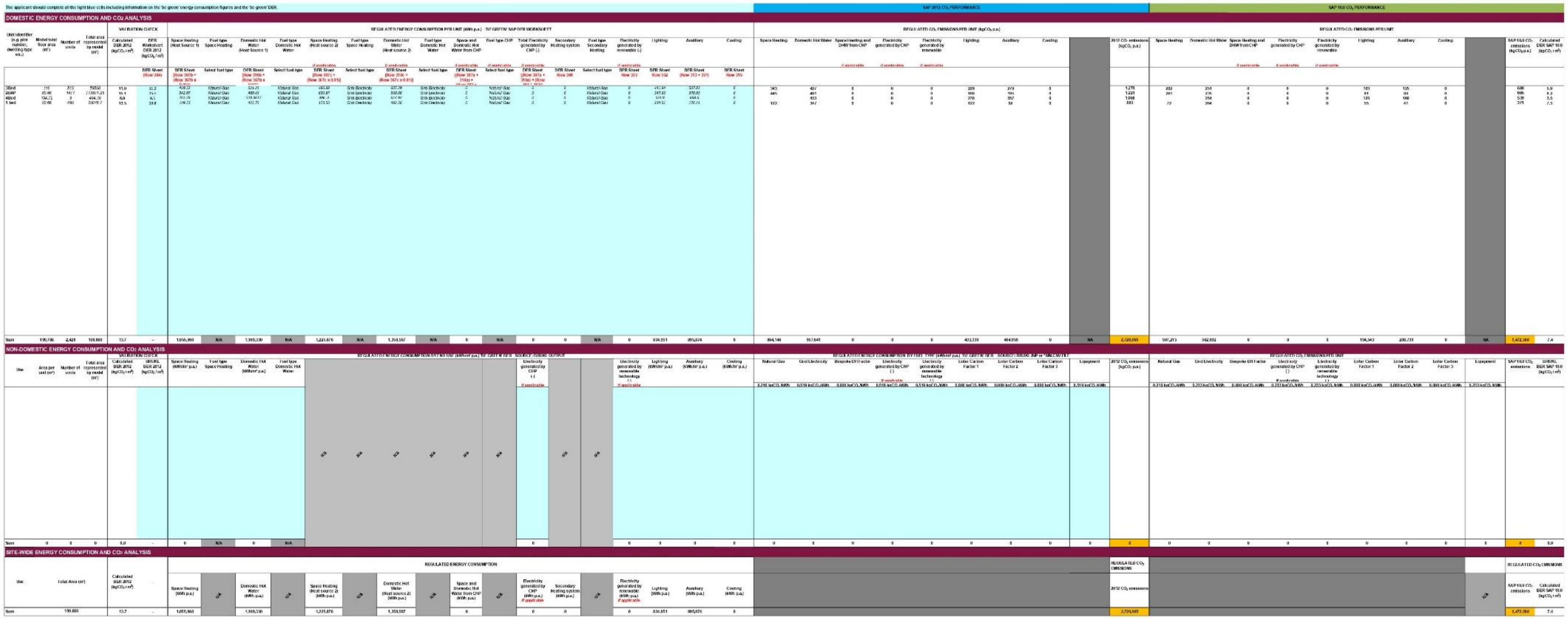
Building Use	Model Area (m^2)	Number of units	Total area represented by model (m^2)	VALIDATION CHECK		REGULATED ENERGY CONSUMPTION BY END USE (kWh/m^2 p.a.) 'BE LEAN' BER - SOURCE: BRUKL OUTPUT								
				Calculated BER 2012 (kgCO$_2$ / m^2)	BRUKL BER 2012 (kgCO$_2$ / m^2)	Space Heating (kWh/m^2 p.a.)	Fuel type Space Heating	Domestic Hot Water (kWh/m^2 p.a.)	Fuel type Domestic Hot Water			Lighting (kWh/m^2 p.a.)	Auxiliary (kWh/m^2 p.a.)	Cooling (kWh/m^2 p.a.)
Sum	0	0	0	0.0	-	0	N/A	0	N/A	N/A	N/A	0	0	0

Building Use	REGULATED ENERGY CONSUMPTION BY FUEL TYPE (kWh/m^2 p.a.) 'BE LEAN' BER - SOURCE: BRUKL.INP or *SIM.CSV FILE							REGULATED CO$_2$ EMISSIONS PER UNIT						N/A
	Natural Gas	Grid Electricity	Equipment				2012 CO$_2$ emissions (kgCO$_2$ p.a.)	Natural Gas	Grid Electricity	Equipment		SAP 10.0 CO$_2$ emissions (kgCO$_2$ p.a.)	BRUKL BER SAP 10.0 (kgCO$_2$ / m^2)	
	0.216 kgCO$_2$/kWh	0.519 kgCO$_2$/kWh	0.519 kgCO$_2$/kWh					0.216 kgCO$_2$/kWh	0.233 kgCO$_2$/kWh	0.233 kgCO$_2$/kWh				
Sum	0	0	0	N/A	N/A	N/A	0	0	0	0		0	0.0	

SITE-WIDE ENERGY CONSUMPTION AND CO$_2$ ANALYSIS

Use	Total Area (m^2)	Calculated BER 2012 (kgCO$_2$ / m^2)	-	REGULATED ENERGY CONSUMPTION										REGULATED CO$_2$ EMISSIONS		REGULATED CO$_2$ EMISSIONS		N/A
				Space Heating (kWh p.a.)	N/A	Domestic Hot Water (kWh p.a.)	N/A	Secondary Heating System (kWh p.a.)	N/A	Lighting (kWh p.a.)	Auxiliary (kWh p.a.)	Cooling (kWh p.a.)		2012 CO$_2$ emissions (kgCO$_2$ p.a.)		SAP 10.0 CO$_2$ emissions (kgCO$_2$ p.a.)	Calculated BER SAP 10.0 (kgCO$_2$ / m^2)	
Sum	198,860	16.5	-	5,279,880		5,846,669		0		860,810	817,585	0		3,274,378		2,727,599	13.7	

SAP10 Worksheets, BE GREEN.
Domestic, Part 1.



The applicant should complete all the light blue cells including information on the 'be green' energy consumption figures and the 'be green' DER.

SAP 2012 CO₂ PERFORMANCE

SAP 10.0 CO₂ PERFORMANCE

DOMESTIC ENERGY CONSUMPTION AND CO₂ ANALYSIS

NON-DOMESTIC ENERGY CONSUMPTION AND CO₂ ANALYSIS

SITE-WIDE ENERGY CONSUMPTION AND CO₂ ANALYSIS

10.3 APPENDIX 3: SAMPLE SAP REPORTS.

BE LEAN WORKSHEETS

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matthew Haskell	**Stroma Number:**	STRO006210
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.8

Property Address: 80m2 2B4P MF

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	80.66	(1a)	x	2.7	(2a)	=	217.78	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	80.66	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	217.78	(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 4 (17)

If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) 0.2 (18)

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

Number of sides sheltered 3 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.78 (20)

Infiltration rate incorporating shelter factor (21) = (18) x (20) = 0.16 (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

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

0.2	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18

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) =	77.35	(23c)

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

(24a)m=	0.31	0.31	0.3	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.3	(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=	0.31	0.31	0.3	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.3	(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			2.1	x	1	=	2.1			(26)
Windows Type 1			16.56	x1/[1/(1.4)+ 0.04]		=	21.95			(27)
Windows Type 2			10.35	x1/[1/(1.4)+ 0.04]		=	13.72			(27)
Walls Type1	48.3	26.91	21.39	x	0.16	=	3.42			(29)
Walls Type2	61.42	2.1	59.32	x	0.16	=	9.49			(29)
Total area of elements, m²			109.73							(31)
Party wall			13.12	x	0	=	0			(32)
Party floor			80.66							(32a)
Party ceiling			80.66							(32b)

** 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) =	50.69	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	16397.92	(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		17.03	(36)

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

Total fabric heat loss	(33) + (36) =	67.72	(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=	22.34	22.06	21.79	20.39	20.11	18.72	18.72	18.44	19.28	20.11	20.67	21.23	(38)

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

(39)m=	90.06	89.78	89.5	88.11	87.83	86.44	86.44	86.16	87	87.83	88.39	88.95	

Average = Sum(39)$_{1…12}$ /12= 88.04 (39)

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

(40)m=	1.12	1.11	1.11	1.09	1.09	1.07	1.07	1.07	1.08	1.09	1.1	1.1

Average = Sum(40)$_{1…12}$ /12= 1.09 (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 2.48 (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 92.99 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	102.29	98.57	94.85	91.13	87.41	83.69	83.69	87.41	91.13	94.85	98.57	102.29	

Total = Sum(44)$_{1…12}$ = 1115.85 (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=	151.69	132.67	136.9	119.35	114.52	98.82	91.57	105.08	106.34	123.93	135.28	146.9

Total = Sum(45)$_{1…12}$ = 1463.06 (45)

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

(46)m=	22.75	19.9	20.54	17.9	17.18	14.82	13.74	15.76	15.95	18.59	20.29	22.04	(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): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 150 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.01 (51)

If community heating see section 4.3

Volume factor from Table 2a 0.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.08 (54)

Enter (50) or (54) in (55) 1.08 (55)

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

(56)m=	33.6	30.34	33.6	32.51	33.6	32.51	33.6	33.6	32.51	33.6	32.51	33.6	(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=	33.6	30.34	33.6	32.51	33.6	32.51	33.6	33.6	32.51	33.6	32.51	33.6	(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)

