MAX FORDHAM

Agar Grove Phase 1C

Energy and Sustainability Update

Rev A

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ISSUE HISTORY

Issue	Date	Description
*	09/08/19	Draft for Comment
A	16/08/19	Update for Planning

CONTENTS

1.0 EXECUTIVE SUMMARY

A Planning Application for the Regeneration of the Agar Grove Estate was submitted in December 2013. Construction of this development is phased to ensure existing residents only move once. The phasing has allowed the designs for plots I and JKL to be revisited. This energy statement provides details of the updated energy strategies for Blocks I and JKL of the Agar Grove Development.

This report is included as an update as part of the planning amendment for Blocks I and JKL.

As described in the initial application the PassivHaus standard will be used to deliver enhanced 'be lean' performance. Block by block heating systems are still proposed but will now be supplied in Blocks I and JKL by air source heat pumps. This is in line with the draft new London plan and the government's plan to phase out gas boilers. Photovoltaic panels will be located on the uppermost roofs of each building.

As a result of these measures a total carbon reduction of 64% is achieved across the residential areas of the development.

1.1 Carbon Dioxide Reduction Targets

The carbon reduction target at the time of the original application was 40% reduction over 2010 Part L requirements. This 40% overall reduction was to include a 20% reduction in carbon dioxide emissions from on-site renewables.

As the carbon intensity of the grid continues to reduce new emission factors have been released and are proposed for use by the draft London Plan. To reflect this, the carbon reduction has been calculated using SAP 10 carbon emission factors in line with the draft new London Plan and to reflect the decarbonisation of the grid. According to the Greater London Authority document 'Energy Assessment Guidance' a 35% reduction against Part L 2013 is equivalent to a 40% reduction against Part L 2010.

1.2 Emissions Factors

Unless otherwise stated SAP 10 carbon emissions have been used throughout.

Existing and new carbon dioxide emissions factors

	SAP 2012 (existing)	**SAP 10 (new)**
Natural Gas	0.216 kg CO2/kWh	0.210 kg CO2/kWh
Electricity	0.519 kg CO2/kWh	0.233 kg CO2/kWh

The SAP 10 carbon factors better reflect the decarbonisation of grid electricity. This results in electrically powered heat pumps being favoured for heating and means CHP engines are less beneficial in carbon terms. It also results in the perceived benefit of PVs being reduced.

1.3 Key Strategies

The key energy strategies are described below:

Be Lean- Demand Reduction

- High fabric performance- Passive House standards
- Mechanical Ventilation with Heat Recovery (MVHR) throughout

Be Clean- Efficient Energy Supply

- High efficiency MVHR

Be Green- Renewable Energy

- Air Source Heat Pumps used to provide heating and generate hot water
- PV array

1.4 Summary of Results

The proposed development has been remodelled in SAP incorporating the fabric and servicing strategy changes described above.

Domestic
<u>Block I – SAP Summary</u>

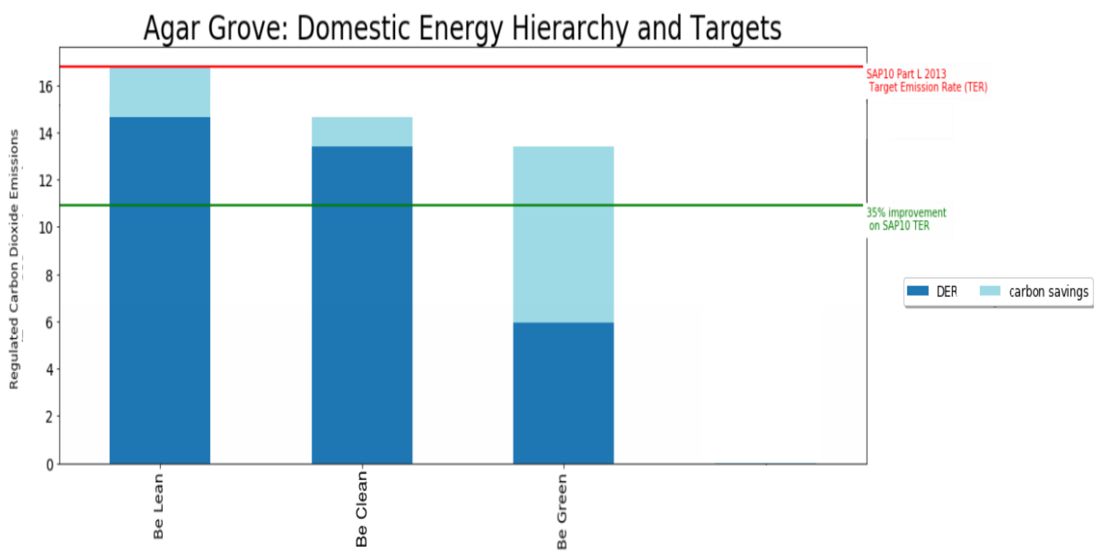


Figure 1: Domestic energy hierarchy and targets Block I, kgC02/m2

Table 1: CO2 emissions after each stage of the Energy Hierarchy for **Block I**

	Carbon dioxide emissions for domestic buildings (tonnes CO2 per annum)
	Regulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	37.6
After energy demand reduction	32.7
After heat network / CHP	30.1
After renewable energy	13.2

Block JKL Summary

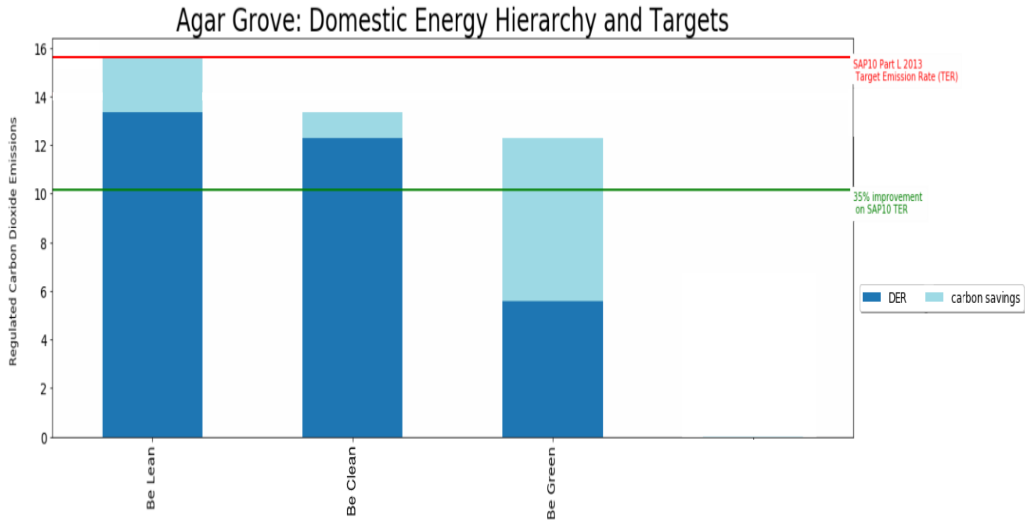


Figure 2 Domestic energy hierarchy and targets Block JKL, kgC02/m2

Table 2: CO2 emissions after each stage of the Energy Hierarchy for **Block JKL**

	Carbon dioxide emissions for domestic buildings (tonnes CO2 per annum)
	Regulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	85.2
After energy demand reduction	73.2
After heat network / CHP	67.2
After renewable energy	30.6

Table 3: Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings-Blocks I and JKL	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	16.95	13.8
Savings from heat network / CHP	8.7	7.1
Savings from renewable energy	53.4	43.5
Cumulative on site savings	79.1	64.3

2.0 CO_2 EMISSIONS

The carbon footprints as shown in the tables above have been calculated using the following methods:

Dwellings:
A Dwelling Emissions Rate (DER) has been calculated in line with the Building Regulations Part L 2013 methodology SAP 2012. The results have then been converted using SAP 10 carbon factors.

These calculations were carried out on a representative sample of properties as shown below. Details of the results of these calculations can be found in Appendix 1

Block I

Ground Floor	First Floor	Second Floor
		
Third Floor	**Fourth Floor**	**Fifth Floor**
		

Block JKL

Ground Floor

First Floor

Second Floor

Third Floor

Fourth Floor

Fifth Floor

Shop:
The non-domestic unit in block JKL will be provided as a shell and core shop. This has been excluded from the modelling as it will have the same thermal envelope as the domestic units and will be provided without services.

3.0 FABRIC PERFORMANCE (BE LEAN)

As described in the previous planning report carbon emissions will be reduced primarily b implementing ‘passive’ energy efficiency measures. Blocks I and JKL have been designed based on the Passivhaus approach.

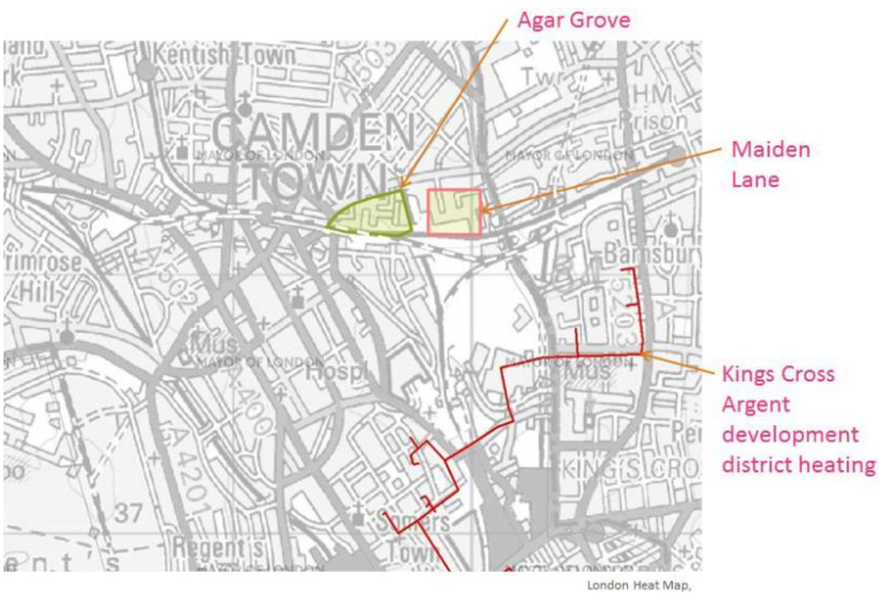
It is recognised that Passivhaus is better at delivering lower energy in use than the SAP methodology. This is in part because it is much more rigorous in its requirements for certification in terms of the Passivhaus Planning Package model, the certified mechanical equipment, and the construction detailing.

Fabric performance targets have not changed since the original planning application.

4.0 HEATING INFRASTRUCTURE (BE CLEAN)

High efficiency gas condensing boilers were previously selected; as guidance has changed the heat source selection has been revisited.

Connection to existing networks
As described in the original planning application connection to the existing King’s Cross Argent network would not be feasible as the route would require crossing a major railway line and the existing boiler house has no spare capacity.



No new heat networks have been developed in the area since the previous application.

Site wide district heating network
The GLA have allowed that CHP is not required for this scheme.

A site wide network was deemed inappropriate due to the phased delivery of the development and objections raised by residents during consultation.

The new blocks will not connect to a site wide heat network; a block-by-block system will be installed. This allows a lower system temperature, and shorter pipe runs, hence reduced losses. This improves efficiency.

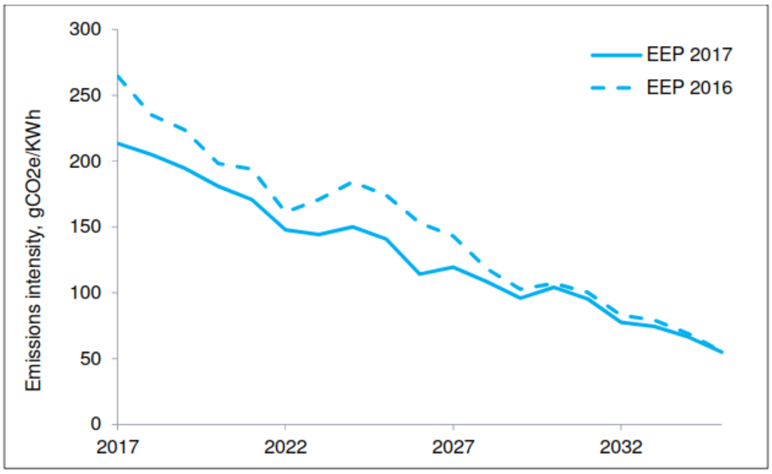
Decarbonisation of the Grid

When looking at energy efficiency it is also useful to consider fuel sources and their carbon efficiency. Heating and hot water provided by natural gas boilers was previously proposed for the site. This is becoming a relatively carbon intense fuel. Meanwhile mains electricity is becoming a relatively low carbon fuel.

The current carbon intensity of the UK electricity grid is considerably lower than the factors written into the 2013 Part L of the Building Regulations. An update to Part L is expected in 2019/2020. This will include updating carbon emission factors which are more representative of the real world. These updated carbon emission factors have already been released as part of the latest version of the standard Assessment Procedure (SAP 10). These carbon factors have been used for our analysis where stated as they give a more accurate representation of current carbon emissions factors.

As more renewable technologies are used to supply the electricity grid it is expected that this figure will continue to reduce. In terms of carbon reduction, efficient all electric systems are preferable. This is shown in the Department of Energy and Climate Change Energy and Emissions Predictions.

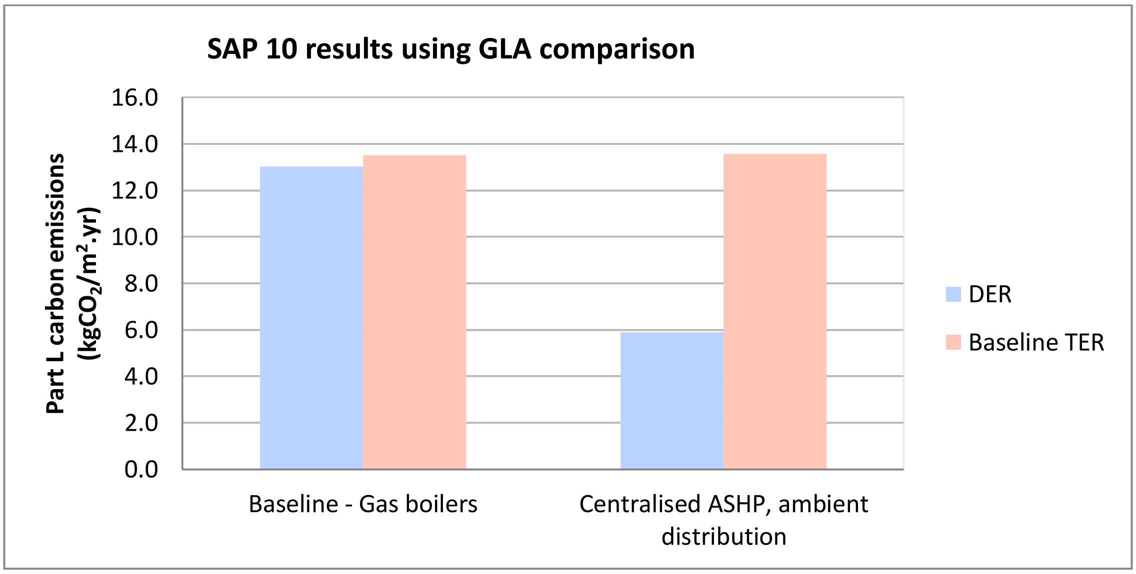
The solid blue line in the following graph shows how the carbon intensity of the UK grid is predicted to drop based on 2017 predictions, and the dashed blue line is the same measure based on 2016 predictions.



Department of Energy and Climate Change (DECC) Energy and Emissions Predictions (EEP) for 2017 and 2016.

Heat Source Selection

As previously discussed the new SAP 10 carbon emission rates more accurately reflect the carbon intensity of the electricity grid. Electricity driven heat pumps are more favourable using these values. This is shown below, a study was undertaken to compare gas fired boilers and electricity driven air source heat pumps using SAP10 emissions rates.



Air source heat pumps show much lower Dwelling Emission Rates (DERs) compared to gas boilers. Air source heat pumps will be discussed in further detail in the renewables section below.

5.0 RENEWABLE ENERGY (BE GREEN)

Heat pumps have been identified in the previous section as a more suitable heat source than gas boilers due to decarbonisation of the grid. This change in heat source will impact the selection of supplementary renewable technologies chosen.

Air Source Heat Pumps
A heat pump is akin to a domestic fridge: it uses electricity to move heat from one material to another. An air source heat pump moves heat from the outside air to a fluid (water). It uses a refrigerant to achieve this, and generally uses electricity as a power source. Figure 1 shows the four stages of a typical ASHP cycle.

As the ASHP is moving heat from one location to another, it is possible to transfer more heat than the energy put in. This is generally defined by the Coefficient of Performance (COP):

$$COP = \frac{Useful\ heat\ transferred}{Energy\ Input}$$

So a heat pump that moved 3kW of heat for 1kW of electrical power input would have a COP of 3. The COP is generally higher the closer the air and water temperatures are to each other.

This heat pump is generally mounted externally, and pipework then brought to within the building - Figure 2 shows example units.

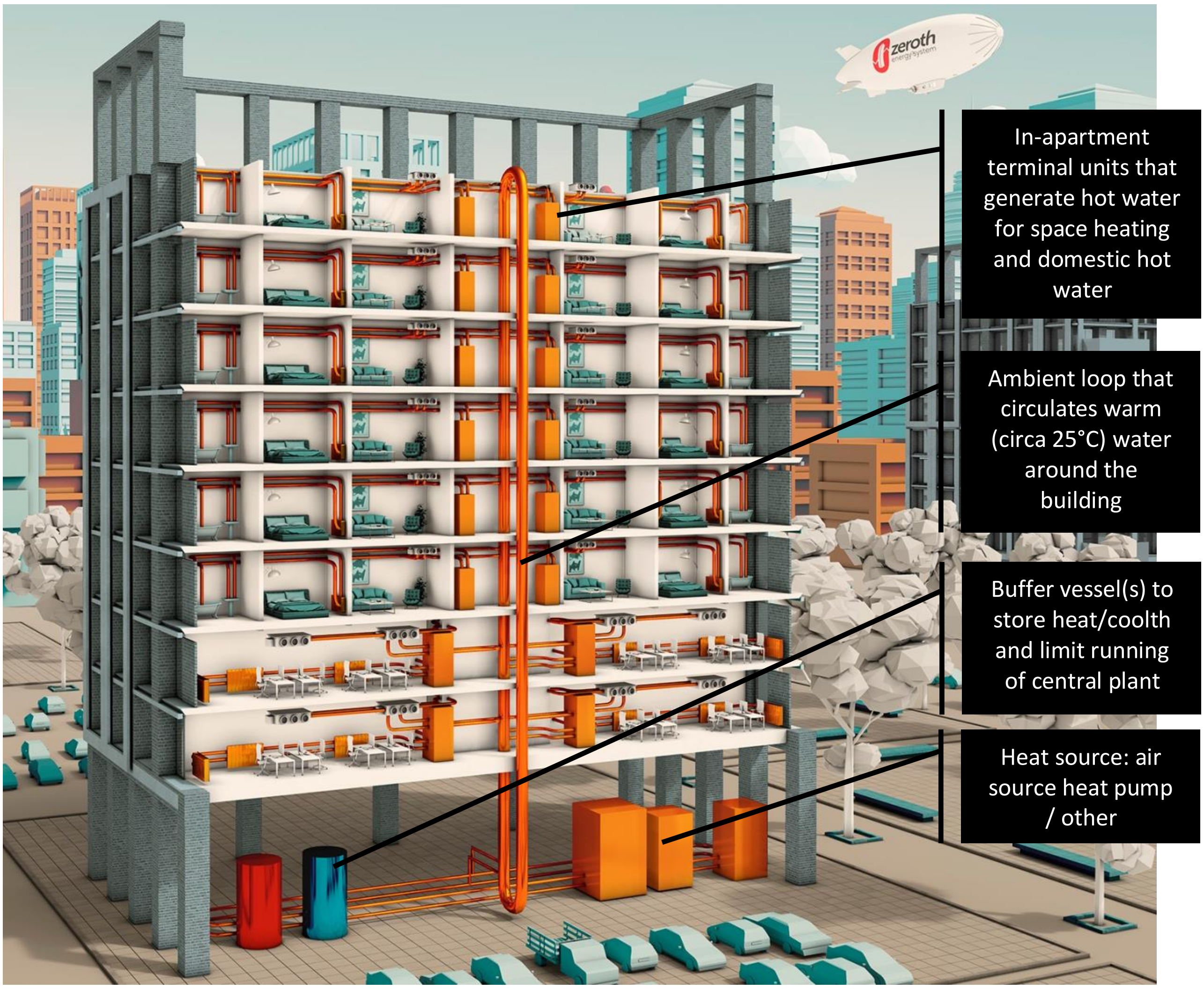
Climate Change
Recent years have seen particularly warm summers, which are anticipated to continue with ongoing climate change, as shown in Figure 4. Carbon emissions contribute to climate change, so there is a responsibility to choose low-carbon solutions where possible.

The increasing temperatures also mean that summer comfort is increasingly becoming a concern. This means designs should allow for future climate change, and ideally ensure comfortable conditions can be achieved, including the provision of comfort cooling where passive measures will be inadequate.

Passivhaus Primary Energy Assessment
For the Passivhaus standard, the anticipated total energy consumption of the building is modelled. Whereas this has been done for specifically Agar Grove which is designed to Passivhaus standards, the results give a useful indication of in-use energy consumption, with numbers more reliable than those associated with Building Regulations compliance.

Proposed System and Rationale
The proposed system uses an external air source heat pump to generate warm water. This warm water is then circulated around the building at low temperatures (circa 25°C). The distribution losses are therefore significantly lower than a conventional system (which would have water temperatures around 55-70°C, depending on the system choice), and once a space reaches 25°C they become zero. As these losses are lower, the risk of overheating in corridors and other circulation spaces is significantly reduced.

In-apartment water to water heat pumps then produce warm water at suitable temperatures for both domestic hot water production and space heating. These in-apartment proprietary units contain a hot water tank, water to water heat pump, and associated controls. The principal elements of the system are shown in the images below.



The principal benefits of this system are:

- Efficiency: the use of air source heat pumps in this arrangement mean distribution losses are minimised, and space heating and domestic hot water production are achieved efficiently
- Environmental impact: the use of electricity is consistent with a decarbonising electricity grid, and a design that is aligned with limiting environmental impact
- Compliance: the use of electricity is in line with the draft new London Plan
- Air quality: the use of electricity means there is no combustion on the site, and so no omission of particulates, or incomplete products of combustion (NO_x etc.)
- Future-proofing: the terminal units can provide both heating and cooling, which allows for the provision of comfort cooling within apartments either initially or in the future, without requiring a change in infrastructure throughout the building
- Passivhaus compliance: the use of electricity, and low energy consumption of the system align with the stringent energy requirements of Passivhaus.
- The ambient loop can readily make use of low-grade waste heat in the area, should it become available in future.

The principal risks are related to the relatively new technology: there are two manufacturers in the UK offering a system of this type (Dimplex and Daikin), with demonstration systems but not completed projects

Supplementary renewable technologies
The original planning application identified solar thermal collectors and photovoltaic (PV) panels as the most appropriate renewable technologies for the site. As the heat source for Block I and JKL is being changed the suitability of these technologies has been reviewed.

Incorporating solar thermal collectors into the proposed system would be difficult. Hot water generated by the solar thermal collectors will be at a higher temperature than the warm water generated by the air source heat pump and cannot be added to the ambient loop system. A separate system would be required to provide the hot water from the solar thermal collectors to dwellings. Additionally the in-apartment terminal units are not capable of taking a secondary heat source.

It is instead proposed that PV panels only are installed on the highest roofs.

6.0 WATER, OTHER RESOURCES AND SUSTAIBLE CONSTRUCTION

The sustainability approach beyond energy and carbon dioxide remains largely unchanged from the original planning application.

6.1 Water

Domestic water consumption is deigned to achieve 105 litres/person/day.

The landscaping strategy also includes the provision of SUDS to the Mayor's preferred standard through green roofs, permeable paving and rain gardens.

6.2 Materials and Sustainable Construction

The aspiration for Passivhaus means a higher embodied energy than a typical building because of the additional insulation required and additional glazing in the triple glazed windows. Wherever possible preference will be given to environmentally low impact materials: cement replacements will be specified in order to reduce the impact of concrete elements; the insulation used will not contain substances known to contribute to ozone depletion or have the potential to contribute to global warming.

7.0 SUMMERTIME COMFORT AND CLIMATE CHANGE ADAPTION

Introduction
Anthropomorphic climate change is a becoming prominent global concern, with significant potential detrimental results, primarily due to the speed of change and the difficulty in adapting to this. Climate change is shifting Britain's climate towards hotter summers with increased probabilities of extended heatwaves. The UK government and Camden council have both introduced legislation to ensure new developments address this issue on two fronts.

1. Reduce carbon emissions to limit the severity of climate change- **minimise energy use**.
2. **Ensure developments are resilient** to increased overheating risks from future climate scenarios.

The Camden Local Plan 2017 calls for following the London Plan Cooling Hierarchy which aims to reduce overheating risk whilst also reducing reliance on air conditioning systems.

As described in the original application, the design team has been aware from an early stage of the need to mitigate the risk of overheating; and to create thermally comfortable spaces that will continue to operate successfully in future climates. The fact that the development is targeting Passivhaus certification reinforces the requirement for acute attention to detail with respect to overheating, as Passivhaus relies on a highly insulated thermal envelope resulting very low heat loss. In the winter, this allows the dwelling to take advantage of Solar Gains for free heating, but in the summer affective strategies to control gain and flush away heat must be considered.

To reduce energy demand from cooling, the design follows the London Plan Cooling Hierarchy by adopting a passive design - opening windows for natural ventilation. However, there is a greater risk of overheating, both with the current and predicted future climate with a natural ventilation strategy. Therefore an overheating analysis was completed with the aims of showing compliance with legislation whilst also driving the design.

Methodology
The design standards for residential summer comfort have advanced since the original application. In line with the draft New London Plan, CIBSE's TM59 was used as the framework to assess overheating risk and to guide design to militate against this. TM59 has two criteria to pass – daytime comfort for all rooms, and night-time comfort for bedrooms. Ten apartments which represent the most onerous examples were analysed. This included apartments with higher solar gains due to being south facing and/or limited shading, single aspect glazing which doesn't allow cross flow and ground floor apartments where security issues mean limited opening of windows.

Results

- 2020 Climate:

Results showed it was feasible to adopt a passive cooling design ONLY if certain features are adopted, such as solar irradiance filters on the glazing, ensuring sufficient opening areas on the glazing and adopting external shading. Refer to the TM59 Summer Comfort report for full details.

- 2050 Climate

Current passive design measures will not be sufficient in mitigating the overheating risk. Solar irradiance is the most significant heat gain.

Following the London Plan Energy Hierarchy 'Be Lean, be clean, be green', the first option should 'be lean' adopting more passive design measures which will bring down energy demand. Measures that could be adopted now include adding blinds/shades/louvres to limit solar gains and the removal of fixed low level glazing which adds to solar gains but does not aid natural ventilation. Retrofit options in the future include providing solar control film, fitting more external shading/louvres and adding ceiling fans.

The above measures will reduce the demand for active cooling but not eliminate it. Following 'be clean', active cooling could be retrofitted by modifying the currently proposed underfloor heating system to be able to also provide underfloor cooling, or alternatively add cooling to the mechanical ventilation system. To 'be clean' this should utilise air source heat pumps with high efficiency ratings (SCOP and SEER).

Further details can be found in Appendix 2.

8.0 APPENDIX 1 – SAP MODELLING OUTPUT

Modelling of regulated energy in the dwellings was carried out using STROMA FSAP software in line with the methodology and occupancy profiles described in Part L 2013 of the Building Regulations. Results were then converted using SAP10 factors in line with the guidance provided by the GLA. The following pages contain examples of the modelling output at each stage of the energy hierarchy.

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: 11_s_m

Address : Block I, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	77.6	(1a) x	3.15	(2a) =	244.44	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	77.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	244.44	(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)

DRAFT

			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			1	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.05	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides sheltered			2	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor		(21) = (18) x (20) =	0.04	(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

SAP WorkSheet: New dwelling design stage

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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			5.6	x	1/[1/(0.85)+ 0.04]	=	4.6			(27)
Windows Type 2			11.1	x	1/[1/(0.85)+ 0.04]	=	9.12			(27)
Walls Type1	38.4	11.1	27.3	x	0.2	=	5.46			(29)
Walls Type2	8.5	5.6	2.9	x	0.2	=	0.58			(29)
Total area of elements, m²			46.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 19.77 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 513.4 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 7.04 (36)

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

Total fabric heat loss (33) + (36) = 26.8 (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=	13.85	13.76	13.68	13.25	13.16	12.74	12.74	12.65	12.91	13.16	13.33	13.51	(38)

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

(39)m=	40.65	40.57	40.48	40.05	39.97	39.54	39.54	39.45	39.71	39.97	40.14	40.31

Average = Sum(39)$_{1…12}$ /12= 40.03 (39)

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

(40)m=	0.52	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.52	0.52	0.52

Average = Sum(40)$_{1…12}$ /12= 0.52 (40)

SAP WorkSheet: New dwelling design stage

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 — 2.42 (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 — 91.57 (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=	100.73	97.07	93.41	89.74	86.08	82.42	82.42	86.08	89.74	93.41	97.07	100.73	
Total = Sum(44)1…12 =												1098.89	(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=	149.38	130.65	134.82	117.54	112.78	97.32	90.18	103.49	104.72	122.04	133.22	144.67	
Total = Sum(45)1…12 =												1440.81	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.41	19.6	20.22	17.63	16.92	14.6	13.53	15.52	15.71	18.31	19.98	21.7	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a — 1.03 (52)

Temperature factor from Table 2b — 0.6 (53)

Energy lost from water storage, kWh/year — (47) x (51) x (52) x (53) = — 1.03 (54)

Enter (50) or (54) in (55) — 1.03 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	(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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	

Output from water heater (annual) 1…12 | 2091.65 | (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=	93.89	83.38	89.05	81.88	81.72	75.15	74.21	78.63	77.62	84.8	87.09	92.32	(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=	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	(66)

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

(67)m=	48.49	43.07	35.03	26.52	19.82	16.73	18.08	23.5	31.55	40.06	46.75	49.84	(67)

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

(68)m=	319.93	323.25	314.88	297.07	274.59	253.46	239.34	236.02	244.39	262.2	284.68	305.81	(68)

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

(69)m=	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	(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=	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	(71)

Water heating gains (Table 5)

(72)m=	126.2	124.08	119.69	113.72	109.84	104.38	99.74	105.69	107.8	113.98	120.96	124.09	(72)

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

(73)m=	594.84	590.62	569.82	537.53	504.48	474.8	457.39	465.44	483.96	516.46	552.62	579.97	(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	0.54	x	11.1	x	19.64	x	0.5	x	0.8	=	42.38	(76)
East	0.9x	0.54	x	11.1	x	38.42	x	0.5	x	0.8	=	82.91	(76)
East	0.9x	0.54	x	11.1	x	63.27	x	0.5	x	0.8	=	136.53	(76)
East	0.9x	0.54	x	11.1	x	92.28	x	0.5	x	0.8	=	199.13	(76)
East	0.9x	0.54	x	11.1	x	113.09	x	0.5	x	0.8	=	244.04	(76)
East	0.9x	0.54	x	11.1	x	115.77	x	0.5	x	0.8	=	249.81	(76)
East	0.9x	0.54	x	11.1	x	110.22	x	0.5	x	0.8	=	237.83	(76)
East	0.9x	0.54	x	11.1	x	94.68	x	0.5	x	0.8	=	204.3	(76)

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East	0.9x	0.54	x	11.1	x	73.59	x	0.5	x	0.8	=	158.79	(76)
East	0.9x	0.54	x	11.1	x	45.59	x	0.5	x	0.8	=	98.37	(76)
East	0.9x	0.54	x	11.1	x	24.49	x	0.5	x	0.8	=	52.84	(76)
East	0.9x	0.54	x	11.1	x	16.15	x	0.5	x	0.8	=	34.85	(76)
West	0.9x	0.77	x	5.6	x	19.64	x	0.5	x	0.8	=	30.49	(80)
West	0.9x	0.77	x	5.6	x	38.42	x	0.5	x	0.8	=	59.64	(80)
West	0.9x	0.77	x	5.6	x	63.27	x	0.5	x	0.8	=	98.22	(80)
West	0.9x	0.77	x	5.6	x	92.28	x	0.5	x	0.8	=	143.25	(80)
West	0.9x	0.77	x	5.6	x	113.09	x	0.5	x	0.8	=	175.56	(80)
West	0.9x	0.77	x	5.6	x	115.77	x	0.5	x	0.8	=	179.71	(80)
West	0.9x	0.77	x	5.6	x	110.22	x	0.5	x	0.8	=	171.09	(80)
West	0.9x	0.77	x	5.6	x	94.68	x	0.5	x	0.8	=	146.97	(80)
West	0.9x	0.77	x	5.6	x	73.59	x	0.5	x	0.8	=	114.23	(80)
West	0.9x	0.77	x	5.6	x	45.59	x	0.5	x	0.8	=	70.77	(80)
West	0.9x	0.77	x	5.6	x	24.49	x	0.5	x	0.8	=	38.01	(80)
West	0.9x	0.77	x	5.6	x	16.15	x	0.5	x	0.8	=	25.07	(80)

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

(83)m=	72.87	142.55	234.75	342.37	419.59	429.53	408.93	351.26	273.03	169.14	90.86	59.92	(83)

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

(84)m=	667.71	733.17	804.58	879.9	924.07	904.33	866.32	816.7	756.99	685.6	643.48	639.89	(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=	0.83	0.77	0.67	0.53	0.4	0.28	0.2	0.22	0.36	0.58	0.76	0.84	(86)

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

(87)m=	20.63	20.74	20.87	20.96	20.99	21	21	21	21	20.95	20.79	20.59	(87)

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

(88)m=	20.5	20.5	20.5	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.5	(88)

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

(89)m=	0.81	0.75	0.66	0.51	0.38	0.26	0.18	0.2	0.33	0.56	0.74	0.83	(89)

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

(90)m=	20	20.16	20.33	20.45	20.5	20.51	20.51	20.51	20.51	20.45	20.24	19.96	(90)

fLA = Living area ÷ (4) = | 0.58 | (91)

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

(92)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(92)

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

(93)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(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