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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=	208.55	184.02	193.76	174.38	171.38	153.85	148.43	161.94	161.36	180.78	190.3	203.76	(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=	208.55	184.02	193.76	174.38	171.38	153.85	148.43	161.94	161.36	180.78	190.3	203.76

Output from water heater (annual)$_{1…12}$ 2132.51 (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=	95.92	85.2	91.01	83.7	83.56	76.88	75.93	80.43	79.38	86.69	89	94.33	(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=	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	(66)

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

(67)m=	19.69	17.48	14.22	10.77	8.05	6.79	7.34	9.54	12.81	16.26	18.98	20.23	(67)

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

(68)m=	220.81	223.11	217.33	205.04	189.52	174.94	165.2	162.9	168.68	180.97	196.49	211.07	(68)

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

(69)m=	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	(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=	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	(71)

Water heating gains (Table 5)

(72)m=	128.93	126.78	122.32	116.25	112.32	106.77	102.06	108.1	110.24	116.52	123.61	126.79	(72)

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

(73)m=	429.56	427.5	414	392.19	370.02	348.64	334.73	340.67	351.86	373.88	399.2	418.22	(73)

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)	
East	0.9x	0.77	x	16.56	x	19.64	x	0.63	x	0.7	=	99.4	(76)
East	0.9x	0.77	x	10.35	x	19.64	x	0.63	x	0.7	=	62.12	(76)
East	0.9x	0.77	x	16.56	x	38.42	x	0.63	x	0.7	=	194.44	(76)
East	0.9x	0.77	x	10.35	x	38.42	x	0.63	x	0.7	=	121.53	(76)
East	0.9x	0.77	x	16.56	x	63.27	x	0.63	x	0.7	=	320.22	(76)

East	0.9x	0.77	x	10.35	x	63.27	x	0.63	x	0.7	=	200.14	(76)
East	0.9x	0.77	x	16.56	x	92.28	x	0.63	x	0.7	=	467.03	(76)
East	0.9x	0.77	x	10.35	x	92.28	x	0.63	x	0.7	=	291.89	(76)
East	0.9x	0.77	x	16.56	x	113.09	x	0.63	x	0.7	=	572.36	(76)
East	0.9x	0.77	x	10.35	x	113.09	x	0.63	x	0.7	=	357.72	(76)
East	0.9x	0.77	x	16.56	x	115.77	x	0.63	x	0.7	=	585.91	(76)
East	0.9x	0.77	x	10.35	x	115.77	x	0.63	x	0.7	=	366.19	(76)
East	0.9x	0.77	x	16.56	x	110.22	x	0.63	x	0.7	=	557.81	(76)
East	0.9x	0.77	x	10.35	x	110.22	x	0.63	x	0.7	=	348.63	(76)
East	0.9x	0.77	x	16.56	x	94.68	x	0.63	x	0.7	=	479.15	(76)
East	0.9x	0.77	x	10.35	x	94.68	x	0.63	x	0.7	=	299.47	(76)
East	0.9x	0.77	x	16.56	x	73.59	x	0.63	x	0.7	=	372.43	(76)
East	0.9x	0.77	x	10.35	x	73.59	x	0.63	x	0.7	=	232.77	(76)
East	0.9x	0.77	x	16.56	x	45.59	x	0.63	x	0.7	=	230.72	(76)
East	0.9x	0.77	x	10.35	x	45.59	x	0.63	x	0.7	=	144.2	(76)
East	0.9x	0.77	x	16.56	x	24.49	x	0.63	x	0.7	=	123.94	(76)
East	0.9x	0.77	x	10.35	x	24.49	x	0.63	x	0.7	=	77.46	(76)
East	0.9x	0.77	x	16.56	x	16.15	x	0.63	x	0.7	=	81.74	(76)
East	0.9x	0.77	x	10.35	x	16.15	x	0.63	x	0.7	=	51.09	(76)

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

(83)m=	161.52	315.97	520.36	758.92	930.08	952.1	906.44	778.62	605.2	374.93	201.4	132.83	(83)

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

(84)m=	591.08	743.47	934.36	1151.1	1300.1	1300.74	1241.17	1119.29	957.06	748.81	600.6	551.05	(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	0.98	0.94	0.81	0.61	0.42	0.31	0.35	0.61	0.91	0.99	1	(86)

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

(87)m=	19.93	20.16	20.51	20.84	20.97	21	21	21	20.98	20.73	20.25	19.89	(87)

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

(88)m=	19.99	19.99	19.99	20.01	20.01	20.02	20.02	20.03	20.02	20.01	20	20	(88)

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

(89)m=	0.99	0.98	0.92	0.76	0.55	0.36	0.24	0.28	0.53	0.88	0.98	1	(89)

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

(90)m=	18.57	18.91	19.4	19.84	19.98	20.02	20.02	20.03	20	19.72	19.06	18.52	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	19.13	19.43	19.86	20.25	20.39	20.43	20.43	20.43	20.41	20.14	19.55	19.09	(92)

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

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(93)m=	19.13	19.43	19.86	20.25	20.39	20.43	20.43	20.43	20.41	20.14	19.55	19.09	(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=	0.99	0.98	0.92	0.78	0.57	0.39	0.27	0.31	0.56	0.88	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	586.09	725.33	861.43	892.61	743.35	501.55	330.67	346.7	535.9	661.32	588.81	547.66	(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=	1335.82	1304.65	1195.83	1000.19	763.29	503.54	330.89	347.16	548.6	837.63	1100.64	1324.43	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	557.81	389.3	248.79	77.46	14.84	0	0	0	0	131.17	368.52	577.92	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2365.79 (98)

Space heating requirement in kWh/m²/year 29.33 (99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none 0 (301)

Fraction of space heat from community system 1 – (301) = 1 (302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers 1 (303a)

Fraction of total space heat from Community boilers (302) x (303a) = 1 (304a)

Factor for control and charging method (Table 4c(3)) for community heating system 1 (305)

Distribution loss factor (Table 12c) for community heating system 1.05 (306)

Space heating **kWh/year**

Annual space heating requirement 2365.79

Space heat from Community boilers (98) x (304a) x (305) x (306) = 2484.08 (307a)

Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) 0 (308

Space heating requirement from secondary/supplementary system (98) x (301) x 100 ÷ (308) = 0 (309)

Water heating

Annual water heating requirement 2132.51

If DHW from community scheme:

Water heat from Community boilers (64) x (303a) x (305) x (306) = 2239.13 (310a)

Electricity used for heat distribution 0.01 × [(307a)…(307e) + (310a)…(310e)] = 47.23 (313)

Cooling System Energy Efficiency Ratio 0 (314)

Space cooling (if there is a fixed cooling system, if not enter 0) = (107) ÷ (314) = 0 (315)

Electricity for pumps and fans within dwelling (Table 4f):

mechanical ventilation - balanced, extract or positive input from outside 328.8 (330a)

warm air heating system fans				0	(330b)
pump for solar water heating				0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =			328.8	(331)
Energy for lighting (calculated in Appendix L)				347.66	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				91.5	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	1114.99	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	24.51	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	1139.5	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				1139.5	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	170.65	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	180.43	(379)
Total CO2, kg/year	sum of (376)…(382) =				1490.58	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				18.48	(384)
EI rating (section 14)					84.1	(385)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matthew Haskell	**Stroma Number:**	STRO006210
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.8

Property Address: 80m2 2B4P MF

Address :

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	80.66	(1a)	x	2.7	(2a)	=	217.78	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	80.66	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	217.78	(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							3	x 10 =	30	(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) =	30	÷ (5) =	0.14	(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)	0.39	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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

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

0.38	0.38	0.37	0.33	0.32	0.29	0.29	0.28	0.3	0.32	0.34	0.35

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

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

(25)m=	0.57	0.57	0.57	0.55	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(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			2.1	x	1	=	2.1			(26)
Windows Type 1			11.12	x1/[1/(1.4)+ 0.04]		=	14.74			(27)
Windows Type 2			6.95	x1/[1/(1.4)+ 0.04]		=	9.21			(27)
Walls Type1	48.3	18.07	30.23	x	0.18	=	5.44			(29)
Walls Type2	61.42	2.1	59.32	x	0.18	=	10.68			(29)
Total area of elements, m²			109.73							(31)
Party wall			13.12	x	0	=	0			(32)
Party floor			80.66							(32a)
Party ceiling			80.66							(32b)

** 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) =	42.18	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	16928.32	(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		16.36	(36)

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

Total fabric heat loss	(33) + (36) =	58.53	(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=	41.21	41	40.8	39.86	39.68	38.86	38.86	38.71	39.18	39.68	40.04	40.41	(38)

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

(39)m=	99.74	99.54	99.34	98.39	98.22	97.4	97.4	97.24	97.71	98.22	98.58	98.95	

Average = Sum(39)$_{1…12}$ /12= 98.39 (39)

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

(40)m=	1.24	1.23	1.23	1.22	1.22	1.21	1.21	1.21	1.21	1.22	1.22	1.23	

Average = Sum(40)$_{1…12}$ /12= 1.22 (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 2.48 (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 92.99 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	102.29	98.57	94.85	91.13	87.41	83.69	83.69	87.41	91.13	94.85	98.57	102.29	
											Total = Sum(44)$_{1…12}$ =	1115.85	(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=	151.69	132.67	136.9	119.35	114.52	98.82	91.57	105.08	106.34	123.93	135.28	146.9	
											Total = Sum(45)$_{1…12}$ =	1463.06	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.75	19.9	20.54	17.9	17.18	14.82	13.74	15.76	15.95	18.59	20.29	22.04	(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)