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Utilisation factor for gains, hm:

(94)m=	0.81	0.75	0.66	0.52	0.39	0.27	0.19	0.21	0.35	0.57	0.74	0.83	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	540.92	553.11	531.08	461.17	359.97	244.46	165.79	173.3	264.26	389.56	477.82	529.03	(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=	653.04	632.59	572.42	474.44	362.99	244.88	165.86	173.4	265.64	405.16	540.27	650.13	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	83.42	53.41	30.76	9.56	2.25	0	0	0	0	11.6	44.97	90.1

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 326.06 (98)

Space heating requirement in kWh/m²/year 4.2 (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		1.15	(306)
Space heating		**kWh/year**	
Annual space heating requirement		326.06	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	374.97	(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		2091.65	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2405.4	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	27.8	(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		250.5	(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) =	250.5	(331)

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Energy for lighting (calculated in Appendix L)			342.54	(332)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	15.9	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	101.99	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	33.04	(349)
Energy for lighting	(332)	13.19	x 0.01 =	45.18	(350)
Additional standing charges (Table 12)				120	(351)
Total energy cost	= (340a)…(342e) + (345)…(354) =			316.11	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	1.08	(357)
SAP rating (section12)		84.89	(358)

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				89.5	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	671.02	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	14.43	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	685.45	(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) =				685.45	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	130.01	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	177.78	(379)
Total CO2, kg/year	sum of (376)…(382) =				993.24	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				12.8	(384)
EI rating (section 14)					89.14	(385)

13b. Primary Energy – Community heating scheme

		Energy kWh/year	**Primary factor**		**P.Energy** kWh/year	
Energy 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				89.5	(367a)
Energy associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		1.22	=	3790	(367)
Electrical energy for heat distribution	[(313) x			=	85.36	(372)

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Total Energy associated with community systems	(363)…(366) + (368)...(372)		=	3875.36	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)				3875.36	(373)
Energy associated with space heating (secondary)	(309) x	0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x	1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =			3875.36	(376)
Energy associated with space cooling	(315) x	3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x	3.07	=	769.04	(378)
Energy associated with electricity for lighting	(332))) x	3.07	=	1051.61	(379)
Total Primary Energy, kWh/year	sum of (376)…(382) =			5696	(383)

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User Details:

Assessor Name: | **Stroma Number:**
Software Name: Stroma FSAP 2012 | **Software Version:** Version: 1.0.4.18

Property Address: 11_s_m

Address : Block I, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	77.6	(1a) x	3.15	(2a) =	244.44	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	77.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	244.44	(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 *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*		0	(11)
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		1	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.05	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.04	(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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			5.6	x1/[1/(0.85)+ 0.04]	=	4.6			(27)
Windows Type 2			11.1	x1/[1/(0.85)+ 0.04]	=	9.12			(27)
Walls Type1	38.4	11.1	27.3	x 0.2	=	5.46			(29)
Walls Type2	8.5	5.6	2.9	x 0.2	=	0.58			(29)
Total area of elements, m²			46.9						(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 19.77 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 513.4 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 7.04 (36)

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

Total fabric heat loss (33) + (36) = 26.8 (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=	13.85	13.76	13.68	13.25	13.16	12.74	12.74	12.65	12.91	13.16	13.33	13.51	(38)

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

(39)m=	40.65	40.57	40.48	40.05	39.97	39.54	39.54	39.45	39.71	39.97	40.14	40.31

Average = $Sum(39)_{1…12}$ /12= 40.03 (39)

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

(40)m=	0.52	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.52	0.52	0.52

Average = $Sum(40)_{1…12}$ /12= 0.52 (40)

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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 2.42 (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 91.57 (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=	100.73	97.07	93.41	89.74	86.08	82.42	82.42	86.08	89.74	93.41	97.07	100.73	
											Total = Sum(44)$_{1...12}$ =	1098.89	(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=	149.38	130.65	134.82	117.54	112.78	97.32	90.18	103.49	104.72	122.04	133.22	144.67	
											Total = Sum(45)$_{1...12}$ =	1440.81	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	22.41	19.6	20.22	17.63	16.92	14.6	13.53	15.52	15.71	18.31	19.98	21.7	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	(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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	

Output from water heater (annual)$_{1...12}$ 2091.65 (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=	93.89	83.38	89.05	81.88	81.72	75.15	74.21	78.63	77.62	84.8	87.09	92.32	(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=	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	(66)

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

(67)m=	48.49	43.07	35.03	26.52	19.82	16.73	18.08	23.5	31.55	40.06	46.75	49.84	(67)

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

(68)m=	319.93	323.25	314.88	297.07	274.59	253.46	239.34	236.02	244.39	262.2	284.68	305.81	(68)

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

(69)m=	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	(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=	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	(71)

Water heating gains (Table 5)

(72)m=	126.2	124.08	119.69	113.72	109.84	104.38	99.74	105.69	107.8	113.98	120.96	124.09	(72)

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

(73)m=	594.84	590.62	569.82	537.53	504.48	474.8	457.39	465.44	483.96	516.46	552.62	579.97	(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	0.54	x	11.1	x	19.64	x	0.5	x	0.8	=	42.38	(76)
East	0.9x	0.54	x	11.1	x	38.42	x	0.5	x	0.8	=	82.91	(76)
East	0.9x	0.54	x	11.1	x	63.27	x	0.5	x	0.8	=	136.53	(76)
East	0.9x	0.54	x	11.1	x	92.28	x	0.5	x	0.8	=	199.13	(76)
East	0.9x	0.54	x	11.1	x	113.09	x	0.5	x	0.8	=	244.04	(76)
East	0.9x	0.54	x	11.1	x	115.77	x	0.5	x	0.8	=	249.81	(76)
East	0.9x	0.54	x	11.1	x	110.22	x	0.5	x	0.8	=	237.83	(76)
East	0.9x	0.54	x	11.1	x	94.68	x	0.5	x	0.8	=	204.3	(76)

East	0.9x	0.54	x	11.1	x	73.59	x	0.5	x	0.8	=	158.79	(76)
East	0.9x	0.54	x	11.1	x	45.59	x	0.5	x	0.8	=	98.37	(76)
East	0.9x	0.54	x	11.1	x	24.49	x	0.5	x	0.8	=	52.84	(76)
East	0.9x	0.54	x	11.1	x	16.15	x	0.5	x	0.8	=	34.85	(76)
West	0.9x	0.77	x	5.6	x	19.64	x	0.5	x	0.8	=	30.49	(80)
West	0.9x	0.77	x	5.6	x	38.42	x	0.5	x	0.8	=	59.64	(80)
West	0.9x	0.77	x	5.6	x	63.27	x	0.5	x	0.8	=	98.22	(80)
West	0.9x	0.77	x	5.6	x	92.28	x	0.5	x	0.8	=	143.25	(80)
West	0.9x	0.77	x	5.6	x	113.09	x	0.5	x	0.8	=	175.56	(80)
West	0.9x	0.77	x	5.6	x	115.77	x	0.5	x	0.8	=	179.71	(80)
West	0.9x	0.77	x	5.6	x	110.22	x	0.5	x	0.8	=	171.09	(80)
West	0.9x	0.77	x	5.6	x	94.68	x	0.5	x	0.8	=	146.97	(80)
West	0.9x	0.77	x	5.6	x	73.59	x	0.5	x	0.8	=	114.23	(80)
West	0.9x	0.77	x	5.6	x	45.59	x	0.5	x	0.8	=	70.77	(80)
West	0.9x	0.77	x	5.6	x	24.49	x	0.5	x	0.8	=	38.01	(80)
West	0.9x	0.77	x	5.6	x	16.15	x	0.5	x	0.8	=	25.07	(80)

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

(83)m=	72.87	142.55	234.75	342.37	419.59	429.53	408.93	351.26	273.03	169.14	90.86	59.92	(83)

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

(84)m=	667.71	733.17	804.58	879.9	924.07	904.33	866.32	816.7	756.99	685.6	643.48	639.89	(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=	0.83	0.77	0.67	0.53	0.4	0.28	0.2	0.22	0.36	0.58	0.76	0.84	(86)

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

(87)m=	20.63	20.74	20.87	20.96	20.99	21	21	21	21	20.95	20.79	20.59	(87)

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

(88)m=	20.5	20.5	20.5	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.5	(88)

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

(89)m=	0.81	0.75	0.66	0.51	0.38	0.26	0.18	0.2	0.33	0.56	0.74	0.83	(89)

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

(90)m=	20	20.16	20.33	20.45	20.5	20.51	20.51	20.51	20.51	20.45	20.24	19.96	(90)

fLA = Living area ÷ (4) = | 0.58 | (91)

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

(92)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(92)

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

(93)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(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=	0.81	0.75	0.66	0.52	0.39	0.27	0.19	0.21	0.35	0.57	0.74	0.83	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	540.92	553.11	531.08	461.17	359.97	244.46	165.79	173.3	264.26	389.56	477.82	529.03	(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=	653.04	632.59	572.42	474.44	362.99	244.88	165.86	173.4	265.64	405.16	540.27	650.13	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	83.42	53.41	30.76	9.56	2.25	0	0	0	0	11.6	44.97	90.1

	Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =	326.06	(98)
Space heating requirement in kWh/m²/year		4.2	(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		1.07	(306)
Space heating		**kWh/year**	
Annual space heating requirement		326.06	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	348.88	(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		2091.65	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2238.07	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	25.87	(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		250.5	(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) =	250.5	(331)

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Energy for lighting (calculated in Appendix L)			342.54	(332)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	14.79	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	94.89	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	33.04	(349)
Energy for lighting	(332)	13.19	x 0.01 =	45.18	(350)
Additional standing charges (Table 12)				120	(351)
Total energy cost	= (340a)…(342e) + (345)…(354) =			307.91	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	1.05	(357)
SAP rating (section12)		85.29	(358)

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				92	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	607.37	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	13.43	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	620.8	(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) =				620.8	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	130.01	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	177.78	(379)
Total CO2, kg/year	sum of (376)…(382) =				928.59	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				11.97	(384)
EI rating (section 14)					89.85	(385)

13b. Primary Energy – Community heating scheme

		Energy kWh/year	**Primary** factor		**P.Energy** kWh/year	
Energy 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				92	(367a)
Energy associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		1.22	=	3430.52	(367)
Electrical energy for heat distribution	[(313) x			=	79.42	(372)

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Total Energy associated with community systems	(363)…(366) + (368)...(372)		=	3509.94	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)				3509.94	(373)
Energy associated with space heating (secondary)	(309) x	0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x	1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =			3509.94	(376)
Energy associated with space cooling	(315) x	3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x	3.07	=	769.04	(378)
Energy associated with electricity for lighting	(332))) x	3.07	=	1051.61	(379)
Total Primary Energy, kWh/year	sum of (376)…(382) =			5330.59	(383)

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User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: 11_s_m

Address : Block I, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	77.6	(1a) x	3.15	(2a) =	244.44	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	77.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	244.44	(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		1	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.05	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.04	(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

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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			5.6	x1/[1/(0.85)+ 0.04] =			4.6			(27)
Windows Type 2			11.1	x1/[1/(0.85)+ 0.04] =			9.12			(27)
Walls Type1	38.4	11.1	27.3	x	0.2	=	5.46			(29)
Walls Type2	8.5	5.6	2.9	x	0.2	=	0.58			(29)
Total area of elements, m²			46.9							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 19.77 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 513.4 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 7.04 (36)

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

Total fabric heat loss (33) + (36) = 26.8 (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=	13.85	13.76	13.68	13.25	13.16	12.74	12.74	12.65	12.91	13.16	13.33	13.51	(38)

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

(39)m=	40.65	40.57	40.48	40.05	39.97	39.54	39.54	39.45	39.71	39.97	40.14	40.31	

Average = Sum(39)$_{1…12}$ /12= 40.03 (39)

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

(40)m=	0.52	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.52	0.52	0.52	

Average = Sum(40)$_{1…12}$ /12= 0.52 (40)

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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 — 2.42 (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 — 91.57 (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=	100.73	97.07	93.41	89.74	86.08	82.42	82.42	86.08	89.74	93.41	97.07	100.73	

Total = Sum(44)$_{1…12}$ = 1098.89 (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=	149.38	130.65	134.82	117.54	112.78	97.32	90.18	103.49	104.72	122.04	133.22	144.67

Total = Sum(45)$_{1…12}$ = 1440.81 (45)

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

(46)m=	22.41	19.6	20.22	17.63	16.92	14.6	13.53	15.52	15.71	18.31	19.98	21.7	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a — 1.03 (52)

Temperature factor from Table 2b — 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) — 1.03 (55)

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

(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	(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=	204.66	180.58	190.1	171.03	168.06	150.82	145.46	158.76	158.22	177.32	186.71	199.94	

Output from water heater (annual)$_{1...12}$ 2091.65 (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=	93.89	83.38	89.05	81.88	81.72	75.15	74.21	78.63	77.62	84.8	87.09	92.32	(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=	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	144.94	(66)

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

(67)m=	48.49	43.07	35.03	26.52	19.82	16.73	18.08	23.5	31.55	40.06	46.75	49.84	(67)

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

(68)m=	319.93	323.25	314.88	297.07	274.59	253.46	239.34	236.02	244.39	262.2	284.68	305.81	(68)

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

(69)m=	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	51.91	(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=	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	-96.63	(71)

Water heating gains (Table 5)

(72)m=	126.2	124.08	119.69	113.72	109.84	104.38	99.74	105.69	107.8	113.98	120.96	124.09	(72)

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

(73)m=	594.84	590.62	569.82	537.53	504.48	474.8	457.39	465.44	483.96	516.46	552.62	579.97	(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	0.54	x	11.1	x	19.64	x	0.5	x	0.8	=	42.38	(76)
East	0.9x	0.54	x	11.1	x	38.42	x	0.5	x	0.8	=	82.91	(76)
East	0.9x	0.54	x	11.1	x	63.27	x	0.5	x	0.8	=	136.53	(76)
East	0.9x	0.54	x	11.1	x	92.28	x	0.5	x	0.8	=	199.13	(76)
East	0.9x	0.54	x	11.1	x	113.09	x	0.5	x	0.8	=	244.04	(76)
East	0.9x	0.54	x	11.1	x	115.77	x	0.5	x	0.8	=	249.81	(76)
East	0.9x	0.54	x	11.1	x	110.22	x	0.5	x	0.8	=	237.83	(76)
East	0.9x	0.54	x	11.1	x	94.68	x	0.5	x	0.8	=	204.3	(76)

East	0.9x	0.54	x	11.1	x	73.59	x	0.5	x	0.8	=	158.79	(76)
East	0.9x	0.54	x	11.1	x	45.59	x	0.5	x	0.8	=	98.37	(76)
East	0.9x	0.54	x	11.1	x	24.49	x	0.5	x	0.8	=	52.84	(76)
East	0.9x	0.54	x	11.1	x	16.15	x	0.5	x	0.8	=	34.85	(76)
West	0.9x	0.77	x	5.6	x	19.64	x	0.5	x	0.8	=	30.49	(80)
West	0.9x	0.77	x	5.6	x	38.42	x	0.5	x	0.8	=	59.64	(80)
West	0.9x	0.77	x	5.6	x	63.27	x	0.5	x	0.8	=	98.22	(80)
West	0.9x	0.77	x	5.6	x	92.28	x	0.5	x	0.8	=	143.25	(80)
West	0.9x	0.77	x	5.6	x	113.09	x	0.5	x	0.8	=	175.56	(80)
West	0.9x	0.77	x	5.6	x	115.77	x	0.5	x	0.8	=	179.71	(80)
West	0.9x	0.77	x	5.6	x	110.22	x	0.5	x	0.8	=	171.09	(80)
West	0.9x	0.77	x	5.6	x	94.68	x	0.5	x	0.8	=	146.97	(80)
West	0.9x	0.77	x	5.6	x	73.59	x	0.5	x	0.8	=	114.23	(80)
West	0.9x	0.77	x	5.6	x	45.59	x	0.5	x	0.8	=	70.77	(80)
West	0.9x	0.77	x	5.6	x	24.49	x	0.5	x	0.8	=	38.01	(80)
West	0.9x	0.77	x	5.6	x	16.15	x	0.5	x	0.8	=	25.07	(80)

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

(83)m=	72.87	142.55	234.75	342.37	419.59	429.53	408.93	351.26	273.03	169.14	90.86	59.92	(83)

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

(84)m=	667.71	733.17	804.58	879.9	924.07	904.33	866.32	816.7	756.99	685.6	643.48	639.89	(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=	0.83	0.77	0.67	0.53	0.4	0.28	0.2	0.22	0.36	0.58	0.76	0.84	(86)

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

(87)m=	20.63	20.74	20.87	20.96	20.99	21	21	21	21	20.95	20.79	20.59	(87)

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

(88)m=	20.5	20.5	20.5	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.51	20.5	(88)

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

(89)m=	0.81	0.75	0.66	0.51	0.38	0.26	0.18	0.2	0.33	0.56	0.74	0.83	(89)

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

(90)m=	20	20.16	20.33	20.45	20.5	20.51	20.51	20.51	20.51	20.45	20.24	19.96	(90)

fLA = Living area ÷ (4) = 0.58 (91)

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

(92)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(92)