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)

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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=	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5	(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=	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5	

Output from water heater (annual)$_{1\ldots12}$ 2011.67 (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=	87.71	77.78	82.8	75.76	75.35	68.93	67.72	72.22	71.43	78.48	81.05	86.12	(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=	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	(66)

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

(67)m=	19.68	17.48	14.22	10.76	8.05	6.79	7.34	9.54	12.81	16.26	18.98	20.23	(67)

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

(68)m=	220.81	223.11	217.33	205.04	189.52	174.94	165.2	162.9	168.68	180.97	196.49	211.07	(68)

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

(69)m=	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	(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=	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	(71)

Water heating gains (Table 5)

(72)m=	117.89	115.74	111.28	105.22	101.28	95.74	91.03	97.06	99.21	105.49	112.57	115.75	(72)

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

(73)m=	421.52	419.46	405.96	384.15	361.98	340.6	326.69	332.64	343.82	365.85	391.17	410.19	(73)

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)	
East	0.9x	0.77	x	11.12	x	19.64	x	0.63	x	0.7	=	66.75	(76)
East	0.9x	0.77	x	6.95	x	19.64	x	0.63	x	0.7	=	41.72	(76)
East	0.9x	0.77	x	11.12	x	38.42	x	0.63	x	0.7	=	130.57	(76)
East	0.9x	0.77	x	6.95	x	38.42	x	0.63	x	0.7	=	81.61	(76)
East	0.9x	0.77	x	11.12	x	63.27	x	0.63	x	0.7	=	215.03	(76)

East	0.9x	0.77	x	6.95	x	63.27	x	0.63	x	0.7	=	134.39	(76)
East	0.9x	0.77	x	11.12	x	92.28	x	0.63	x	0.7	=	313.61	(76)
East	0.9x	0.77	x	6.95	x	92.28	x	0.63	x	0.7	=	196	(76)
East	0.9x	0.77	x	11.12	x	113.09	x	0.63	x	0.7	=	384.34	(76)
East	0.9x	0.77	x	6.95	x	113.09	x	0.63	x	0.7	=	240.21	(76)
East	0.9x	0.77	x	11.12	x	115.77	x	0.63	x	0.7	=	393.44	(76)
East	0.9x	0.77	x	6.95	x	115.77	x	0.63	x	0.7	=	245.9	(76)
East	0.9x	0.77	x	11.12	x	110.22	x	0.63	x	0.7	=	374.57	(76)
East	0.9x	0.77	x	6.95	x	110.22	x	0.63	x	0.7	=	234.1	(76)
East	0.9x	0.77	x	11.12	x	94.68	x	0.63	x	0.7	=	321.75	(76)
East	0.9x	0.77	x	6.95	x	94.68	x	0.63	x	0.7	=	201.09	(76)
East	0.9x	0.77	x	11.12	x	73.59	x	0.63	x	0.7	=	250.09	(76)
East	0.9x	0.77	x	6.95	x	73.59	x	0.63	x	0.7	=	156.3	(76)
East	0.9x	0.77	x	11.12	x	45.59	x	0.63	x	0.7	=	154.93	(76)
East	0.9x	0.77	x	6.95	x	45.59	x	0.63	x	0.7	=	96.83	(76)
East	0.9x	0.77	x	11.12	x	24.49	x	0.63	x	0.7	=	83.22	(76)
East	0.9x	0.77	x	6.95	x	24.49	x	0.63	x	0.7	=	52.02	(76)
East	0.9x	0.77	x	11.12	x	16.15	x	0.63	x	0.7	=	54.89	(76)
East	0.9x	0.77	x	6.95	x	16.15	x	0.63	x	0.7	=	34.31	(76)

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

(83)m=	108.46	212.17	349.42	509.61	624.55	639.33	608.67	522.84	406.39	251.76	135.24	89.19	(83)

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

(84)m=	529.98	631.64	755.38	893.76	986.53	979.93	935.36	855.48	750.21	617.61	526.41	499.38	(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	0.99	0.98	0.92	0.79	0.61	0.45	0.51	0.78	0.96	0.99	1	(86)

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

(87)m=	19.7	19.88	20.19	20.58	20.85	20.97	20.99	20.99	20.9	20.51	20.03	19.66	(87)

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

(88)m=	19.89	19.89	19.89	19.9	19.91	19.91	19.91	19.92	19.91	19.91	19.9	19.9	(88)

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

(89)m=	1	0.99	0.97	0.9	0.73	0.52	0.34	0.4	0.7	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=	18.17	18.44	18.89	19.43	19.77	19.89	19.91	19.91	19.84	19.35	18.66	18.12	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.8	19.04	19.43	19.91	20.22	20.34	20.36	20.36	20.28	19.83	19.22	18.76	(92)

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

(93)m=	18.8	19.04	19.43	19.91	20.22	20.34	20.36	20.36	20.28	19.83	19.22	18.76	(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=	0.99	0.99	0.97	0.9	0.75	0.55	0.39	0.44	0.73	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	527.1	623.81	729.28	801.13	743.01	542.46	363.81	380.4	545.92	582.67	520.55	497.3	(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=	1446.28	1406.99	1284.45	1082.91	836.56	559	366.22	384.87	603.44	906.52	1195.11	1440.82	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	683.87	526.29	413.05	202.88	69.6	0	0	0	0	240.95	485.68	701.98	

Total per year (kWh/year) = Sum(98)$_{1\ldots5,9\ldots12}$ = 3324.31 (98)

Space heating requirement in kWh/m²/year 41.21 (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)													
	683.87	526.29	413.05	202.88	69.6	0	0	0	0	240.95	485.68	701.98	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	731.41	562.88	441.76	216.99	74.44	0	0	0	0	257.7	519.45	750.78	

Total (kWh/year) =Sum(211)$_{1\ldots5,10\ldots12}$= 3555.41 (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)$_{1\ldots5,10\ldots12}$= 0 (215)

Water heating

Output from water heater (calculated above)

	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5	
Efficiency of water heater												79.8	(216)
(217)m=	87.85	87.57	86.92	85.38	82.75	79.8	79.8	79.8	79.8	85.74	87.33	87.95	(217)

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

(219)m=	225.7	199.55	211.12	192.61	194.7	180.35	173.15	190.07	189.76	198.89	206.54	220

Total = Sum(219a)$_{1\ldots12}$ = 2382.45 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		3555.41

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Water heating fuel used			2382.45	
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			347.63	(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	=	767.97	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	514.61	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1282.58	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	180.42	(268)
Total CO2, kg/year			sum of (265)…(271) =		1501.92	(272)

TER =	18.62	(273)

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User Details:

Assessor Name:	Matthew Haskell	**Stroma Number:**	STRO006210
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.8

Property Address: 80m2 2B4P MF

Address :

1. Overall dwelling dimensions:

	Area(m²)			**Av. Height(m)**			**Volume(m³)**	
Ground floor	80.66	(1a)	x	2.7	(2a)	=	217.78	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	80.66	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	217.78	(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		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.2	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.16	(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

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

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

0.2	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18

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) = 77.35 (23c)

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

(24a)m=	0.31	0.31	0.3	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.3	(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=	0.31	0.31	0.3	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.3	(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			2.1	x	1	=	2.1			(26)
Windows Type 1			16.56	x1/[1/(1.4)+ 0.04]		=	21.95			(27)
Windows Type 2			10.35	x1/[1/(1.4)+ 0.04]		=	13.72			(27)
Walls Type1	48.3	26.91	21.39	x	0.16	=	3.42			(29)
Walls Type2	61.42	2.1	59.32	x	0.16	=	9.49			(29)
Total area of elements, m²			109.73							(31)
Party wall			13.12	x	0	=	0			(32)
Party floor			80.66							(32a)
Party ceiling			80.66							(32b)

** 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) = 50.69 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 16397.92 (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 17.03 (36)

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

Total fabric heat loss (33) + (36) = 67.72 (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=	22.34	22.06	21.79	20.39	20.11	18.72	18.72	18.44	19.28	20.11	20.67	21.23	(38)

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

(39)m=	90.06	89.78	89.5	88.11	87.83	86.44	86.44	86.16	87	87.83	88.39	88.95	

Average = Sum(39)$_{1…12}$ /12= 88.04 (39)

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

(40)m=	1.12	1.11	1.11	1.09	1.09	1.07	1.07	1.07	1.08	1.09	1.1	1.1	

Average = Sum(40)$_{1…12}$ /12= 1.09 (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 2.48 (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 92.99 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	102.29	98.57	94.85	91.13	87.41	83.69	83.69	87.41	91.13	94.85	98.57	102.29	

Total = Sum(44)$_{1…12}$ = 1115.85 (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=	151.69	132.67	136.9	119.35	114.52	98.82	91.57	105.08	106.34	123.93	135.28	146.9	

Total = Sum(45)$_{1…12}$ = 1463.06 (45)

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

(46)m=	22.75	19.9	20.54	17.9	17.18	14.82	13.74	15.76	15.95	18.59	20.29	22.04	(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): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 150 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.01 (51)

If community heating see section 4.3

Volume factor from Table 2a 0.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.08 (54)

Enter (50) or (54) in (55) 1.08 (55)

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

(56)m=	33.6	30.34	33.6	32.51	33.6	32.51	33.6	33.6	32.51	33.6	32.51	33.6	(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=	33.6	30.34	33.6	32.51	33.6	32.51	33.6	33.6	32.51	33.6	32.51	33.6	(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)

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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=	208.55	184.02	193.76	174.38	171.38	153.85	148.43	161.94	161.36	180.78	190.3	203.76	(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=	208.55	184.02	193.76	174.38	171.38	153.85	148.43	161.94	161.36	180.78	190.3	203.76	

Output from water heater (annual)$_{1\ldots12}$ 2132.51 (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=	95.92	85.2	91.01	83.7	83.56	76.88	75.93	80.43	79.38	86.69	89	94.33	(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=	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	(66)

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

(67)m=	19.69	17.48	14.22	10.77	8.05	6.79	7.34	9.54	12.81	16.26	18.98	20.23	(67)

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

(68)m=	220.81	223.11	217.33	205.04	189.52	174.94	165.2	162.9	168.68	180.97	196.49	211.07	(68)

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

(69)m=	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	(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=	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	(71)

Water heating gains (Table 5)

(72)m=	128.93	126.78	122.32	116.25	112.32	106.77	102.06	108.1	110.24	116.52	123.61	126.79	(72)

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

(73)m=	429.56	427.5	414	392.19	370.02	348.64	334.73	340.67	351.86	373.88	399.2	418.22	(73)

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)	
East	0.9x	0.77	x	16.56	x	19.64	x	0.63	x	0.7	=	99.4	(76)
East	0.9x	0.77	x	10.35	x	19.64	x	0.63	x	0.7	=	62.12	(76)
East	0.9x	0.77	x	16.56	x	38.42	x	0.63	x	0.7	=	194.44	(76)
East	0.9x	0.77	x	10.35	x	38.42	x	0.63	x	0.7	=	121.53	(76)
East	0.9x	0.77	x	16.56	x	63.27	x	0.63	x	0.7	=	320.22	(76)

East	0.9x	0.77	x	10.35	x	63.27	x	0.63	x	0.7	=	200.14	(76)
East	0.9x	0.77	x	16.56	x	92.28	x	0.63	x	0.7	=	467.03	(76)
East	0.9x	0.77	x	10.35	x	92.28	x	0.63	x	0.7	=	291.89	(76)
East	0.9x	0.77	x	16.56	x	113.09	x	0.63	x	0.7	=	572.36	(76)
East	0.9x	0.77	x	10.35	x	113.09	x	0.63	x	0.7	=	357.72	(76)
East	0.9x	0.77	x	16.56	x	115.77	x	0.63	x	0.7	=	585.91	(76)
East	0.9x	0.77	x	10.35	x	115.77	x	0.63	x	0.7	=	366.19	(76)
East	0.9x	0.77	x	16.56	x	110.22	x	0.63	x	0.7	=	557.81	(76)
East	0.9x	0.77	x	10.35	x	110.22	x	0.63	x	0.7	=	348.63	(76)
East	0.9x	0.77	x	16.56	x	94.68	x	0.63	x	0.7	=	479.15	(76)
East	0.9x	0.77	x	10.35	x	94.68	x	0.63	x	0.7	=	299.47	(76)
East	0.9x	0.77	x	16.56	x	73.59	x	0.63	x	0.7	=	372.43	(76)
East	0.9x	0.77	x	10.35	x	73.59	x	0.63	x	0.7	=	232.77	(76)
East	0.9x	0.77	x	16.56	x	45.59	x	0.63	x	0.7	=	230.72	(76)
East	0.9x	0.77	x	10.35	x	45.59	x	0.63	x	0.7	=	144.2	(76)
East	0.9x	0.77	x	16.56	x	24.49	x	0.63	x	0.7	=	123.94	(76)
East	0.9x	0.77	x	10.35	x	24.49	x	0.63	x	0.7	=	77.46	(76)
East	0.9x	0.77	x	16.56	x	16.15	x	0.63	x	0.7	=	81.74	(76)
East	0.9x	0.77	x	10.35	x	16.15	x	0.63	x	0.7	=	51.09	(76)

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

(83)m=	161.52	315.97	520.36	758.92	930.08	952.1	906.44	778.62	605.2	374.93	201.4	132.83	(83)

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

(84)m=	591.08	743.47	934.36	1151.1	1300.1	1300.74	1241.17	1119.29	957.06	748.81	600.6	551.05	(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	0.98	0.94	0.81	0.61	0.42	0.31	0.35	0.61	0.91	0.99	1	(86)

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

(87)m=	19.93	20.16	20.51	20.84	20.97	21	21	21	20.98	20.73	20.25	19.89	(87)

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

(88)m=	19.99	19.99	19.99	20.01	20.01	20.02	20.02	20.03	20.02	20.01	20	20	(88)

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

(89)m=	0.99	0.98	0.92	0.76	0.55	0.36	0.24	0.28	0.53	0.88	0.98	1	(89)

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

(90)m=	18.57	18.91	19.4	19.84	19.98	20.02	20.02	20.03	20	19.72	19.06	18.52	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	19.13	19.43	19.86	20.25	20.39	20.43	20.43	20.43	20.41	20.14	19.55	19.09	(92)

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

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(93)m=	19.13	19.43	19.86	20.25	20.39	20.43	20.43	20.43	20.41	20.14	19.55	19.09	(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=	0.99	0.98	0.92	0.78	0.57	0.39	0.27	0.31	0.56	0.88	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	586.09	725.33	861.43	892.61	743.35	501.55	330.67	346.7	535.9	661.32	588.81	547.66	(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=	1335.82	1304.65	1195.83	1000.19	763.29	503.54	330.89	347.16	548.6	837.63	1100.64	1324.43	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	557.81	389.3	248.79	77.46	14.84	0	0	0	0	131.17	368.52	577.92	

	Total per year (kWh/year) = $\text{Sum}(98)_{1...5,9...12}$ =	2365.79	(98)
Space heating requirement in kWh/m²/year		29.33	(99)

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none		0	(301)
Fraction of space heat from community system 1 – (301) =		1	(302)

The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.

Fraction of heat from Community boilers		0.2	(303a)
Fraction of community heat from heat source 2		0.8	(303b)
Fraction of total space heat from Community boilers	(302) x (303a) =	0.2	(304a)
Fraction of total space heat from community heat source 2	(302) x (303b) =	0.8	(304b)
Factor for control and charging method (Table 4c(3)) for community heating system		1	(305)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)
Space heating		**kWh/year**	
Annual space heating requirement		2365.79	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	496.82	(307a)
Space heat from heat source 2	(98) x (304b) x (305) x (306) =	1987.27	(307b)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)		0	(308
Space heating requirement from secondary/supplementary system	(98) x (301) x 100 ÷ (308) =	0	(309)
Water heating			
Annual water heating requirement		2132.51	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	447.83	(310a)
Water heat from heat source 2	(64) x (303b) x (305) x (306) =	1791.31	(310b)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	47.23	(313)

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Cooling System Energy Efficiency Ratio		0	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	= (107) ÷ (314) =	0	(315)
Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside		328.8	(330a)
warm air heating system fans		0	(330b)
pump for solar water heating		0	(330g)
Total electricity for the above, kWh/year	=(330a) + (330b) + (330g) =	328.8	(331)
Energy for lighting (calculated in Appendix L)		347.66	(332)

12b. CO2 Emissions – Community heating scheme

		Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
CO2 from other sources of space and water heating (not CHP)						
Efficiency of heat source 1 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				91.5	(367a)
Efficiency of heat source 2 (%)	If there is CHP using two fuels repeat (363) to (366) for the second fuel				315	(367b)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	223	(367)
CO2 associated with heat source 2	[(307b)+(310b)] x 100 ÷ (367b) x		0.52	=	622.56	(368)
Electrical energy for heat distribution	[(313) x		0.52	=	24.51	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	870.08	(373)
CO2 associated with space heating (secondary)	(309) x		0	=	0	(374)
CO2 associated with water from immersion heater or instantaneous heater	(312) x		0.22	=	0	(375)
Total CO2 associated with space and water heating	(373) + (374) + (375) =				870.08	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	170.65	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	180.43	(379)

Total CO2, kg/year	sum of (376)…(382) =	1221.15	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =	15.14	(384)
EI rating (section 14)		86.98	(385)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matthew Haskell	**Stroma Number:**	STRO006210
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.8

Property Address: 80m2 2B4P MF

Address :

1. Overall dwelling dimensions:

	Area(m^2)		Av. Height(m)		Volume(m^3)	
Ground floor	80.66	(1a) x	2.7	(2a) =	217.78	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	80.66	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		217.78	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m^3 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							3	x 10 =	30	(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) =	30	÷ (5) =	0.14	(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)	0.39	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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

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

0.38	0.38	0.37	0.33	0.32	0.29	0.29	0.28	0.3	0.32	0.34	0.35

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

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

(25)m=	0.57	0.57	0.57	0.55	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(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			2.1	x	1	=	2.1			(26)
Windows Type 1			11.12	x1/[1/(1.4)+ 0.04]		=	14.74			(27)
Windows Type 2			6.95	x1/[1/(1.4)+ 0.04]		=	9.21			(27)
Walls Type1	48.3	18.07	30.23	x	0.18	=	5.44			(29)
Walls Type2	61.42	2.1	59.32	x	0.18	=	10.68			(29)
Total area of elements, m²			109.73							(31)
Party wall			13.12	x	0	=	0			(32)
Party floor			80.66							(32a)
Party ceiling			80.66							(32b)