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

(93)m=	20.36	20.49	20.64	20.75	20.78	20.79	20.79	20.8	20.79	20.74	20.56	20.33	(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=	0.81	0.75	0.66	0.52	0.39	0.27	0.19	0.21	0.35	0.57	0.74	0.83	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	540.92	553.11	531.08	461.17	359.97	244.46	165.79	173.3	264.26	389.56	477.82	529.03	(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=	653.04	632.59	572.42	474.44	362.99	244.88	165.86	173.4	265.64	405.16	540.27	650.13	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	83.42	53.41	30.76	9.56	2.25	0	0	0	0	11.6	44.97	90.1

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 326.06 (98)

Space heating requirement in kWh/m²/year 4.2 (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 heat pump 1 (303a)

Fraction of total space heat from Community heat pump (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 326.06

Space heat from Community heat pump (98) x (304a) x (305) x (306) = 342.36 (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 2091.65

If DHW from community scheme:

Water heat from Community heat pump (64) x (303a) x (305) x (306) = 2196.24 (310a)

Electricity used for heat distribution 0.01 × [(307a)…(307e) + (310a)…(310e)] = 25.39 (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 250.5 (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) = 250.5 (331)

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Energy for lighting (calculated in Appendix L)	342.54	(332)
Electricity generated by PVs (Appendix M) (negative quantity)	-331.63	(333)
Electricity generated by wind turbine (Appendix M) (negative quantity)	0	(334)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	14.52	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	93.12	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	33.04	(349)
Energy for lighting	(332)	13.19	x 0.01 =	45.18	(350)
Additional standing charges (Table 12)				120	(351)
Energy saving/generation technologies Item 1		13.19	x 0.01 =	-43.74	(352)
Total energy cost	= (340a)…(342e) + (345)…(354) =			262.12	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.9	(357)
SAP rating (section12)		87.47	(358)

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			219	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x	0.52	=	601.61	(367)
Electrical energy for heat distribution	[(313) x	0.52	=	13.18	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)		=	614.79	(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) =			614.79	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x	0.52	=	130.01	(378)
CO2 associated with electricity for lighting	(332))) x	0.52	=	177.78	(379)
Energy saving/generation technologies (333) to (334) as applicable Item 1		0.52	x 0.01 =	-172.12	(380)
Total CO2, kg/year	sum of (376)…(382) =			750.46	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =			9.67	(384)
EI rating (section 14)				91.8	(385)

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13b. Primary Energy – Community heating scheme

		Energy kWh/year	Primary factor		P.Energy kWh/year	
Energy 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				219	(367a)
Energy associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		3.07	=	3558.67	(367)
Electrical energy for heat distribution	[(313) x			=	77.93	(372)
Total Energy associated with community systems	(363)…(366) + (368)...(372)			=	3636.61	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)					3636.61	(373)
Energy associated with space heating (secondary)	(309) x		0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x		1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =				3636.61	(376)
Energy associated with space cooling	(315) x		3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x		3.07	=	769.04	(378)
Energy associated with electricity for lighting	(332))) x		3.07	=	1051.61	(379)
Energy saving/generation technologies						
Item 1		3.07	x 0.01 =		-1018.1	(380)
Total Primary Energy, kWh/year	sum of (376)…(382) =				4439.15	(383)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: 08_s_m

Address : Block JKL, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.1	(1a) x	3.15	(2a) =	227.12	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	227.12	(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 *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*		0	(11)
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		1	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.05	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.04	(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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			17.6	x1/[1/(0.85)+ 0.04]	=	14.47			(27)
Windows Type 2			7.9	x1/[1/(0.85)+ 0.04]	=	6.49			(27)
Walls Type1	41	17.6	23.4	x 0.2	=	4.68			(29)
Walls Type2	18.9	7.9	11	x 0.2	=	2.2			(29)
Total area of elements, m²			59.9						(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 27.84 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 584.8 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 8.99 (36)

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

Total fabric heat loss (33) + (36) = 36.83 (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=	12.87	12.79	12.71	12.31	12.23	11.83	11.83	11.75	11.99	12.23	12.39	12.55	(38)

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

(39)m=	49.69	49.62	49.54	49.14	49.06	48.66	48.66	48.58	48.82	49.06	49.22	49.38	

Average = Sum(39)$_{1…12}$ /12= 49.12 (39)

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

(40)m=	0.69	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.68	0.68	0.68	0.68	

Average = Sum(40)$_{1…12}$ /12= 0.68 (40)

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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 2.3 (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 88.73 (43)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	97.6	94.05	90.5	86.96	83.41	79.86	79.86	83.41	86.96	90.5	94.05	97.6	

Total = $\text{Sum}(44)_{1...12}$ = 1064.76 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	144.74	126.59	130.63	113.89	109.28	94.3	87.38	100.27	101.47	118.25	129.08	140.18	

Total = $\text{Sum}(45)_{1...12}$ = 1396.07 (45)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	21.71	18.99	19.59	17.08	16.39	14.14	13.11	15.04	15.22	17.74	19.36	21.03	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	(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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	

Output from water heater (annual)$_{1...12}$ 2046.91 (64)

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

(65)m=	92.35	82.03	87.66	80.66	80.56	74.15	73.28	77.56	76.53	83.54	85.72	90.83	(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=	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	45.05	40.02	32.54	24.64	18.42	15.55	16.8	21.84	29.31	37.22	43.44	46.31	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	301.71	304.84	296.95	280.16	258.96	239.03	225.72	222.59	230.48	247.27	268.47	288.4	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	(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=	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	(71)
Water heating gains (Table 5)													
(72)m=	124.12	122.07	117.82	112.03	108.28	102.99	98.49	104.25	106.3	112.29	119.05	122.08	(72)
Total internal gains =						(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m							
(73)m=	567.88	563.93	544.31	513.82	482.64	454.56	438	445.67	463.08	493.77	527.95	553.78	(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)	
North	0.9x	0.77	x	17.6	x	10.63	x	0.5	x	0.8	=	51.88	(74)
North	0.9x	0.77	x	17.6	x	20.32	x	0.5	x	0.8	=	99.14	(74)
North	0.9x	0.77	x	17.6	x	34.53	x	0.5	x	0.8	=	168.46	(74)
North	0.9x	0.77	x	17.6	x	55.46	x	0.5	x	0.8	=	270.6	(74)
North	0.9x	0.77	x	17.6	x	74.72	x	0.5	x	0.8	=	364.52	(74)
North	0.9x	0.77	x	17.6	x	79.99	x	0.5	x	0.8	=	390.23	(74)
North	0.9x	0.77	x	17.6	x	74.68	x	0.5	x	0.8	=	364.33	(74)
North	0.9x	0.77	x	17.6	x	59.25	x	0.5	x	0.8	=	289.05	(74)

North	0.9x	0.77	x	17.6	x	41.52	x	0.5	x	0.8	=	202.55	(74)
North	0.9x	0.77	x	17.6	x	24.19	x	0.5	x	0.8	=	118.01	(74)
North	0.9x	0.77	x	17.6	x	13.12	x	0.5	x	0.8	=	64	(74)
North	0.9x	0.77	x	17.6	x	8.86	x	0.5	x	0.8	=	43.25	(74)
East	0.9x	0.77	x	7.9	x	19.64	x	0.5	x	0.8	=	43.01	(76)
East	0.9x	0.77	x	7.9	x	38.42	x	0.5	x	0.8	=	84.14	(76)
East	0.9x	0.77	x	7.9	x	63.27	x	0.5	x	0.8	=	138.56	(76)
East	0.9x	0.77	x	7.9	x	92.28	x	0.5	x	0.8	=	202.08	(76)
East	0.9x	0.77	x	7.9	x	113.09	x	0.5	x	0.8	=	247.66	(76)
East	0.9x	0.77	x	7.9	x	115.77	x	0.5	x	0.8	=	253.52	(76)
East	0.9x	0.77	x	7.9	x	110.22	x	0.5	x	0.8	=	241.36	(76)
East	0.9x	0.77	x	7.9	x	94.68	x	0.5	x	0.8	=	207.33	(76)
East	0.9x	0.77	x	7.9	x	73.59	x	0.5	x	0.8	=	161.15	(76)
East	0.9x	0.77	x	7.9	x	45.59	x	0.5	x	0.8	=	99.83	(76)
East	0.9x	0.77	x	7.9	x	24.49	x	0.5	x	0.8	=	53.63	(76)
East	0.9x	0.77	x	7.9	x	16.15	x	0.5	x	0.8	=	35.37	(76)

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

(83)m=	94.89	183.28	307.02	472.68	612.18	643.75	605.69	496.38	363.7	217.85	117.63	78.62	(83)

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

(84)m=	662.77	747.2	851.33	986.5	1094.82	1098.31	1043.69	942.04	826.78	711.62	645.58	632.4	(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=	0.87	0.81	0.72	0.56	0.41	0.28	0.2	0.24	0.4	0.64	0.81	0.88	(86)

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

(87)m=	20.24	20.43	20.68	20.88	20.97	20.99	21	21	20.98	20.84	20.52	20.19	(87)

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

(88)m=	20.35	20.35	20.35	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.35	(88)

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

(89)m=	0.85	0.8	0.7	0.54	0.38	0.25	0.18	0.2	0.36	0.61	0.79	0.87	(89)

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

(90)m=	19.35	19.61	19.95	20.22	20.32	20.36	20.36	20.36	20.34	20.17	19.74	19.28	(90)

fLA = Living area ÷ (4) = | 0.4 | (91)

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

(92)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(92)

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

(93)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(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

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Utilisation factor for gains, hm:

(94)m=	0.84	0.79	0.69	0.54	0.39	0.27	0.19	0.22	0.38	0.62	0.78	0.85	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	556.34	587.58	588.84	535.55	427.2	291.1	195.22	204.38	311.68	439.25	505.48	540.24	(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=	765.67	746.33	680.62	569.25	435.82	292.62	195.52	204.9	317.2	482.91	637.76	762.66	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	155.74	106.68	68.28	24.27	6.42	0	0	0	0	32.49	95.24	165.48

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 654.6 (98)

Space heating requirement in kWh/m²/year 9.08 (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		1.15	(306)
Space heating		**kWh/year**	
Annual space heating requirement		654.6	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	752.79	(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		2046.91	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2353.95	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	31.07	(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		240.51	(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) =	240.51	(331)

Energy for lighting (calculated in Appendix L)			318.27	(332)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	31.92	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	99.81	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	31.72	(349)
Energy for lighting	(332)	13.19	x 0.01 =	41.98	(350)
Additional standing charges (Table 12)				120	(351)
Total energy cost	= (340a)…(342e) + (345)…(354) =			325.43	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	1.17	(357)
SAP rating (section12)		83.72	(358)

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				89.5	(367a)
CO2 associated with heat source 1		[(307b)+(310b)] x 100 ÷ (367b) x	0.22	=	749.78	(367)
Electrical energy for heat distribution		[(313) x	0.52	=	16.12	(372)
Total CO2 associated with community systems		(363)…(366) + (368)...(372)		=	765.91	(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) =			765.91	(376)
CO2 associated with electricity for pumps and fans within dwelling		(331)) x	0.52	=	124.82	(378)
CO2 associated with electricity for lighting		(332))) x	0.52	=	165.18	(379)
Total CO2, kg/year	sum of (376)…(382) =				1055.91	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				14.65	(384)
EI rating (section 14)					87.92	(385)

13b. Primary Energy – Community heating scheme

		Energy kWh/year	**Primary** factor		**P.Energy** kWh/year	
Energy 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				89.5	(367a)
Energy associated with heat source 1		[(307b)+(310b)] x 100 ÷ (367b) x	1.22	=	4234.89	(367)
Electrical energy for heat distribution		[(313) x		=	95.38	(372)

SAP WorkSheet: New dwelling design stage

Total Energy associated with community systems	(363)…(366) + (368)...(372)		=	4330.26	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)				4330.26	(373)
Energy associated with space heating (secondary)	(309) x	0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x	1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =			4330.26	(376)
Energy associated with space cooling	(315) x	3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x	3.07	=	738.35	(378)
Energy associated with electricity for lighting	(332))) x	3.07	=	977.08	(379)
Total Primary Energy, kWh/year	sum of (376)…(382) =			6045.7	(383)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: 08_s_m

Address : Block JKL, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	72.1	(1a)	x	3.15	(2a)	=	227.12	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.1	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			227.12	(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		1	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.05	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.04	(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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			17.6	x1/[1/(0.85)+ 0.04]	=	14.47			(27)
Windows Type 2			7.9	x1/[1/(0.85)+ 0.04]	=	6.49			(27)
Walls Type1	41	17.6	23.4	x 0.2	=	4.68			(29)
Walls Type2	18.9	7.9	11	x 0.2	=	2.2			(29)
Total area of elements, m²			59.9						(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 27.84 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 584.8 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 8.99 (36)

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

Total fabric heat loss (33) + (36) = 36.83 (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=	12.87	12.79	12.71	12.31	12.23	11.83	11.83	11.75	11.99	12.23	12.39	12.55	(38)

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

(39)m=	49.69	49.62	49.54	49.14	49.06	48.66	48.66	48.58	48.82	49.06	49.22	49.38	

Average = Sum(39)$_{1…12}$ /12= 49.12 (39)

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

(40)m=	0.69	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.68	0.68	0.68	0.68

Average = Sum(40)$_{1…12}$ /12= 0.68 (40)

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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 — 2.3 (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 — 88.73 (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=	97.6	94.05	90.5	86.96	83.41	79.86	79.86	83.41	86.96	90.5	94.05	97.6	

Total = Sum(44)$_{1...12}$ = 1064.76 (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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	144.74	126.59	130.63	113.89	109.28	94.3	87.38	100.27	101.47	118.25	129.08	140.18	

Total = Sum(45)$_{1...12}$ = 1396.07 (45)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	21.71	18.99	19.59	17.08	16.39	14.14	13.11	15.04	15.22	17.74	19.36	21.03	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a — 1.03 (52)

Temperature factor from Table 2b — 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) — 1.03 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	(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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	

Output from water heater (annual)1…12 | 2046.91 | (64)

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

(65)m=	92.35	82.03	87.66	80.66	80.56	74.15	73.28	77.56	76.53	83.54	85.72	90.83	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	45.05	40.02	32.54	24.64	18.42	15.55	16.8	21.84	29.31	37.22	43.44	46.31	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	301.71	304.84	296.95	280.16	258.96	239.03	225.72	222.59	230.48	247.27	268.47	288.4	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	(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=	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	(71)
Water heating gains (Table 5)													
(72)m=	124.12	122.07	117.82	112.03	108.28	102.99	98.49	104.25	106.3	112.29	119.05	122.08	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	567.88	563.93	544.31	513.82	482.64	454.56	438	445.67	463.08	493.77	527.95	553.78	(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)	
North	0.9x	0.77	x	17.6	x	10.63	x	0.5	x	0.8	=	51.88	(74)
North	0.9x	0.77	x	17.6	x	20.32	x	0.5	x	0.8	=	99.14	(74)
North	0.9x	0.77	x	17.6	x	34.53	x	0.5	x	0.8	=	168.46	(74)
North	0.9x	0.77	x	17.6	x	55.46	x	0.5	x	0.8	=	270.6	(74)
North	0.9x	0.77	x	17.6	x	74.72	x	0.5	x	0.8	=	364.52	(74)
North	0.9x	0.77	x	17.6	x	79.99	x	0.5	x	0.8	=	390.23	(74)
North	0.9x	0.77	x	17.6	x	74.68	x	0.5	x	0.8	=	364.33	(74)
North	0.9x	0.77	x	17.6	x	59.25	x	0.5	x	0.8	=	289.05	(74)

North	0.9x	0.77	x	17.6	x	41.52	x	0.5	x	0.8	=	202.55	(74)
North	0.9x	0.77	x	17.6	x	24.19	x	0.5	x	0.8	=	118.01	(74)
North	0.9x	0.77	x	17.6	x	13.12	x	0.5	x	0.8	=	64	(74)
North	0.9x	0.77	x	17.6	x	8.86	x	0.5	x	0.8	=	43.25	(74)
East	0.9x	0.77	x	7.9	x	19.64	x	0.5	x	0.8	=	43.01	(76)
East	0.9x	0.77	x	7.9	x	38.42	x	0.5	x	0.8	=	84.14	(76)
East	0.9x	0.77	x	7.9	x	63.27	x	0.5	x	0.8	=	138.56	(76)
East	0.9x	0.77	x	7.9	x	92.28	x	0.5	x	0.8	=	202.08	(76)
East	0.9x	0.77	x	7.9	x	113.09	x	0.5	x	0.8	=	247.66	(76)
East	0.9x	0.77	x	7.9	x	115.77	x	0.5	x	0.8	=	253.52	(76)
East	0.9x	0.77	x	7.9	x	110.22	x	0.5	x	0.8	=	241.36	(76)
East	0.9x	0.77	x	7.9	x	94.68	x	0.5	x	0.8	=	207.33	(76)
East	0.9x	0.77	x	7.9	x	73.59	x	0.5	x	0.8	=	161.15	(76)
East	0.9x	0.77	x	7.9	x	45.59	x	0.5	x	0.8	=	99.83	(76)
East	0.9x	0.77	x	7.9	x	24.49	x	0.5	x	0.8	=	53.63	(76)
East	0.9x	0.77	x	7.9	x	16.15	x	0.5	x	0.8	=	35.37	(76)

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

(83)m=	94.89	183.28	307.02	472.68	612.18	643.75	605.69	496.38	363.7	217.85	117.63	78.62	(83)