** 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) =	42.18	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	16928.32	(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		16.36	(36)

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

Total fabric heat loss	(33) + (36) =	58.53	(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=	41.21	41	40.8	39.86	39.68	38.86	38.86	38.71	39.18	39.68	40.04	40.41	(38)

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

(39)m=	99.74	99.54	99.34	98.39	98.22	97.4	97.4	97.24	97.71	98.22	98.58	98.95	

Average = Sum(39)$_{1…12}$ /12= 98.39 (39)

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

(40)m=	1.24	1.23	1.23	1.22	1.22	1.21	1.21	1.21	1.21	1.22	1.22	1.23

Average = Sum(40)$_{1…12}$ /12= 1.22 (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 2.48 (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 92.99 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	102.29	98.57	94.85	91.13	87.41	83.69	83.69	87.41	91.13	94.85	98.57	102.29	

Total = Sum(44)$_{1…12}$ = 1115.85 (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=	151.69	132.67	136.9	119.35	114.52	98.82	91.57	105.08	106.34	123.93	135.28	146.9

Total = Sum(45)$_{1…12}$ = 1463.06 (45)

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

(46)m=	22.75	19.9	20.54	17.9	17.18	14.82	13.74	15.76	15.95	18.59	20.29	22.04	(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)

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=	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5	(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=	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5	

Output from water heater (annual)$_{1…12}$ 2011.67 (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=	87.71	77.78	82.8	75.76	75.35	68.93	67.72	72.22	71.43	78.48	81.05	86.12	(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=	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	123.76	(66)

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

(67)m=	19.68	17.48	14.22	10.76	8.05	6.79	7.34	9.54	12.81	16.26	18.98	20.23	(67)

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

(68)m=	220.81	223.11	217.33	205.04	189.52	174.94	165.2	162.9	168.68	180.97	196.49	211.07	(68)

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

(69)m=	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	35.38	(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=	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	-99.01	(71)

Water heating gains (Table 5)

(72)m=	117.89	115.74	111.28	105.22	101.28	95.74	91.03	97.06	99.21	105.49	112.57	115.75	(72)

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

(73)m=	421.52	419.46	405.96	384.15	361.98	340.6	326.69	332.64	343.82	365.85	391.17	410.19	(73)

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)	
East	0.9x	0.77	x	11.12	x	19.64	x	0.63	x	0.7	=	66.75	(76)
East	0.9x	0.77	x	6.95	x	19.64	x	0.63	x	0.7	=	41.72	(76)
East	0.9x	0.77	x	11.12	x	38.42	x	0.63	x	0.7	=	130.57	(76)
East	0.9x	0.77	x	6.95	x	38.42	x	0.63	x	0.7	=	81.61	(76)
East	0.9x	0.77	x	11.12	x	63.27	x	0.63	x	0.7	=	215.03	(76)

East	0.9x	0.77	x	6.95	x	63.27	x	0.63	x	0.7	=	134.39	(76)
East	0.9x	0.77	x	11.12	x	92.28	x	0.63	x	0.7	=	313.61	(76)
East	0.9x	0.77	x	6.95	x	92.28	x	0.63	x	0.7	=	196	(76)
East	0.9x	0.77	x	11.12	x	113.09	x	0.63	x	0.7	=	384.34	(76)
East	0.9x	0.77	x	6.95	x	113.09	x	0.63	x	0.7	=	240.21	(76)
East	0.9x	0.77	x	11.12	x	115.77	x	0.63	x	0.7	=	393.44	(76)
East	0.9x	0.77	x	6.95	x	115.77	x	0.63	x	0.7	=	245.9	(76)
East	0.9x	0.77	x	11.12	x	110.22	x	0.63	x	0.7	=	374.57	(76)
East	0.9x	0.77	x	6.95	x	110.22	x	0.63	x	0.7	=	234.1	(76)
East	0.9x	0.77	x	11.12	x	94.68	x	0.63	x	0.7	=	321.75	(76)
East	0.9x	0.77	x	6.95	x	94.68	x	0.63	x	0.7	=	201.09	(76)
East	0.9x	0.77	x	11.12	x	73.59	x	0.63	x	0.7	=	250.09	(76)
East	0.9x	0.77	x	6.95	x	73.59	x	0.63	x	0.7	=	156.3	(76)
East	0.9x	0.77	x	11.12	x	45.59	x	0.63	x	0.7	=	154.93	(76)
East	0.9x	0.77	x	6.95	x	45.59	x	0.63	x	0.7	=	96.83	(76)
East	0.9x	0.77	x	11.12	x	24.49	x	0.63	x	0.7	=	83.22	(76)
East	0.9x	0.77	x	6.95	x	24.49	x	0.63	x	0.7	=	52.02	(76)
East	0.9x	0.77	x	11.12	x	16.15	x	0.63	x	0.7	=	54.89	(76)
East	0.9x	0.77	x	6.95	x	16.15	x	0.63	x	0.7	=	34.31	(76)

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

(83)m=	108.46	212.17	349.42	509.61	624.55	639.33	608.67	522.84	406.39	251.76	135.24	89.19	(83)

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

(84)m=	529.98	631.64	755.38	893.76	986.53	979.93	935.36	855.48	750.21	617.61	526.41	499.38	(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	0.99	0.98	0.92	0.79	0.61	0.45	0.51	0.78	0.96	0.99	1	(86)

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

(87)m=	19.7	19.88	20.19	20.58	20.85	20.97	20.99	20.99	20.9	20.51	20.03	19.66	(87)

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

(88)m=	19.89	19.89	19.89	19.9	19.91	19.91	19.91	19.92	19.91	19.91	19.9	19.9	(88)

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

(89)m=	1	0.99	0.97	0.9	0.73	0.52	0.34	0.4	0.7	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=	18.17	18.44	18.89	19.43	19.77	19.89	19.91	19.91	19.84	19.35	18.66	18.12	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.8	19.04	19.43	19.91	20.22	20.34	20.36	20.36	20.28	19.83	19.22	18.76	(92)

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

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(93)m=	18.8	19.04	19.43	19.91	20.22	20.34	20.36	20.36	20.28	19.83	19.22	18.76	(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=	0.99	0.99	0.97	0.9	0.75	0.55	0.39	0.44	0.73	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	527.1	623.81	729.28	801.13	743.01	542.46	363.81	380.4	545.92	582.67	520.55	497.3	(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=	1446.28	1406.99	1284.45	1082.91	836.56	559	366.22	384.87	603.44	906.52	1195.11	1440.82	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	683.87	526.29	413.05	202.88	69.6	0	0	0	0	240.95	485.68	701.98	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3324.31 (98)

Space heating requirement in kWh/m²/year 41.21 (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)														
	683.87	526.29	413.05	202.88	69.6	0	0	0	0	240.95	485.68	701.98		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	731.41	562.88	441.76	216.99	74.44	0	0	0	0	257.7	519.45	750.78		
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													3555.41	(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)														
	198.28	174.75	183.5	164.44	161.12	143.92	138.17	151.68	151.43	170.52	180.37	193.5		
Efficiency of water heater													79.8	(216)
(217)m=	87.85	87.57	86.92	85.38	82.75	79.8	79.8	79.8	79.8	85.74	87.33	87.95		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	225.7	199.55	211.12	192.61	194.7	180.35	173.15	190.07	189.76	198.89	206.54	220		
Total = Sum(219a)$_{1...12}$ =													2382.45	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		3555.41

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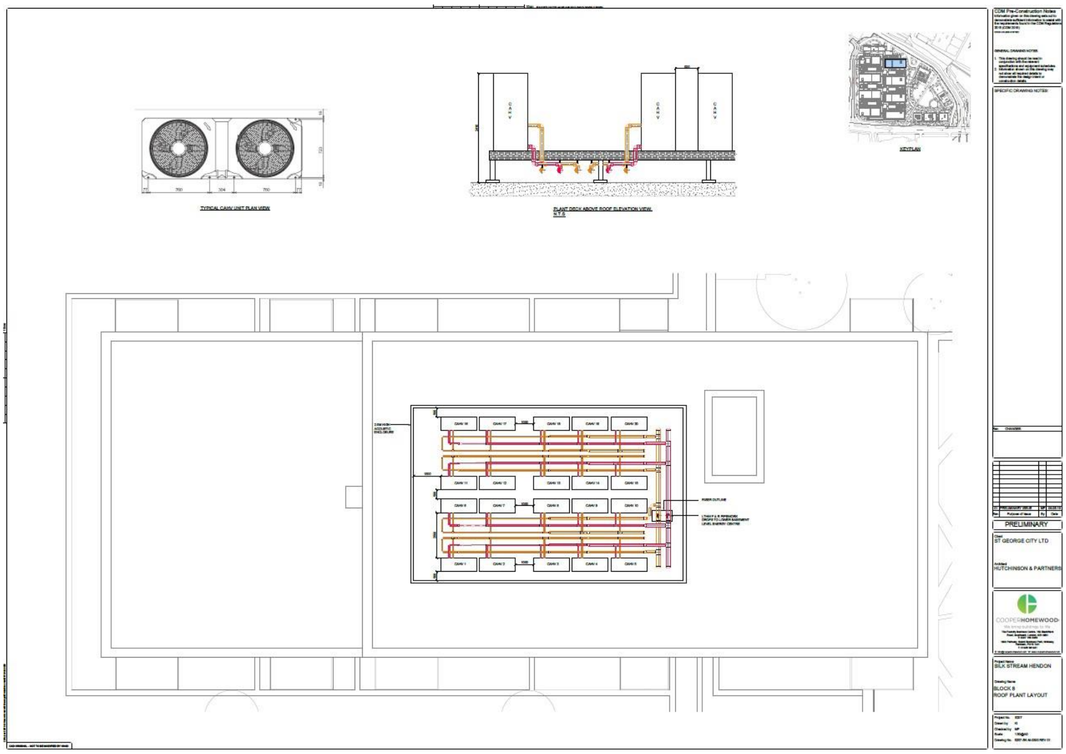
Water heating fuel used				2382.45	
Electricity for pumps, fans and electric keep-hot					
central heating pump:			30		(230c)
boiler with a fan-assisted flue			45		(230e)
Total electricity for the above, kWh/year		sum of (230a)…(230g) =		75	(231)
Electricity for lighting				347.63	(232)

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

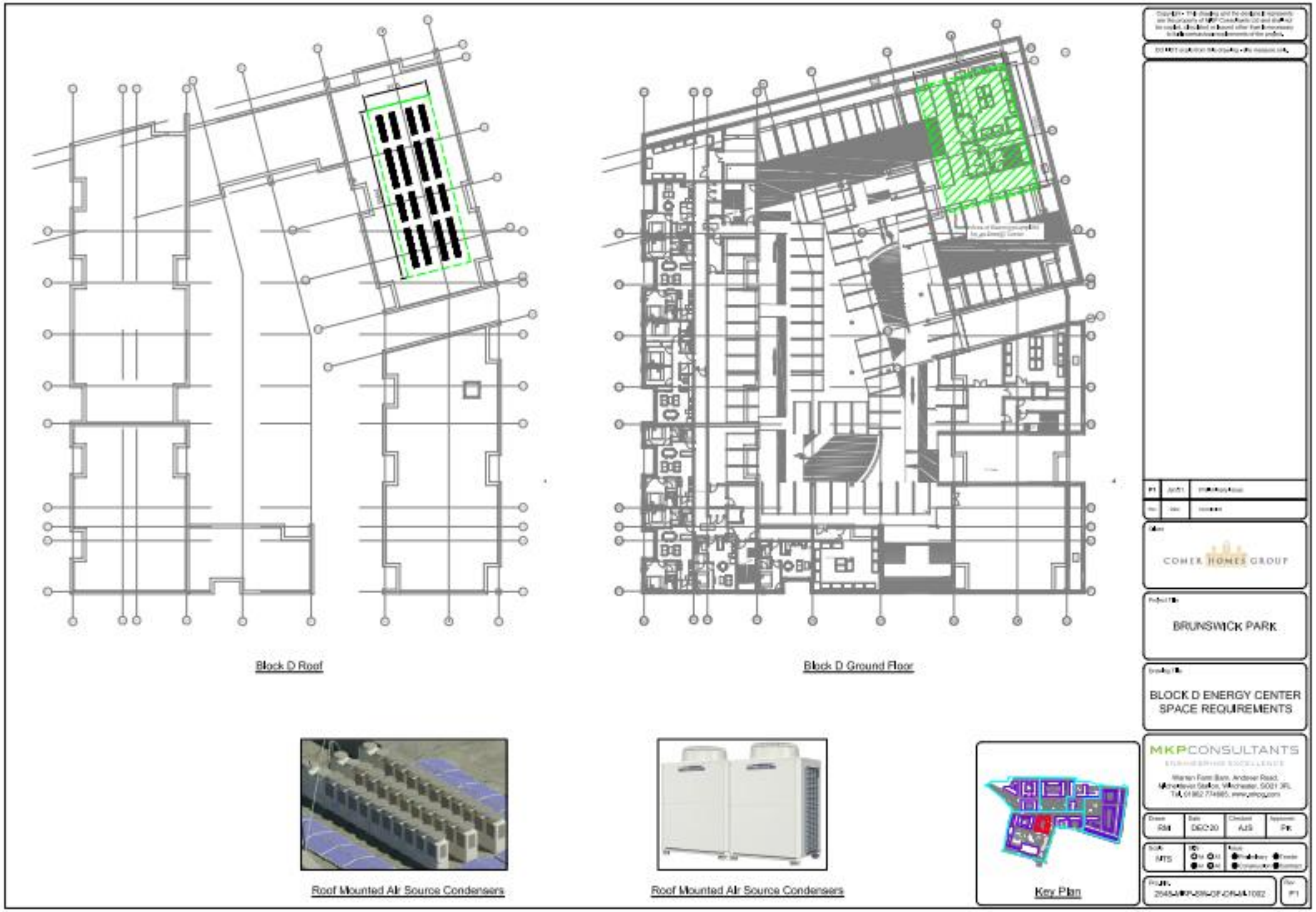
	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	767.97	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	514.61	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1282.58	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	180.42	(268)
Total CO2, kg/year		sum of (265)…(271) =		1501.92	(272)

TER = 18.62 (273)

10.4 APPENDIX 4 ASHP LAYOUT



10.5 ENERGY CENTRE LOCATION



10.6 APPENDIX 5: ASSESSMENT OF LOW- AND ZERO-CARBON TECHNOLOGIES

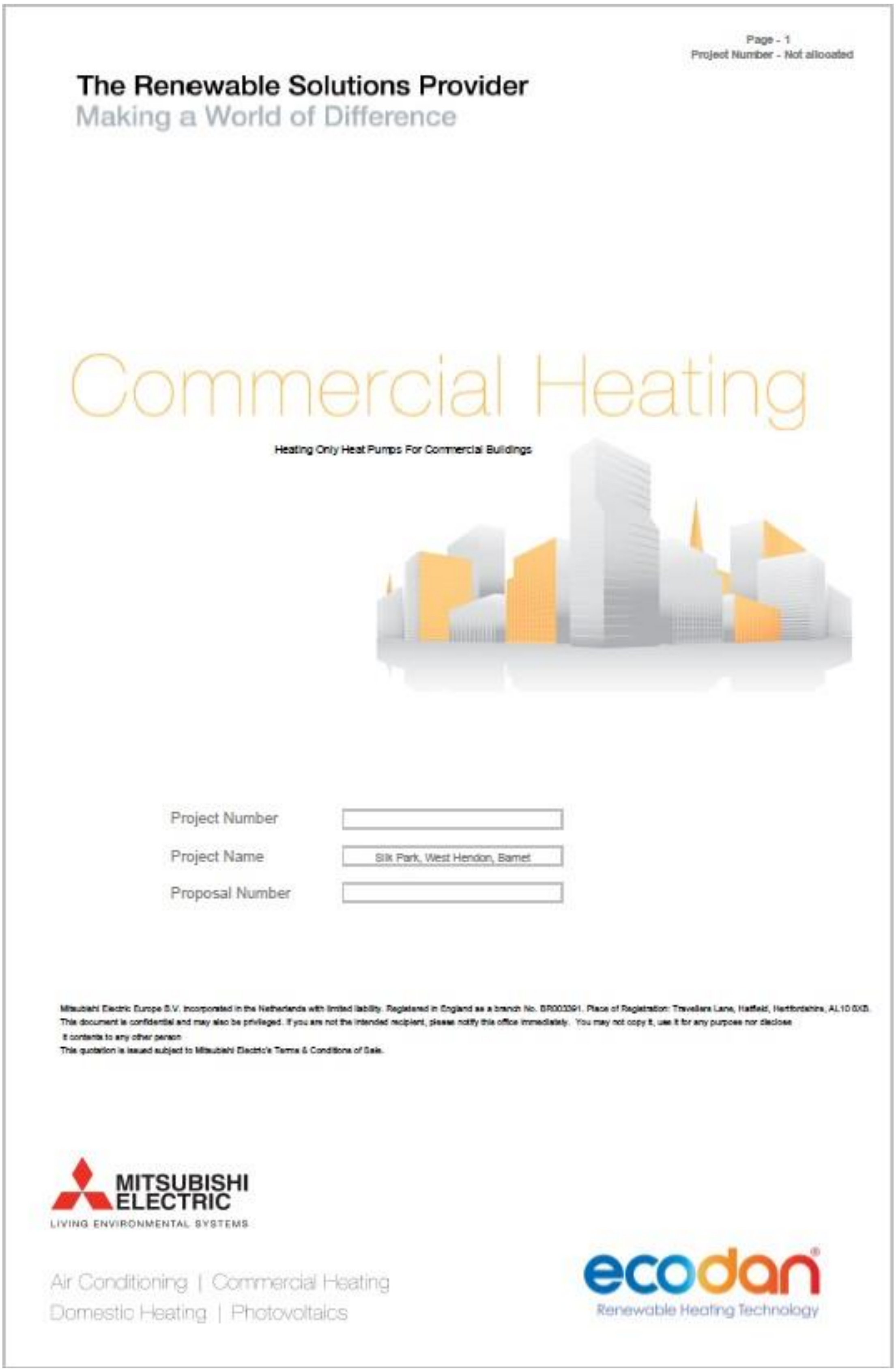
Wind	The ability to generate electricity via a turbine or similar device which harnesses natural wind energy. This could be considered as an onsite solution to reducing carbon emissions (turbines included within the development), or offsite (investing financially into a nearby wind farm).
Installation considerations	• Wind turbines come in a variety of sizes and shapes. Turbines of 1 Kw can be installed to single house and large- scale turbines of 1-2 MW can be installed on a development to generate electricity to multiple dwellings and other buildings. In both instances the electricity generated can be used on site or exported to the grid. Vertical- or horizontal- axis turbines are available. • A roof-mounted 1 kW micro wind system costs up to £3,000. A 2.5 kW pole-mounted system costs between £9,900 and £19,000. A 6 kW pole-mounted system costs between £21,000 and £30,000 (taken from the Energy Saving Trust, TBC by supplier) • Local average wind speed is a determining factor. A minimum average wind speed of 6 m/s is required. • Noise considerations can be an issue dependent on density and build-up of the surrounding area. • Buildings in the immediate area can disrupt wind speed and reduce performance of the system. • Planning permission will be required along with suitable space to site the turbine, whether ground installed or roof mounted.
Advantages	• Generation of clean electricity which can be exported to the grid or used onsite. • Can benefit from the Feed in Tariff, reducing payback costs.
Disadvantages	• Planning restrictions and local climate often limit installation opportunities. • Annual maintenance required. • High initial capital cost. It is usual for an investor to consider a series of turbines to make the investment financially sound.
Development feasibility	• Installing a large turbine in an area such as this is not considered to be appropriate due to its appearance and physical impact on the built-up environment. Residents' and neighbours' concerns may include the look of the turbine, the hum of the generator and the possibility of stroboscopic shadowing from the blades on homes. • Wind speed has been checked for the development scheme using the NOABL wind map: http://www.rensmart.com/Weather/BERR. The wind speed at ten metres for the development scheme is 4.7 metres per second (m/s) which is below the minimum of 5 m/s and threshold for technical viability. • Typical payback times for a single turbine are expected to be greater than 15 years which means that the cost of installing and maintaining a single wind turbine is not considered a commercially-viable option.
Solar PV Solar Thermal	The ability to generate energy (either electricity, hot water or a combination of the two) through harnessing natural solar energy. This could include the use of solar thermal panels, photovoltaic (PV) panels, or a combined solution. PV panels, similarly to turbines, can be considered both on and offsite. Solar Photovoltaics convert solar radiation into electricity which can be used on site or exported to the national grid. Solar Thermal generates domestic hot water from the sun's radiation. Glycol circulates within either flat plate or evacuated tube panels, absorbing heat from the sun, and transferring this energy to a water cylinder. A well designed solar thermal system will account for 50-60% of a dwelling's annual hot water demand. Sizing the system to meet a higher demand will lead to excess heat generation in the summer months, and overheating of the system.