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

(84)m=	662.77	747.2	851.33	986.5	1094.82	1098.31	1043.69	942.04	826.78	711.62	645.58	632.4	(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=	0.87	0.81	0.72	0.56	0.41	0.28	0.2	0.24	0.4	0.64	0.81	0.88	(86)

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

(87)m=	20.24	20.43	20.68	20.88	20.97	20.99	21	21	20.98	20.84	20.52	20.19	(87)

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

(88)m=	20.35	20.35	20.35	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.35	(88)

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

(89)m=	0.85	0.8	0.7	0.54	0.38	0.25	0.18	0.2	0.36	0.61	0.79	0.87	(89)

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

(90)m=	19.35	19.61	19.95	20.22	20.32	20.36	20.36	20.36	20.34	20.17	19.74	19.28	(90)

fLA = Living area ÷ (4) = | 0.4 | (91)

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

(92)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(92)

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

(93)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(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

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Utilisation factor for gains, hm:

(94)m=	0.84	0.79	0.69	0.54	0.39	0.27	0.19	0.22	0.38	0.62	0.78	0.85	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	556.34	587.58	588.84	535.55	427.2	291.1	195.22	204.38	311.68	439.25	505.48	540.24	(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=	765.67	746.33	680.62	569.25	435.82	292.62	195.52	204.9	317.2	482.91	637.76	762.66	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	155.74	106.68	68.28	24.27	6.42	0	0	0	0	32.49	95.24	165.48

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =	654.6	(98)
Space heating requirement in kWh/m²/year	9.08	(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		1.07	(306)
Space heating		**kWh/year**	
Annual space heating requirement		654.6	
Space heat from Community boilers	(98) x (304a) x (305) x (306) =	700.42	(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		2046.91	
If DHW from community scheme: Water heat from Community boilers	(64) x (303a) x (305) x (306) =	2190.2	(310a)
Electricity used for heat distribution	0.01 × [(307a)…(307e) + (310a)…(310e)] =	28.91	(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		240.51	(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) =	240.51	(331)

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Energy for lighting (calculated in Appendix L)			318.27	(332)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	Fuel Price (Table 12)		Fuel Cost £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	29.7	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	92.86	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	31.72	(349)
Energy for lighting	(332)	13.19	x 0.01 =	41.98	(350)
Additional standing charges (Table 12)				120	(351)
Total energy cost	= (340a)…(342e) + (345)…(354) =			316.26	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	1.13	(357)
SAP rating (section12)		84.18	(358)

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				92	(367a)
CO2 associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		0.22	=	678.67	(367)
Electrical energy for heat distribution	[(313) x		0.52	=	15	(372)
Total CO2 associated with community systems	(363)…(366) + (368)...(372)			=	693.67	(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) =				693.67	(376)
CO2 associated with electricity for pumps and fans within dwelling	(331)) x		0.52	=	124.82	(378)
CO2 associated with electricity for lighting	(332))) x		0.52	=	165.18	(379)
Total CO2, kg/year	sum of (376)…(382) =				983.67	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				13.64	(384)
EI rating (section 14)					88.74	(385)

13b. Primary Energy – Community heating scheme

		Energy kWh/year	Primary factor		P.Energy kWh/year	
Energy 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				92	(367a)
Energy associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		1.22	=	3833.21	(367)
Electrical energy for heat distribution	[(313) x			=	88.74	(372)

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Total Energy associated with community systems	(363)…(366) + (368)...(372)		=	3921.95	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)				3921.95	(373)
Energy associated with space heating (secondary)	(309) x	0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x	1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =			3921.95	(376)
Energy associated with space cooling	(315) x	3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x	3.07	=	738.35	(378)
Energy associated with electricity for lighting	(332))) x	3.07	=	977.08	(379)
Total Primary Energy, kWh/year	sum of (376)…(382) =			5637.39	(383)

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User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.18

Property Address: 08_s_m

Address : Block JKL, Agar Grove, Camden, London, NW1 9TB

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	72.1	(1a) x	3.15	(2a) =	227.12	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	72.1	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	227.12	(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		1	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.05	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.04	(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

0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05

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) = 76.5 (23c)

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

(24a)m=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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=	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	(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	
Windows Type 1			17.6	x1/[1/(0.85)+ 0.04] =			14.47			(27)
Windows Type 2			7.9	x1/[1/(0.85)+ 0.04] =			6.49			(27)
Walls Type1	41	17.6	23.4	x	0.2	=	4.68			(29)
Walls Type2	18.9	7.9	11	x	0.2	=	2.2			(29)
Total area of elements, m²			59.9							(31)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 27.84 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 584.8 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (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 8.99 (36)

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

Total fabric heat loss (33) + (36) = 36.83 (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=	12.87	12.79	12.71	12.31	12.23	11.83	11.83	11.75	11.99	12.23	12.39	12.55	(38)

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

(39)m=	49.69	49.62	49.54	49.14	49.06	48.66	48.66	48.58	48.82	49.06	49.22	49.38	

Average = $Sum(39)_{1…12}$ /12= 49.12 (39)

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

(40)m=	0.69	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.68	0.68	0.68	0.68

Average = $Sum(40)_{1…12}$ /12= 0.68 (40)

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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 2.3 (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 88.73 (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=	97.6	94.05	90.5	86.96	83.41	79.86	79.86	83.41	86.96	90.5	94.05	97.6	
Total = Sum(44)1...12 =												1064.76	(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=	144.74	126.59	130.63	113.89	109.28	94.3	87.38	100.27	101.47	118.25	129.08	140.18	
Total = Sum(45)1...12 =												1396.07	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.71	18.99	19.59	17.08	16.39	14.14	13.11	15.04	15.22	17.74	19.36	21.03	(46)

Water storage loss:

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

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

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

Water storage loss:

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

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 110 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

If community heating see section 4.3

Volume factor from Table 2a 1.03 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 1.03 (54)

Enter (50) or (54) in (55) 1.03 (55)

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

(56)m=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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=	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	(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=	200.02	176.52	185.91	167.38	164.56	147.79	142.66	155.55	154.96	173.53	182.58	195.45	

Output from water heater (annual)$_{1...12}$ 2046.91 (64)

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

(65)m=	92.35	82.03	87.66	80.66	80.56	74.15	73.28	77.56	76.53	83.54	85.72	90.83	(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=	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	137.76	(66)

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

(67)m=	45.05	40.02	32.54	24.64	18.42	15.55	16.8	21.84	29.31	37.22	43.44	46.31	(67)

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

(68)m=	301.71	304.84	296.95	280.16	258.96	239.03	225.72	222.59	230.48	247.27	268.47	288.4	(68)

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

(69)m=	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	51.07	(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=	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	-91.84	(71)

Water heating gains (Table 5)

(72)m=	124.12	122.07	117.82	112.03	108.28	102.99	98.49	104.25	106.3	112.29	119.05	122.08	(72)

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

(73)m=	567.88	563.93	544.31	513.82	482.64	454.56	438	445.67	463.08	493.77	527.95	553.78	(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)	
North	0.9x	0.77	x	17.6	x	10.63	x	0.5	x	0.8	=	51.88	(74)
North	0.9x	0.77	x	17.6	x	20.32	x	0.5	x	0.8	=	99.14	(74)
North	0.9x	0.77	x	17.6	x	34.53	x	0.5	x	0.8	=	168.46	(74)
North	0.9x	0.77	x	17.6	x	55.46	x	0.5	x	0.8	=	270.6	(74)
North	0.9x	0.77	x	17.6	x	74.72	x	0.5	x	0.8	=	364.52	(74)
North	0.9x	0.77	x	17.6	x	79.99	x	0.5	x	0.8	=	390.23	(74)
North	0.9x	0.77	x	17.6	x	74.68	x	0.5	x	0.8	=	364.33	(74)
North	0.9x	0.77	x	17.6	x	59.25	x	0.5	x	0.8	=	289.05	(74)

North	0.9x	0.77	x	17.6	x	41.52	x	0.5	x	0.8	=	202.55	(74)
North	0.9x	0.77	x	17.6	x	24.19	x	0.5	x	0.8	=	118.01	(74)
North	0.9x	0.77	x	17.6	x	13.12	x	0.5	x	0.8	=	64	(74)
North	0.9x	0.77	x	17.6	x	8.86	x	0.5	x	0.8	=	43.25	(74)
East	0.9x	0.77	x	7.9	x	19.64	x	0.5	x	0.8	=	43.01	(76)
East	0.9x	0.77	x	7.9	x	38.42	x	0.5	x	0.8	=	84.14	(76)
East	0.9x	0.77	x	7.9	x	63.27	x	0.5	x	0.8	=	138.56	(76)
East	0.9x	0.77	x	7.9	x	92.28	x	0.5	x	0.8	=	202.08	(76)
East	0.9x	0.77	x	7.9	x	113.09	x	0.5	x	0.8	=	247.66	(76)
East	0.9x	0.77	x	7.9	x	115.77	x	0.5	x	0.8	=	253.52	(76)
East	0.9x	0.77	x	7.9	x	110.22	x	0.5	x	0.8	=	241.36	(76)
East	0.9x	0.77	x	7.9	x	94.68	x	0.5	x	0.8	=	207.33	(76)
East	0.9x	0.77	x	7.9	x	73.59	x	0.5	x	0.8	=	161.15	(76)
East	0.9x	0.77	x	7.9	x	45.59	x	0.5	x	0.8	=	99.83	(76)
East	0.9x	0.77	x	7.9	x	24.49	x	0.5	x	0.8	=	53.63	(76)
East	0.9x	0.77	x	7.9	x	16.15	x	0.5	x	0.8	=	35.37	(76)

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

(83)m=	94.89	183.28	307.02	472.68	612.18	643.75	605.69	496.38	363.7	217.85	117.63	78.62	(83)

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

(84)m=	662.77	747.2	851.33	986.5	1094.82	1098.31	1043.69	942.04	826.78	711.62	645.58	632.4	(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=	0.87	0.81	0.72	0.56	0.41	0.28	0.2	0.24	0.4	0.64	0.81	0.88	(86)

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

(87)m=	20.24	20.43	20.68	20.88	20.97	20.99	21	21	20.98	20.84	20.52	20.19	(87)

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

(88)m=	20.35	20.35	20.35	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.36	20.35	(88)

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

(89)m=	0.85	0.8	0.7	0.54	0.38	0.25	0.18	0.2	0.36	0.61	0.79	0.87	(89)

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

(90)m=	19.35	19.61	19.95	20.22	20.32	20.36	20.36	20.36	20.34	20.17	19.74	19.28	(90)

fLA = Living area ÷ (4) = 0.4 (91)

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

(92)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(92)

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

(93)m=	19.71	19.94	20.24	20.48	20.58	20.61	20.62	20.62	20.6	20.44	20.06	19.65	(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

SAP WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

(94)m=	0.84	0.79	0.69	0.54	0.39	0.27	0.19	0.22	0.38	0.62	0.78	0.85	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	556.34	587.58	588.84	535.55	427.2	291.1	195.22	204.38	311.68	439.25	505.48	540.24	(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=	765.67	746.33	680.62	569.25	435.82	292.62	195.52	204.9	317.2	482.91	637.76	762.66	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	155.74	106.68	68.28	24.27	6.42	0	0	0	0	32.49	95.24	165.48

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 654.6 (98)

Space heating requirement in kWh/m²/year 9.08 (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 heat pump 1 (303a)

Fraction of total space heat from Community heat pump (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 654.6

Space heat from Community heat pump (98) x (304a) x (305) x (306) = 687.33 (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 2046.91

If DHW from community scheme:

Water heat from Community heat pump (64) x (303a) x (305) x (306) = 2149.26 (310a)

Electricity used for heat distribution 0.01 × [(307a)…(307e) + (310a)…(310e)] = 28.37 (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 240.51 (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) = 240.51 (331)

SAP WorkSheet: New dwelling design stage

Energy for lighting (calculated in Appendix L)				318.27	(332)
Electricity generated by PVs (Appendix M) (negative quantity)				-331.63	(333)
Electricity generated by wind turbine (Appendix M) (negative quantity)				0	(334)

10b. Fuel costs – Community heating scheme

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating from CHP	(307a) x	4.24	x 0.01 =	29.14	(340a)
Water heating from CHP	(310a) x	4.24	x 0.01 =	91.13	(342a)
		Fuel Price			
Pumps and fans	(331)	13.19	x 0.01 =	31.72	(349)
Energy for lighting	(332)	13.19	x 0.01 =	41.98	(350)
Additional standing charges (Table 12)				120	(351)
Energy saving/generation technologies Item 1		13.19	x 0.01 =	-43.74	(352)
Total energy cost	= (340a)…(342e) + (345)…(354) =			270.23	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.42	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.97	(357)
SAP rating (section12)		86.48	(358)

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				219	(367a)
CO2 associated with heat source 1		[(307b)+(310b)] x 100 ÷ (367b) x	0.52	=	672.23	(367)
Electrical energy for heat distribution		[(313) x	0.52	=	14.72	(372)
Total CO2 associated with community systems		(363)…(366) + (368)...(372)		=	686.95	(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) =			686.95	(376)
CO2 associated with electricity for pumps and fans within dwelling		(331)) x	0.52	=	124.82	(378)
CO2 associated with electricity for lighting		(332))) x	0.52	=	165.18	(379)
Energy saving/generation technologies (333) to (334) as applicable Item 1			0.52	x 0.01 =	-172.12	(380)
Total CO2, kg/year	sum of (376)…(382) =				804.84	(383)
Dwelling CO2 Emission Rate	(383) ÷ (4) =				11.16	(384)
EI rating (section 14)					90.79	(385)

13b. Primary Energy – Community heating scheme

		Energy kWh/year	Primary factor		P.Energy kWh/year	
Energy 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				219	(367a)
Energy associated with heat source 1	[(307b)+(310b)] x 100 ÷ (367b) x		3.07	=	3976.41	(367)
Electrical energy for heat distribution	[(313) x			=	87.08	(372)
Total Energy associated with community systems	(363)…(366) + (368)...(372)			=	4063.49	(373)
if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)					4063.49	(373)
Energy associated with space heating (secondary)	(309) x		0	=	0	(374)
Energy associated with water from immersion heater or instantaneous heater	(312) x		1.22	=	0	(375)
Total Energy associated with space and water heating	(373) + (374) + (375) =				4063.49	(376)
Energy associated with space cooling	(315) x		3.07	=	0	(377)
Energy associated with electricity for pumps and fans within dwelling	(331)) x		3.07	=	738.35	(378)
Energy associated with electricity for lighting	(332))) x		3.07	=	977.08	(379)
Energy saving/generation technologies						
Item 1		3.07	x 0.01 =		-1018.1	(380)
Total Primary Energy, kWh/year	sum of (376)…(382) =				4760.82	(383)

9.0 APPENDIX 2 – OVERHEATING REPORT

MAX FORDHAM

Agar Grove Estate Redevelopment

Summer Comfort & TM59 Assessment

Report

16th July 2019

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ISSUE HISTORY

Issue	Date	Description
00	14/07/2019	Draft V3
01	16/07/2019	Draft V4
02	16/07/2019	Draft V5

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer (Initials)	Role
SW	TM59 Assessment
GS	Engineer

CONTENTS

1 Executive Summary

Summer comfort is important in all occupied buildings, and with climate catastrophe leading to increasing temperatures, is critical to the long-term success of buildings. As a reference for Agar, a recent study found London's predicted 2050 climate is comparable to Barcelona's current climate (Bastin, 2019). As with any design that depends on human operation, and is influenced by behaviour outside the client and design team's control, there are risks, and ways to mitigate these risks. This report details design work carried out, with actions for the client and design team.

The design standards for residential summer comfort have advanced since the original design of Agar for planning, including the publication of CIBSE TM59 "Design methodology for the assessment of overheating risk in homes" in 2017 (referred to as TM59 from this point on). This has two criteria – daytime comfort for all rooms, and night-time comfort for bedrooms.

The summer comfort strategy for both buildings uses a combination of natural ventilation from opening windows and mechanical ventilation. This depends on assumptions, including how open windows are, how often they are opened, and how much heat is generated inside the building (from cooking, appliances etc.). It is particularly sensitive to window operation as a way of rejecting heat from the building, and providing passive cooling. This operation depends on the building occupants, but is also influenced by the design of the windows: how easy they are to operate, internal space planning etc.

TM59 Modelling has been carried out based on 10 apartments, which have been selected to represent the most onerous examples, including apartments higher up the buildings with more exposure to solar gains, and ground floor apartments with limited openings for security. This modelling has been carried out for current weather data (2020), and future weather data (2050). TM59 uses relatively high internal gains but also assumes windows are open a lot of the time when people are in, which is potentially optimistic. For example, windows are assumed to be open whenever a room is warmer than 22°C, and bedrooms are assumed occupied 24/7.

To achieve summer comfort for 2020 weather data the following are required – without them, there is a significant risk of overheating:

Block I summer comfort requirements
Windows able to open wide day or night, 100% area of typical window to be openable: • **Ground floor: 15° wide.** • **First floor and above: windows: 45° wide** • **First floor and above: balconies: 45° wide**

Block JKL summer comfort requirements
Windows able to open wide day or night, 60% area of typical window to be openable: • **Ground floor: 15° wide.** • **First floor and above: 45° wide** **External solar shading to 5th floor apartments**

ACTION 1
Design team and client to review and comment on Summer Comfort Requirements (tables above)

Assuming these requirements are met, the same tests have been run with predicted 2050 weather, and in this case both buildings fail both TM59 criteria. Solar heating is a significant contributor to overheating. Certain glazing, such as on Block JKL, goes to floor level with the lowest panes non-openable. These lowest panes add solar gains but relatively little to overall daylighting and do not aid natural ventilation, so we suggest omitting these. Please see section 8.2.1 for more detail.