Installation considerations	• Operate most efficiently on a south-facing sloping roof (between 30 and 45-degree pitch.) • Shading must be minimal (one shaded panel can impact the output of the rest of the array.) • Panels must not be laid horizontally on a flat roof as they will not self-clean. Panels will therefore need to be installed at an angle and with appropriate space between them, to avoid over-shading. • Large arrays may require upgrades to substations if exporting electricity to the grid. • Local planning requirements may restrict installation of panels on certain elevations. • Installation must take into account pitch and fall of the roof, along with any additional plant on the roof to ensure there • is sufficient room. • The average domestic solar PV system is 4kWp and costs • £5,000 - £8,000 (including VAT at 5 per cent) - (taken from the Energy Saving Trust, TBC by supplier.)
Advantages	• Relatively straightforward installation, connection to landlord's supply and metering. • Linear improvement in performance as more panels are installed. • Maintenance free. • Installation costs are continually reducing. • Can benefit from the Feed in Tariff to improve financial payback.
Disadvantages	• Not appropriate for high-rise developments, due to lack of roof space in relation to total floor area. • With Solar Thermal, performance is limited by the hot water demand of the building – system oversizing will lead to overheating.
Development feasibility	• The suitability of Solar panels has been considered for this Development. • At a formal pre-app meeting with the GLA on 12/06/2019, the Applicant was asked to consider the potential for Solar PV within their development proposals. An assessment of viability has now been carried out. • The suitability of Solar Panels has been considered for this development and whilst they can be concluded as one potentially viable option, they are not incorporated within the LZC for the following reasons: • There are practical constraints in terms of roof area available for installation. Roofs will be used for installation of multiple ASHP units and associated noise attenuation measures. Living roofs and surface water run-off measures will also be incorporated, refer to proposed landscape features and location of brown roofs within the Landscape Management Plan overleaf. • Furthermore, in adopting a SAP10 emission-factors approach, carbon-emission reductions associated with Solar PV as a LZC technology are far lower when compared to SAP2012 which impacts negatively on the financial viability of Solar PV.
Aerothermal	The transfer of latent heat in the atmosphere to a compressed refrigerant gas to warm the water in a heating system. This includes air to water heat pumps and air conditioning systems. Air Source Heat Pumps (ASHPs) extract heat from the external air and condense this energy to heat a smaller space within a dwelling or non-domestic building. A pump circulates a refrigerant through a coil to absorb energy from the air. This refrigerant is then compressed to raise its temperature which can then be used for space heating and domestic hot water. They can feed either low-temperature radiators or underfloor heating and often have electric immersion heater back-up for the winter months.

Installation considerations	• ASHPs operate effectively in buildings with a low energy demand, as they emit low levels of energy suitable for maintaining rather than dramatically increasing internal temperatures. It is therefore vital that the dwelling has a low heating demand to ensure the system can provide appropriate space-heating capability. • Underfloor heating will give the best performance but oversized radiators can also be used. • Noise from the external unit can limit areas for installation. • £7,000-£11,000 per dwelling (taken from the Energy Saving Trust, TBC by supplier.)
Advantages	• Air source systems are a good alternative solution to providing heating and hot water to well-insulated, low heat loss dwellings. • They require additional space when compared to a gas boiler. Space for an external unit is needed, as is space for the hot water cylinder and internal pump. • Heat pumps are generally quiet to run, however if a collection of pumps were used, this could generate a noticeable hum while in operation. • Running costs between heat pumps and modern gas boilers are comparable.
Disadvantages	• Residents need to be made aware of the most efficient way of using a heat pump; as the low flow rates used by such a system means that room temperature cannot be changed as reactively as a conventional gas or oil boiler system. • Will not perform well in homes that are left unoccupied and unheated for a long period of time. • Back-up immersion heating can drastically increase running costs. • Noise and aesthetic considerations limit installation opportunities.
Development feasibility	• ASHPs are considered a technically-viable option for this development scheme and will be included in the development proposals as the preferred LZC technology for achieving planning policy targets.
Geothermal	The transfer of latent heat from the ground to a compressed refrigerant gas to warm the water in a heating system. This includes ground source heat pumps. Heat can be collected through the use of either horizontally laid or vertically installed coils. Ground Source Heat Pumps (GSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the ground) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the ground, either through coils or in bore holes and piles, circulating a mix of water and antifreeze to extract energy from the ground, where the year-round temperature is relatively consistent (approx. 10 Ĉ at 4 metres depth). This leads to a reliable source of heat for the building. Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for GSHPs tend to be higher than those of ASHPs.
Installation considerations	• Require appropriate ground conditions to sink piles/bore holes or excavate for coils (which also require a large area of land.) • Decision between coils or piles can lead to significant extra cost. • Need to consider whether low temperature output is fed through underfloor heating (most efficient) or oversized radiators. • Similar to ASHPs, perform best in well-insulated buildings with a low heating demand. • Electric immersion heater required for winter use. • £11,000-£15,000 per dwelling dependent on the size of the system (taken from the Energy Saving Trust, TBC by supplier.)
Advantages	• Perform well in well-insulated buildings, with limited heating demand. • More efficient than ASHPs.

Disadvantages	• The coils can be damaged by natural earthworks and by intensive gardening practices – occupants would need to be aware of the location of the coils for this system, and how to operate the system efficiently. Coils may also be damaged within the dwelling where the circuit is connected to the internal unit. • Will not perform well in buildings that are left unoccupied and unheated for a long period of time. • Back up immersion heating can drastically increase running costs. • Large area of ground needed for coil installation.
Development feasibility	• GSHPs are not considered a technically-viable option for this development scheme as there are physical constraints in terms of ground conditions and area available for installation.
Biomass	Providing a heating system fuelled by plant based materials such as wood, crops or food waste. Biomass boilers generate heat for space heating and domestic hot water through the combustion of biofuels, such as woodchip, wood pellets or potentially biofuel or bio diesel. Biomass is considered to be virtually zero carbon. They can be used on an individual scale or for multiple dwellings as part of a district-heating network. A back-up heat source should be provided as consistent delivery of fuel is necessary for continued operation.
Installation considerations	• Biomass boilers are larger than conventional gas-fired boilers and also require what can be significant storage space for the fuel source. This needs to be considered at planning stage to ensure an appropriate plant room can be provided. • Flue required to expel exhaust gases – design needs to be in line with the requirements of the Building Regulations. • Need to consider whether fuel deliveries will be reliable and consistent to the location of the site (especially relevant in rural areas) and whether the plant room can be easily accessed by the delivery vehicle. • £9,000-£21,000 per dwelling dependent on size (taken from Energy Saving Trust, TBC by Supplier).
Advantages	• Considerable reduction in CO2 emissions.
Disadvantages	• Limited reduction in running costs compared to A-rated gas boilers, but at a substantially higher up-front cost. • Plant room space required for boiler and storage. • Dependent on consistent delivery of fuel. • Ongoing maintenance costs (need to be cleaned regularly to remove ash.)
Development feasibility	• Biomass is not considered a technically-viable option for the development scheme. The primary reason for this is down to the Development’s location within the context of Inner City London and the negative environmental impact of high levels of NOx gases that are emitted from biomass boilers and the subsequent impact on local air quality. This is contrary to planning policies for air quality in London.

10.7 APPENDIX 6: MANUFACTURERS INFORMATION FOR ASHP



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Project Number - Not allocated

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Making a World of Difference

Commercial Heating

Heating Only Heat Pumps For Commercial Buildings

Project Number	
Project Name	Silk Park, West Hendon, Barnet
Proposal Number	

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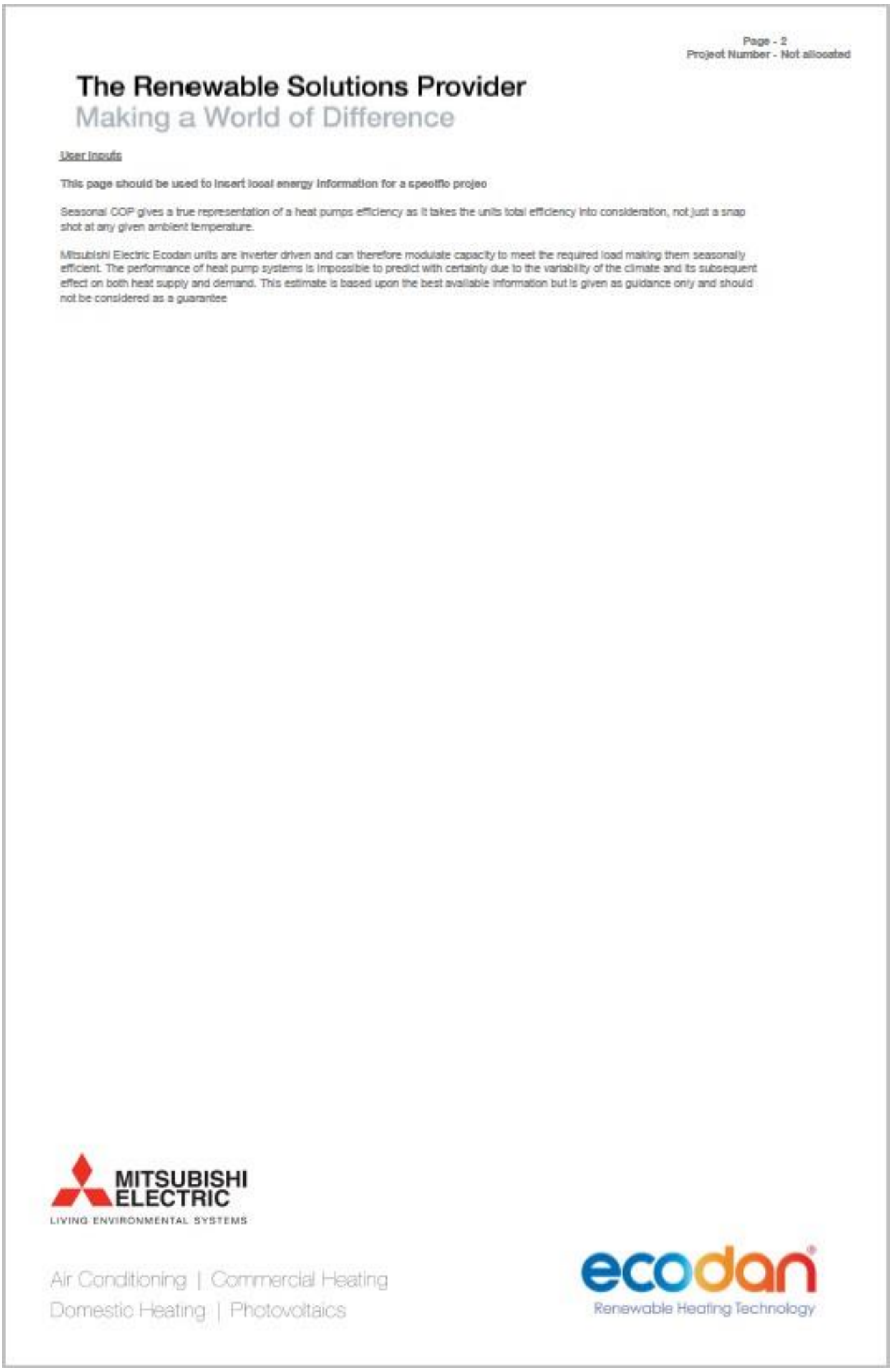

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Making a World of Difference

User Inputs

This page should be used to insert local energy information for a specific projec

Seasonal COP gives a true representation of a heat pumps efficiency as it takes the units total efficiency into consideration, not just a snap shot at any given ambient temperature.

Mitsubishi Electric Ecodan units are inverter driven and can therefore modulate capacity to meet the required load making them seasonally efficient. The performance of heat pump systems is impossible to predict with certainty due to the variability of the climate and its subsequent effect on both heat supply and demand. This estimate is based upon the best available information but is given as guidance only and should not be considered as a guarantee

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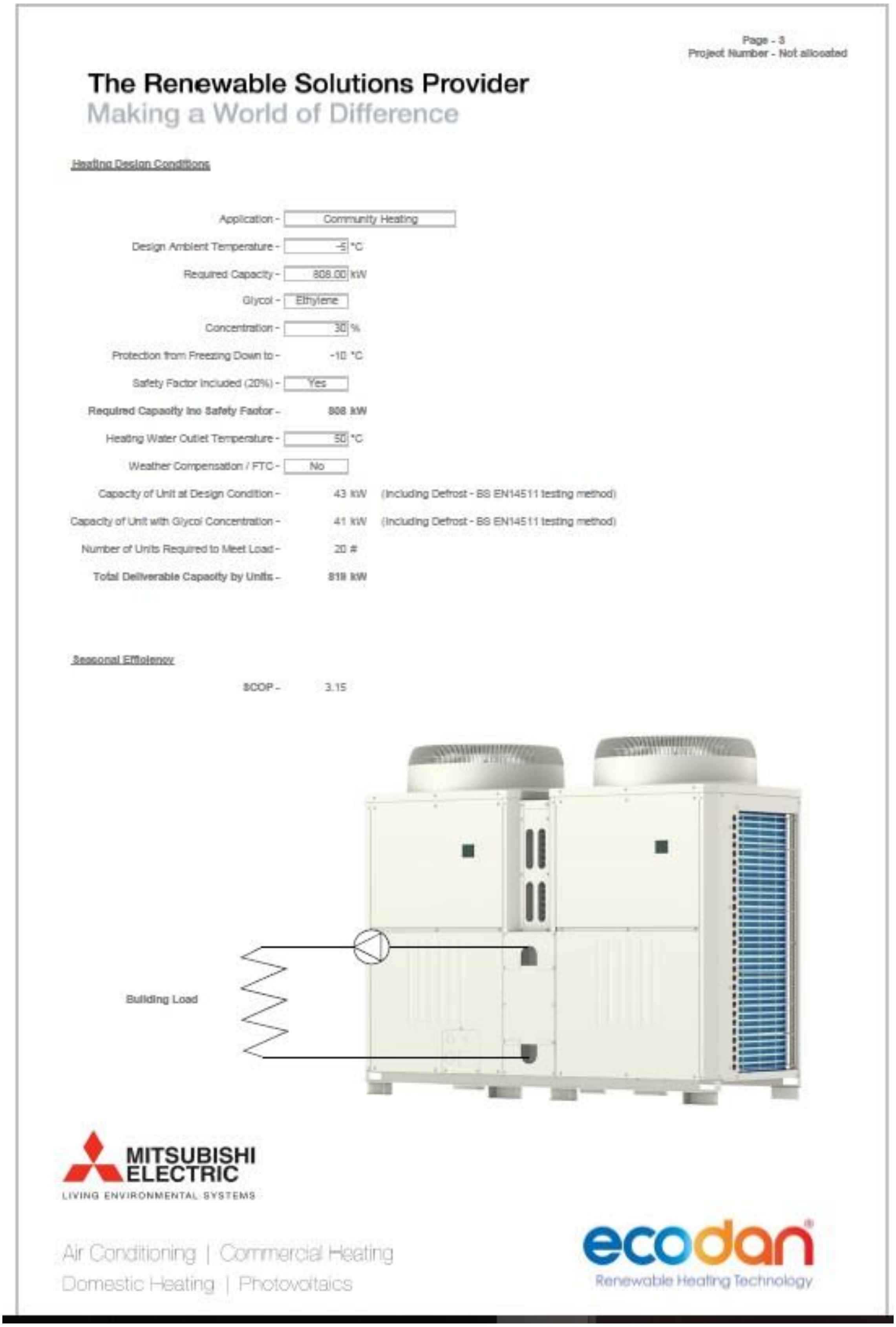

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Heating Design Conditions

Application - Community Heating

Design Ambient Temperature - -5 °C

Required Capacity - 808.00 kW

Glycol - Ethylene

Concentration - 30 %

Protection from Freezing Down to - -10 °C

Safety Factor Included (20%) - Yes

Required Capacity Inc Safety Factor - 808 kW

Heating Water Outlet Temperature - 50 °C

Weather Compensation / FTC - No

Capacity of Unit at Design Condition - 43 kW (Including Defrost - BS EN14511 testing method)

Capacity of Unit with Glycol Concentration - 41 kW (Including Defrost - BS EN14511 testing method)

Number of Units Required to Meet Load - 20 #

Total Deliverable Capacity by Units - 819 kW

Seasonal Efficiency

SCOP - 3.15

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