ACTION 2
Architects to review options to omit fixed low level glazing

There are other aspects of the design that can help mitigate the risk of overheating, including:

Potential changes and design development for the current designs
Add blinds / shades / louvres
Ensure the internal space planning allows for opening of windows
Design windows so that they can be securely held open
Ensure windows are usable i.e. detailed so they are not too heavy to operate

Potential retrofit options
Providing solar control film to reduce solar gains
Including underfloor cooling: could be accommodated/retrofitted with some changes to the Dimplex Zeroth system
Adding cooling to the mechanical ventilation system: could be accommodated with some changes to the Dimplex Zeroth system and in-apartment ductwork
Fitting external shading / louvres to limit solar gains: window reveals could be designed to incorporate this
Ceiling fans

ACTION 3
Design team to review and comment on feasibility of incorporating above options in current design

2 Introduction

This report details the process and results of a CIBSE TM59 overheating study for Blocks I and JKL of the Agar Grove Development, Phase 1C. Agar Grove is a major development of circa 500 homes for the London Borough of Camden. Current and future weather data was used to understand the current level of overheating risk as well as potential future risks due to a changing climate. The process was iterative, testing various options to find the most suitable as well as to understand what measures may need to be taken to future proof the building against potential future climate scenarios.

It is important to note, although final results indicate rooms passing with the 2020 weather file, this is predicated on assumptions and values adjusted during iterations. Therefore it is important to read these assumptions to understand their feasibility or to consider some alternative measures which could be adopted.

	Assumptions	Value	Comments
Both Buildings	Year 2050 - Mechanical Cooling required	50W/m2	Cooling is applied. Hence, in this case there would need to be a retrofit of a mechanical cooling system in the future. Previous iterations tried lower cooling values (20, 30 and 40W/m2). Although some rooms passed at these lower values, 50W/m2 was required for all rooms to pass
	Ground floor glazing opening fraction	15%	Due to security – have contacted Camden Council for clarification on this and still awaiting a response
	U-Value - Glazing	0.85W/m2.K	Total, including frames
	U-Value - External Walls	0.2W/m2.K	
	U-Value - External Floors	0.2W/m2.K	
	U-Value - Roof	0.1W/m2.K	
	Infiltration	0.5ach	air changes per hour
	Stage D drawing Plans		
Block I	Typical glazing opening fraction	50%	# excludes ground floor
	Metal rail ballustrades		# as opposed to glass etc which would limit air flow
Block JKL	Typical glazing opening fraction	35%	# excludes ground floor
	Balcony glazing opening fraction	50%	
	5th floor shading		# 5th floor only passes with addition of shading

Figure 1: Table of Assumptions

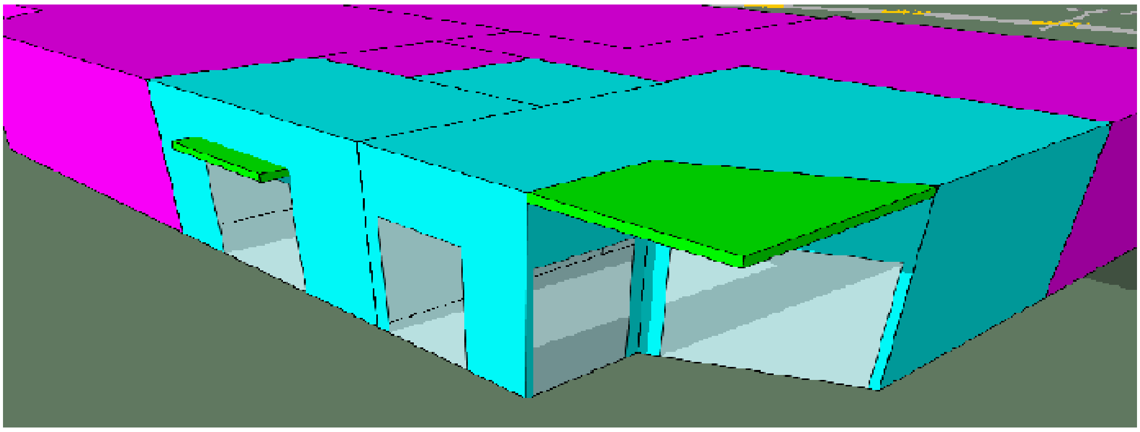


Figure 2: Block JKL 5th Floor Shading. 400mm deep shade required for bedroom, and shade to cover balcony on living/kitchen room corner

3 Legislation and Guidance

According to the Camden Borough's *Energy Efficiency and Adaptation, "Natural light makes buildings more attractive, pleasant and energy efficient. Building layouts should be designed to maximise sunlight and daylight while taking into account other factors such as overheating and privacy."* Hence the design process needs to strike the balance between beneficial solar gains (such as in colder seasons) and good daylighting versus the risk of overheating in summer.

3.1 Part L1A: limiting the effects of heat gains in summer.

It must be demonstrated by calculation that a minimum standard is met in terms of limiting overheating.

3.2 The London Plan

The Mayor of London has a legal duty to set out policies and proposals in this strategy for adapting to climate change and a duty to take action on climate change. The London Plan sets out risks associated with climate change as well as practical steps to mitigate this.

3.2.1 Chapter 5 – London's Response to Climate Change, Section 5.8 (2016)

"For development proposals the ***early design stage is the most cost effective time*** *to incorporate relevant design and technological measures, enabling proposals to realise their full potential to reduce carbon dioxide emissions and adapt to climate change. Responding to climate change has to be an integral and essential part of the development process and not a set of 'bolt-ons' ".*

3.2.2 Policy 8.4.3 Minimise the risk of new development overheating

"Developers will be required to ***follow the cooling hierarchy*** (see below) *to reduce the risk of developments* ***overheating*** *and reduce the impact on the UHI effect through avoiding mechanical cooling where possible and promoting passive cooling measures. Where mechanical cooling is proposed, developers will need to consider the use of low global warming potential refrigerants to reduce harmful emissions."*

3.2.3 Policy 5.9 Overheating and Cooling

Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following **cooling hierarchy**:

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

3.2.4 Climate Change Adaptation Section 5.47

*The GLA is developing with the Chartered Institute of Building Services Engineers (CIBSE) guidance for developers to address the risk of overheating in buildings……****The Mayor encourages the use of this guidance in the preparation of development proposals.*** Refer to Section 3.3.1.

3.3 New draft London Plan (2018)

3.3.1 9.2.10

As a minimum, energy strategies should contain the following information:

f. The results of dynamic overheating modelling which should be undertaken in line with relevant Chartered Institution of Building Services Engineers (CIBSE) guidance, along with any mitigating actions (see Policy SI4 Managing heat risk).

3.3.2 Policy SI4 Managing heat risk

9.4.3 Many aspects of building design can lead to increases in overheating risk, including high proportions of glazing and an increase in the air tightness of buildings. Single aspect dwellings are more difficult to ventilate naturally and are more likely to overheat, and should normally be avoided in line with Policy D4 Housing quality and standards. There are a number of low-energy-intensive measures that can mitigate overheating risk. These include solar shading, building orientation and solar-controlled glazing.

*9.45 The Chartered Institution of Building Services Engineers (CIBSE) has produced guidance on assessing and mitigating overheating risk in new developments…**TM 59 should be used for domestic developments** and TM 52 should be used for non-domestic developments. In addition, TM 49 guidance and datasets should also be used to ensure that all new development is designed for **the climate it will experience over its design life.***

3.4 The Camden Local Plan 2017

3.4.1 Policy CC2 Adapting to Climate Change

This requires developments to be resilient to climate change. All development should adopt appropriate climate change adaptation measures such as:

d). measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Any development involving 5 or more residential units or 500 sqm or more of any additional floor space is required to demonstrate the above in a Sustainability Statement.

4 About the buildings

4.1 General

- Mae are the architects for Block I
- Hawkins Brown Associates are the architects for Block JKL

Both buildings follow a general north south axis and hence a large proportion of the glazing is on the east and west facades. This is generally difficult to shade effectively against summer sun. Block I has stepped in windows with columns and balconies whereas JKL has a mixture of balconies and 'winter gardens' which are within the thermal envelope.

4.2 Cooling Strategy

Both buildings are being designed to *Passivhaus* standards. The strategy is for high levels of insulation to avoid heat loss or gain via the external façade. In addition a mechanical ventilation system with heat recovery is proposed (MVHR). This will rely on relatively low flow rates of air which helps bring down energy usage associated with fans as well as a high heat recovery rate. The MVHR will have a summer bypass for the heat exchanger, allowing fresh air to be brought in not tempered when it will help cool the building in summer. During peak summertime temperatures, the system will operate as 'mixed mode' allowing the occupant to open windows as well as receive fresh air from the mechanical ventilation system.

In the modelling we accounted for both the fresh air from openable windows in addition to the mechanical ventilation rates assigned to each space. No mechanical cooling is proposed, instead relying on passive cooling aligning with the London Plan Cooling Hierarchy.

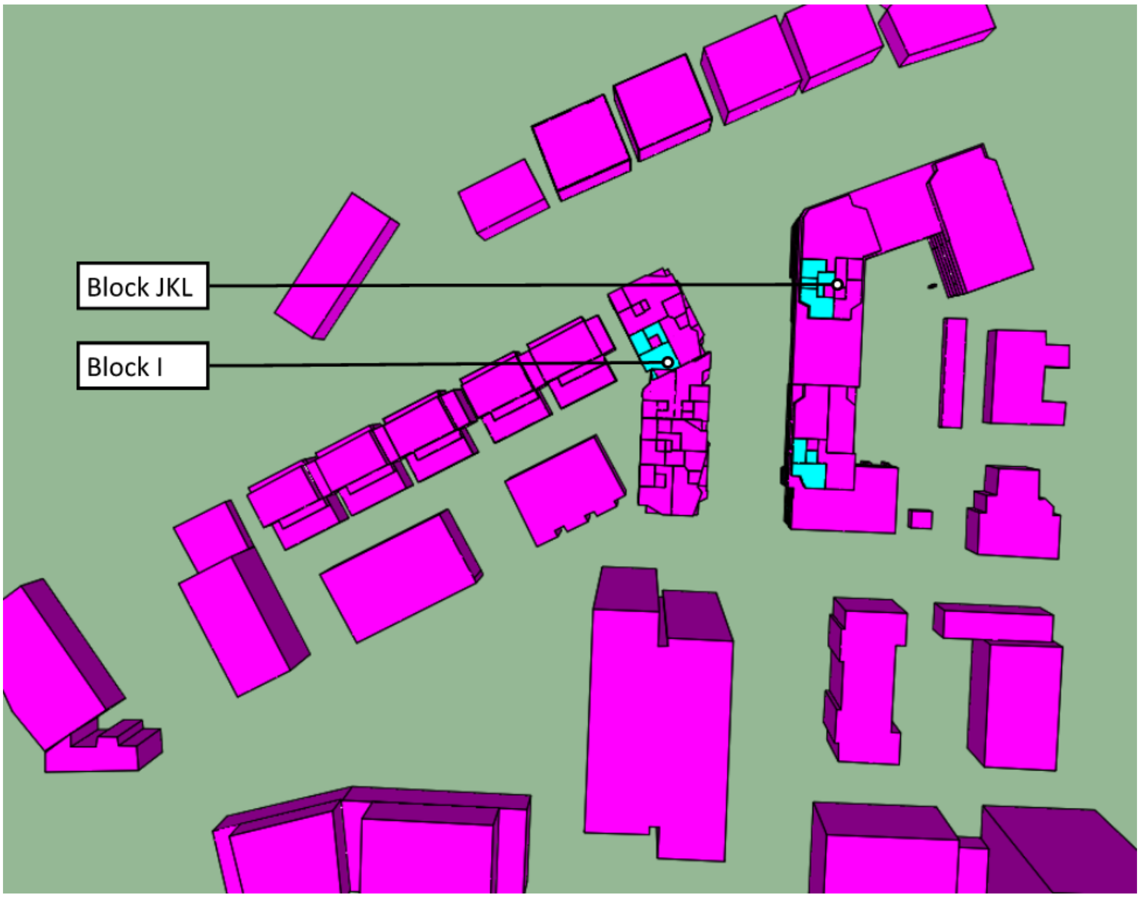


Figure 3: 3D Model from above

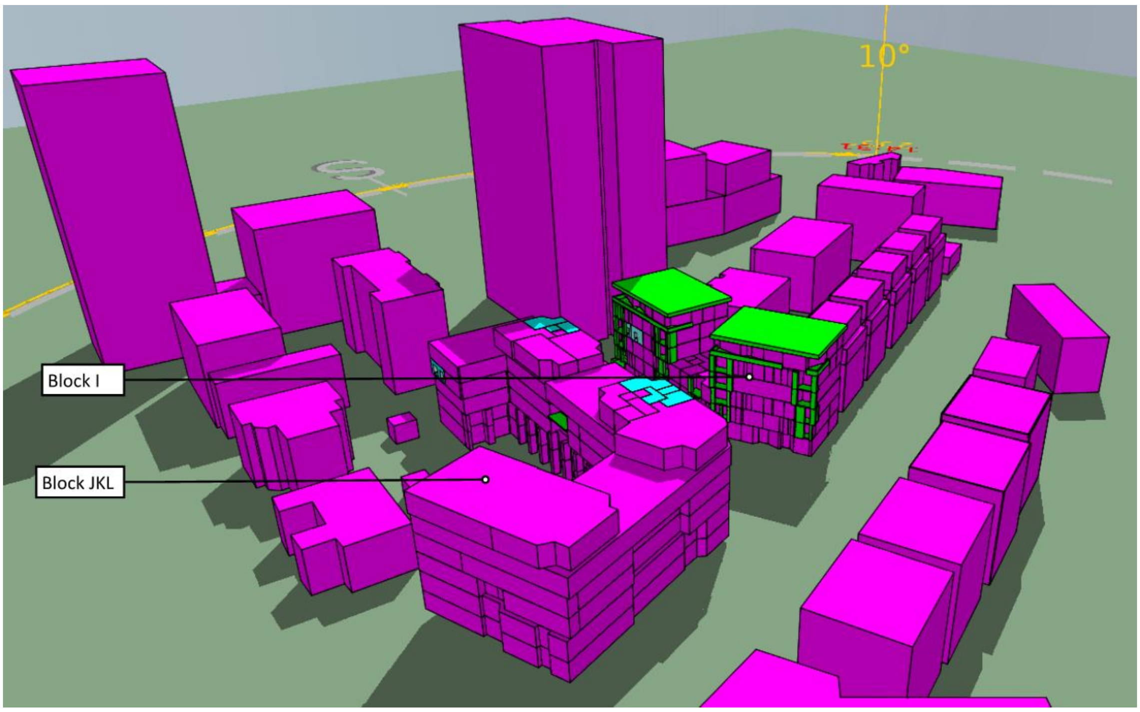


Figure 4: 3D Model showing adjacent buildings

5 Methodology

5.1 Selecting Sample Rooms:

Block I: 12 rooms modelled plus 5 integral corridors.

Block JKL: 13 rooms modelled plus 5 integral corridors.

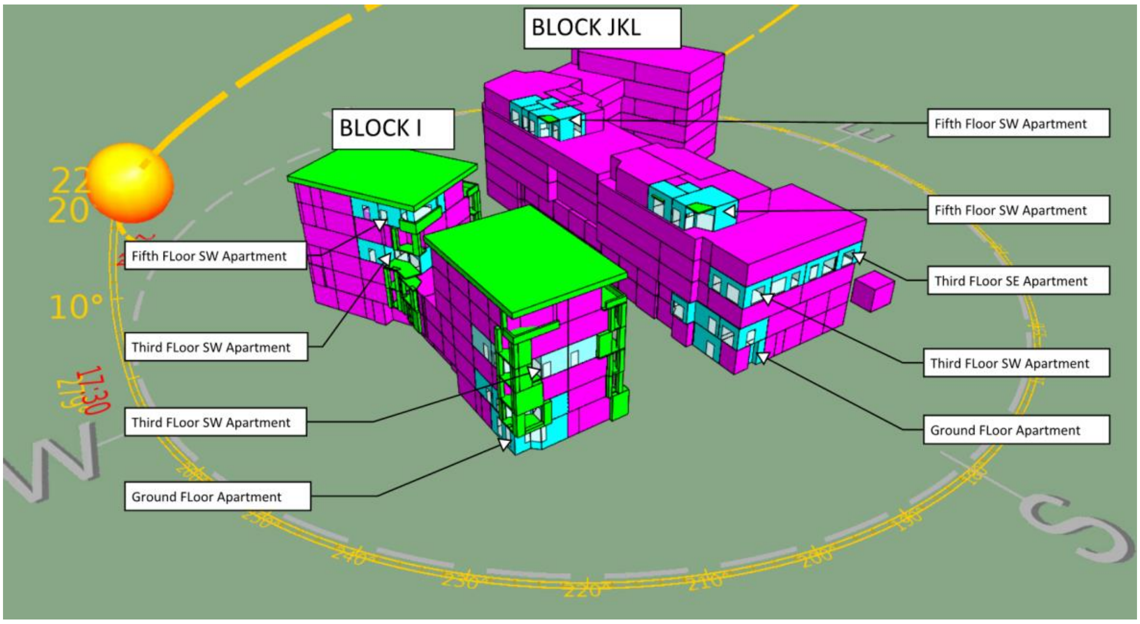


Figure 5: 3D IES Model

Refer to Modelled Spaces in the Appendix for plan drawings showing all selected rooms.

5.2 Why were these rooms chosen?

- Solar Gains - The relative position of the sun is a major factor in the heat gain of buildings. The rooms chosen were typically those deemed to have high solar gains. In particular, those with south and west glazing which will experience long afternoon exposure to the sun's rays in combination with the heat already gained throughout the day from both solar and internal gains. As the buildings are surrounded by other high rise blocks, the top floors were expected to get the least overshadow from these adjacent buildings. Hence South-Westerly apartments on the top floors were modelled.
- Security – As the strategy includes natural ventilation via openable windows, the lower floors were assumed to need security measures which will restrict how much the windows can be opened. Hence ground floor apartments were modelled.
- Asymmetry – As the top floor levels were not the exact layout as lower floors, some typical mid-level (3rd floor) apartments were modelled.
- Single sided ventilation – Where there was no possibility for cross flow from openings on adjacent facades there was a greater risk of insufficient fresh air flow rates to expel heat gains

5.3 TM59 Design Methodology

CIBSE TM59 Design Methodology for the assessment of overheating risk in homes is a standard approach using dynamic thermal analysis and the guiding framework of the calculations and this report.

TM59 gives two criteria, both of which must be met for the space to have passed. In addition corridors should be analysed if there is a deemed risk. Refer to TM59 for full definitions but a basic summary is:

5.3.1 Criteria (a) – living rooms, kitchens and bedrooms.

Primarily focused on the need to ensure the internal temperature does not exceed the adaptive temperature for more than 3% of occupied hours. The adaptive temperature is dependent on the external temperature as it is deemed that occupant's subjective feeling of comfort inside a building is based on external temperatures and humidity levels. For example, if the external temperature is high, say 28°C, then occupants will be satisfied with a higher internal temperature than if the external temperature was 21 .°C.

5.3.2 Criteria (B) – bedrooms only.

People tend to prefer cooler temperatures for sleeping, and so there is an additional standard for bedrooms during the typical sleeping hours (10pm to 7am) by ensuring the temperature does not exceed 26C for more than 1% of annual hours.

5.3.3 Corridors – Temperature should not exceed 28C for more than 3% of the total annual hours.

Unlike (a) and (b) this is not mandatory, but should be highlighted as a risk if a corridor does fail.

5.4 Weather Data

Two weather files were used. Both are design summer year (DSY1) datasets. The DSY1 data used represents a moderately warm summer year. It is used to evaluate overheating risk within buildings with a set of years which better describe overheating events, their relative severity and their expected frequency. It should be noted there is DSY 2 (short intense warm spells) and DSY 3 (long, less intense warm spell) weather data which were not used in this modelling.

- For current analysis: London_LWC_DSY1_2020High50.epw
- For adaptation for future climate, a year 2050 dataset was used: London_LWC_DSY1_2050High50.epw

5.5 Modelling Software

IES VE 2018 modelling software was used to build a 3D model, applying all data such as internal gains (as dictated by TM59) and applying the correct weather files, fabric values, glazing opening fractions, solar 'g' values and dimensions.

6 Results

6.1 Block I

6.1.1 2020 Weather File

All rooms pass both Criteria (a) and (b).

All integral corridors pass.

BLOCK I	CRITERIA (a)		CRITERIA (b)		Overall RESULTS	Integral corridors/Halls	
Threshold	Top-Tadap>= 1°C	May-Sept 24h	Top>26°C	Year 22pm - 7am		Top>28C	
	>3%		>1%			>3%	
Room Name	%	FAIL/PASS	%	FAIL/PASS/NA	FAIL/PASS		PASS/CAUTION
I.5.Apt.MW.Living/Kitchen	1.8%	PASS	-	N/A	PASS	-	-
I.5.Apt.MW.Corridor	-	-	-	-	-	1.2%	PASS
I.5.Apt.MW.Bedroom	1.0%	PASS	0.7%	PASS	PASS	-	-
I.3.Apt.Living.SW	2.0%	PASS	-	N/A	PASS	-	-
I.3.Apt.Bedroom.SW	0.9%	PASS	0.8%	PASS	PASS	-	-
I.3.Apt.Corridor.SW	-	-	-	-	-	1.1%	PASS
I.3.Apt.Living.SE	1.8%	PASS	-	N/A	PASS	-	-
I.1.Bedroom1.SW	0.8%	PASS	0.4%	PASS	PASS	-	-
I.1.Corridor.SW	-	-	-	-	-	0.7%	PASS
I.1.Bedroom2.SW	0.7%	PASS	0.7%	PASS	PASS	-	-
I.GF.Living/Kitchen.SW	1.6%	PASS	-	N/A	PASS	-	-
I.3.Apt.Bedroom.MW	0.8%	PASS	0.9%	PASS	PASS	-	-
I.3.Apt.Corridor.MW	-	-	-	-	-	1.3%	PASS
I.3.Apt.Corridor.SE	-	-	-	-	-	1.0%	PASS
I.3.Apt.Bedroom1.SE	0.8%	PASS	0.8%	PASS	PASS	-	-
I.3.Apt.Living.MW	2.0%	PASS	-	N/A	PASS	-	-
I.GF.Living/Kitchen.SW	1.6%	PASS	-	N/A	PASS	-	-

Figure 6: Block I Table of Results

6.1.2 2050 Weather File

All rooms fail both criteria with the 2050 future weather file for passive cooling.

Next, active cooling was applied at 50W/m2 of floor area. All rooms then passed both Criteria (a) and Criteria (b).

The need for active (mechanical) cooling is not unsurprising for a future climate scenario of 2050. Once the external temperatures reach a certain threshold and maintain these high levels over longer periods of time, it is difficult to maintain a lower internal temperature. Options for this are discussed in section 8

6.2 Block JKL

6.2.1 2020 Weather File

All rooms pass both Criteria (a) and (b).

One integral corridor failed. As the corridors are not a mandatory part of passing, this report simply highlights this as a risk to consider. The model reflects the layouts of the time which included heat losses from a Dimplex Xeroth space heating and DHW unit along with associated pipework losses. To mitigate overheating risks where these are located, options include adding extract vents from the cupboard and/or insulating the cupboard.

BLOCK JKL	CRITERIA (a)		CRITERIA (b)		Overall RESULTS	Integral corridors/Halls	
Threshold	op-Tadap>= 1°	May-Sept 24h	Top>26°C	Year 22pm - 7am		Top>28C	
	>3%		>1%			>3%	
Room Name	%	FAIL/PASS	%	FAIL/PASS/NA	FAIL/PASS		PASS/CAUTION
JKL.5.Core C. West Bedroom	2.4%	PASS	0.4%	PASS	PASS	-	-
JKL.5.Core C. West Corridor	-	-	-	-	-	4.5%	CAUTION
JKL.GF.Core A.Corridor.SW	-	-	-	-	-	1.2%	PASS
JKL.GF.Core A.Living.SW	2.4%	PASS	-	N/A	PASS	-	-
JKL.1.Core A.Double Bed 1.SW	0.8%	PASS	0.4%	PASS	PASS	-	-
JKL.1.Core A.Corridor.SW	-	-	-	-	-	0.9%	PASS
JKL.1.Core A.Single Bed.SW	0.8%	PASS	0.7%	PASS	PASS	-	-
JKL.1.Core A.Double Bed 2.SW	0.8%	PASS	0.6%	PASS	PASS	-	-
JKL.3.SW Living/Kitchen	2.3%	PASS	-	N/A	PASS	-	-
JKL.3.Core C. SW Corridor	-	-	-	-	-	1.1%	PASS
JKL.3.Core C. SE Corridor	-	-	-	-	-	1.0%	PASS
JKL.3.Core C. SW Bedroom	1.0%	PASS	0.4%	PASS	PASS	-	-
JKL.3.Core C. SE Bedroom	1.1%	PASS	0.4%	PASS	PASS	-	-
JKL.3.Core C. SE Living/Kitchen	2.2%	PASS	-	N/A	PASS	-	-
JKL.5.Core C. West Living/Kitchen	2.5%	PASS	-	N/A	PASS	-	-
JKL.5.Core B. Main block West 2nd Bedroom	1.5%	PASS	0.6%	PASS	PASS	-	-
JKL.5.Core B. Main block West1st Bedroom	2.0%	PASS	0.7%	PASS	PASS	-	-
JKL.5.Core B. Main block West Corridor	-	-	-	-	-	1.6%	PASS
JKL.5.Core B. Main block West Living/Kitchen	2.9%	PASS	-	N/A	PASS	-	-

Figure 7: Block JKL Table of Results

6.2.2 2050 Weather File

All rooms fail both criteria with the 2050 future weather file for passive cooling. Refer to 6.1 for more details.

6.3 Absent neighbour

Where a neighbour is away and therefore not opening their windows, there is a chance the overheating neighbouring apartment could cause overheating in the occupied apartment.

For both Block I and Block JKL modelling was carried out where 3rd floor south-east apartments were set as unoccupied to determine the added overheating risk to the 3rd floor south-west apartments.

Room	Criteria (a)			Criteria (b)		
	Standard Results	w/ absent neighbour	Difference %	Standard Results	w/ absent neighbour	Difference %
I.3.Apt.Living.SW	2.0%	2.0%	0.0%		-	
I.3.Apt.Bedroom.SW	0.9%	0.9%	0.0%	0.8%	0.7%	-0.1%
JKL.3.SW Living/Kitchen	2.3%	2.5%	0.2%		-	
JKL.3.Core C. SW Bedroom	1.0%	1.1%	0.1%	0.4%	0.5%	0.1%

Figure 8: Absent Neighbour, Table of Results

The results show that an absent neighbour does add to the overheating risk. However in this scenario the increase was relatively small. It should be noted there are other scenarios where the affect may be larger, such as if a neighbour on the floor below is absent - larger ceiling/floor area between apartments means more heat transfer, typically two to three times as much, or if two neighbours are absent at the same time – summer holidays.

7 How we reached compliance

7.1 Variables tried

- ‘g’ values (decreasing limits the amount of solar radiation that can pass through glazing)
- Sill height
- Opening Fraction
- Shading
- Assuming occupant will close window if external temperature greater than 28C
- Redesign of rooms

7.2 Block I

In previous iterations, Block I was passing criteria (a) but some rooms failing (b) for the 2020 weather data.

Steps taken:

1. Changed ‘g’ value from 0.5 to 0.4 (keeping 30% free area glazing) - Bedrooms still fail.

2. Changed the assumed typical free area from 30 to 50% (after discussion with the architects, Mae) - All bedrooms in Block I then pass.

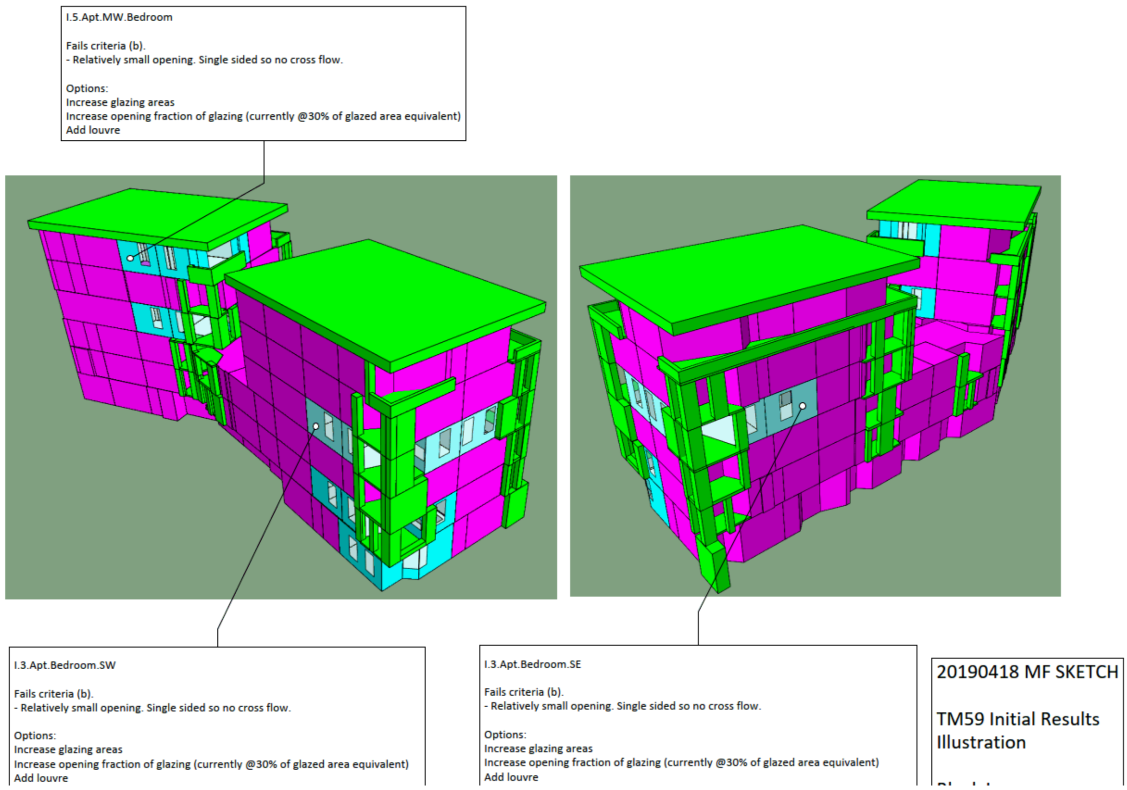


Figure 9: Block I Previous failing rooms

7.3 Block JKL

In previous iterations Block JKL had issues with the following:

- Ground floor: The small kitchen had high internal gains and limited openings due to the security issue.

Steps taken: Architect's updated layouts and relocated kitchen from the ground floor to the first. This resolved the issue of limited openings and the rooms then passed both criteria.

- Single sided bedrooms failing criteria (b) – night time.

Steps taken: Increased opening fraction of glazing from 30% to 35%. Rooms then passed.

- 5th floor living/kitchen failing due to being highly glazed and south west facing.

Steps taken:

1. Changed typical glazing free area from 35 to 50%:- still failing criteria (a) – day-time comfort.
2. Reduced 'g' value from 0.5 to 0.35 - still failing. Did not try reducing further than 0.35 due to the negative effects of lower annual solar gains and daylighting levels.
3. Raised sill height and in doing so decreased window area - Results: Still failing, minimal improvement (probable the reduced solar gains are offset by reduced fresh air rates). It is important to note this is different from removing the bottom pane when the bottom pane is non-opening anyway. In that case, the opening fraction will stay the same but reduce the solar gain, which is desirable.
4. Added shading. For the living/kitchen spaces achieved by adding a shade over the 'cut corner' area. For the bedroom, a 400mm deep shade directly over the windows. - Results: Rooms now pass. See Figure 10 below.

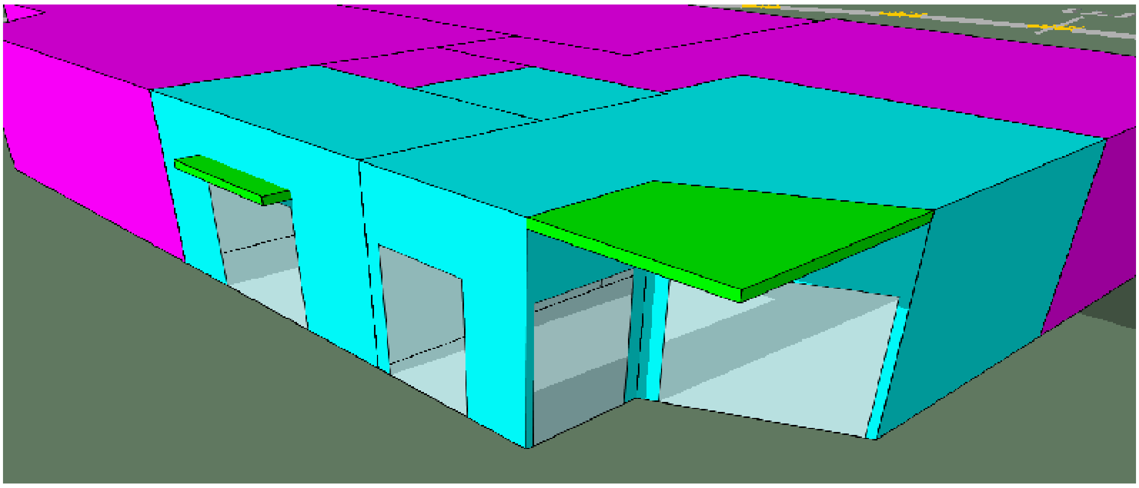


Figure 10: JKL Required Shading, 5th Floor

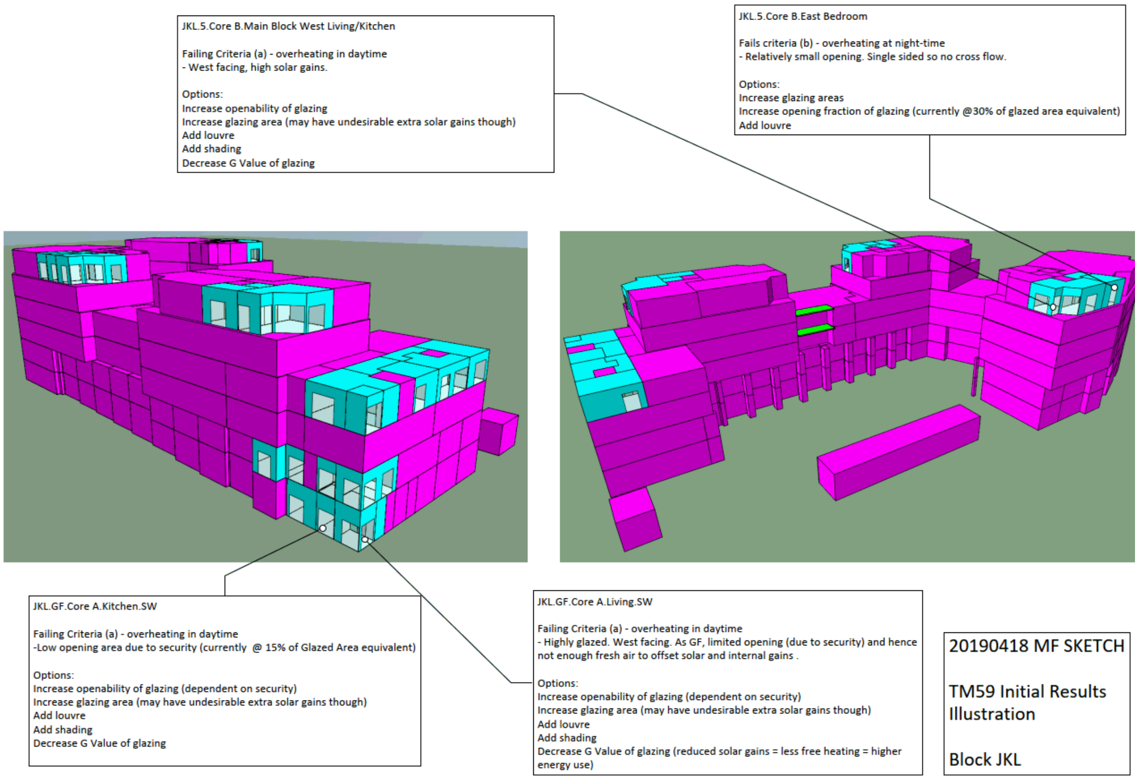


Figure 11: Block JKL Previous failing rooms

8 Recommendations

8.1 General

Camden Borough's planning guidance gives some examples to limit internal gains, which will in turn reduce overheating:

- Energy Efficient lighting
- Use smaller windows on the south elevations and larger on the north.
- Include high performance glazing

8.2 Limiting Gains

8.2.1 Solar

The lower pane is generally non-opening, meaning it contributes to solar gains but does not add to fresh air rates. In addition this lowest pane, being at floor level, only has a marginal effect on daylighting. We recommend removing this pane.

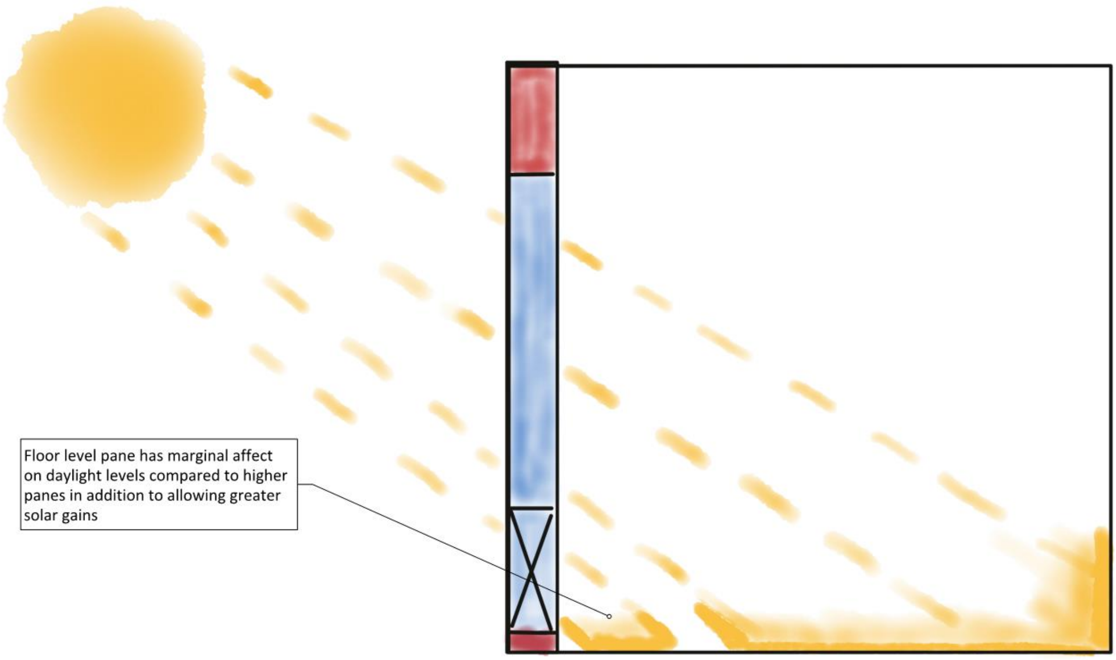


Figure 12: Illustration showing how lower pane allows little useful daylight while contributing to solar gains

8.2.2 Other gains

In this study we have focused on limiting solar gains and increasing fresh air rates to reduce the risk of overheating. Another option is to reduce internal gains. For the analysis this will not have an effect because the values used are dictated by TM59. However in reality we have the option of reducing these by good design.

Annually, solar gains only account for 30% of all gains, occupancy for 25% and 45% from equipment and lighting. The solar gains increase to 70% of all gains on a typical hot summer midday.

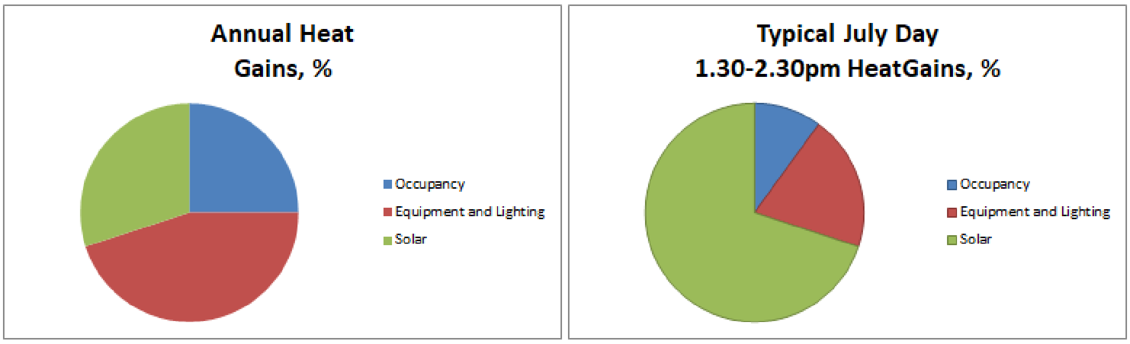


Figure 13: Annual and typical peak Heat Gains

Figure 13 above indicates it is worthwhile limiting equipment and lighting gains. For the analysis this will not have an effect because the values used are dictated by TM59. However in reality we have the option of reducing these by good design.

Generally speaking the more efficient a product the less energy is required to run it. Typically that energy is released as excess heat, contributing to heat gains. Hence by selecting energy efficient equipment, such as A++ rated fridges, induction hobs, high efficacy lighting and applying good insulation on mechanical pipework we can reduce these heat gains. Figure 14 below breaks down internal gains, showing lighting, audio-visual and cooking to be some of the biggest contributors.

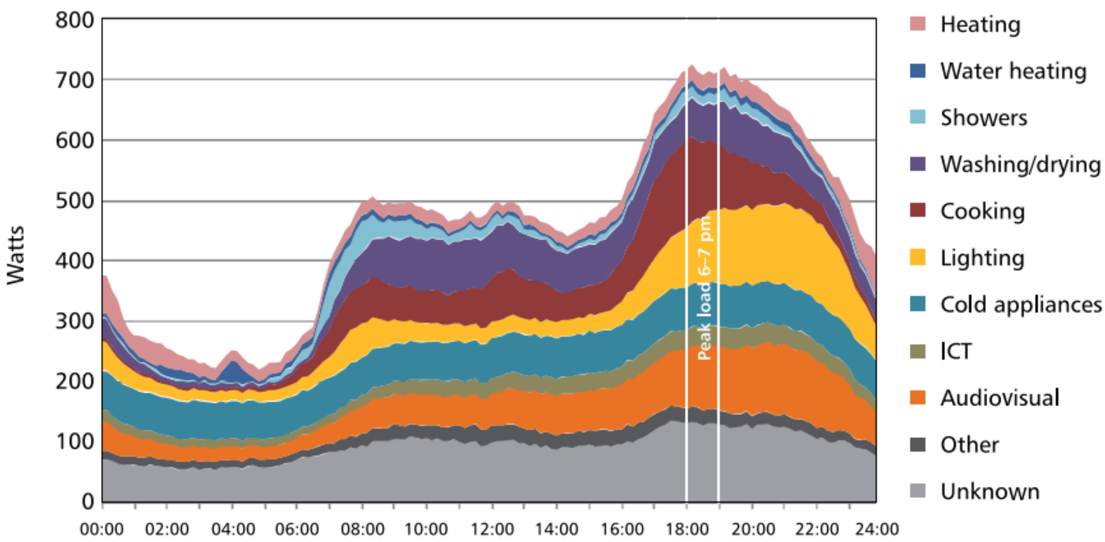


Figure 14: Average 24-hour profile for 250 homes (source: DECC, 2013)

8.3 Increasing Fresh Air

Iterations have shown that reducing solar gains helps reduce the overheating risk, but in general is not always enough, due primarily to the fact that solar gains only account for a proportion of all the gains. Reducing glazing dimensions was shown to limit solar gains but also limited the fresh air rate available which was a net negative.

The variable that drove the largest improvement was increasing the openable fraction of the glazing. This is due to rooms requiring large fresh air rates, and this is not only driven by solar gains but also by internal gains.

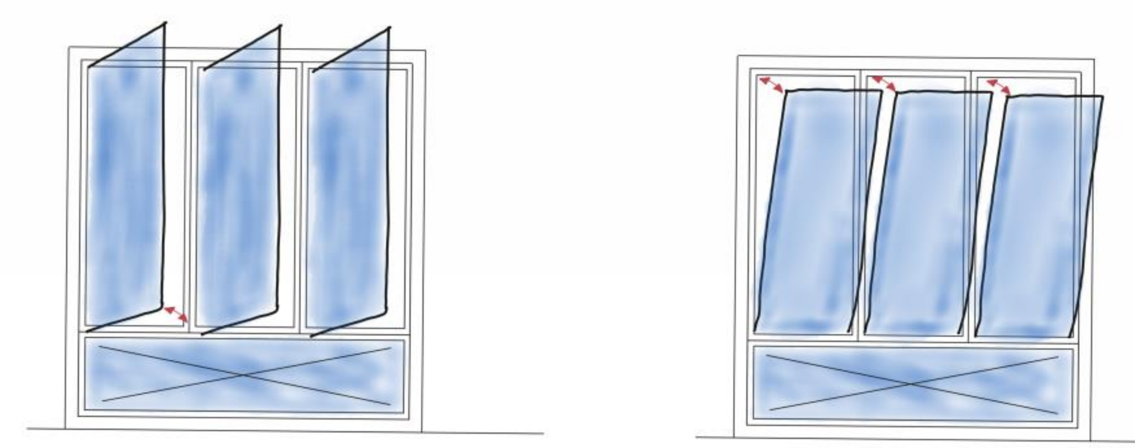


Figure 15: Side hung VS bottom hung windows – Side hung generally allow a greater opening fraction but are a greater security risk. This can be mitigated by including limiting locks which can be overridden by the occupants when security risk is low and overheating risk is high, such as a summer day when occupants are home. The best option is generally tilt and turn, allowing both options.

8.4 Glazing and Blinds

If adopting internal blinds that move with the glazing, outward opening glazing allows more heat to escape while still blocking the sun.

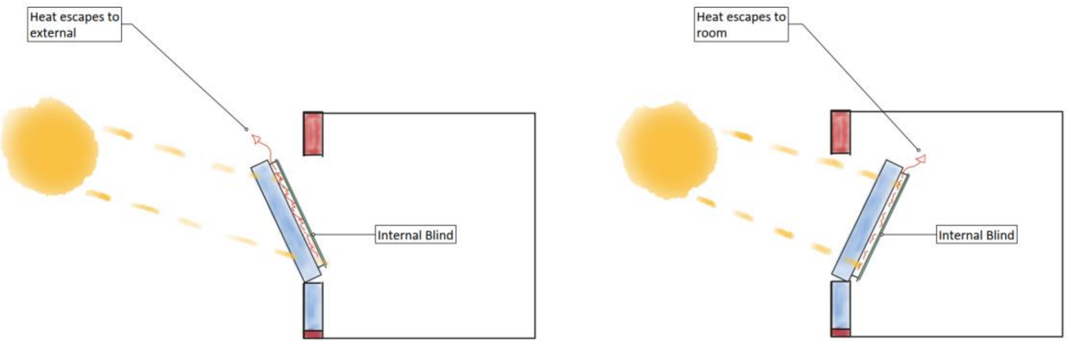


Figure 16: Integral blinds

If blinds are not integral they can restrict air flow:

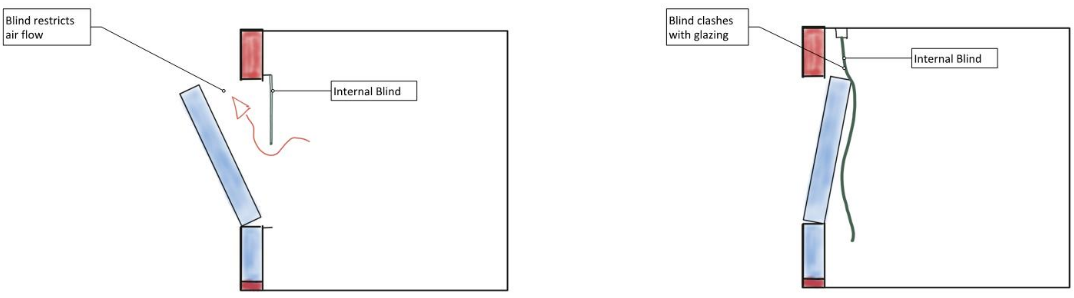


Figure 17: Blinds vs glazing

8.5 Future Climate Change adaptation

Both buildings current passive cooling design is insufficient in keeping the overheating level to within an acceptable level given the 2050 DSY future climate scenario and assumptions in the TM59 protocol. In the modelling we demonstrated that applying 50W/m2 cooling was required. There are also passive measures which, when applied in combination, may be enough to mitigate the overheating risk. Failing that, these passive measures may reduce the mechanical cooling load to below 50W/m2.

Below is a list of design features which could either be implemented now or adopted later on.

8.5.1 Current design options:

- Include external blinds
- Include internal blinds integral to glazing
- Add more external shading
- Remove lower glazing panes which are unopenable
- Make glazing 'tilt and turn' type
- Limit internal gains by using better than industry standard insulation on pipework and limiting heat losses from HIUs
- Add louvres – this will increase fresh air rates to help mitigate heat gains. In addition louvres are secure and can be left open while windows need to be closed due to security risks
- Underfloor Cooling (UFC) – At present underfloor heating (UFH) is proposed. Ensuring this type of system is adopted as opposed to, say, a radiator ensures the possibility of adapting the UFH to also provide cooling (UFC). This would not be possible with a radiator system because of the larger surface areas required for UFC. It should be noted UFC is unlikely to be able to provide 50W/m2 of cooling (more typically 7W/m2). However this should still be considered as, in combination with other passive measures listed, could be effective.

8.5.2 Future design measures:

- Retrofit mechanical cooling – see 'current design options' above
- Retrofit blinds – internal or external, see 'current design options' above
- Retrofit glazing with screen with lower 'g' value

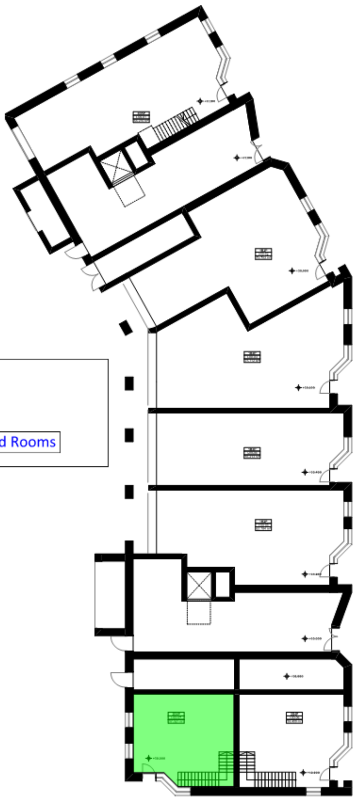
9 Conclusions

The results have shown that if we adopt the assumptions laid out in this report ('g' values, shading on JKL 5th floor and high opening fractions of glazing) then the risk of overheating is limited to within an acceptable level according to TM59.

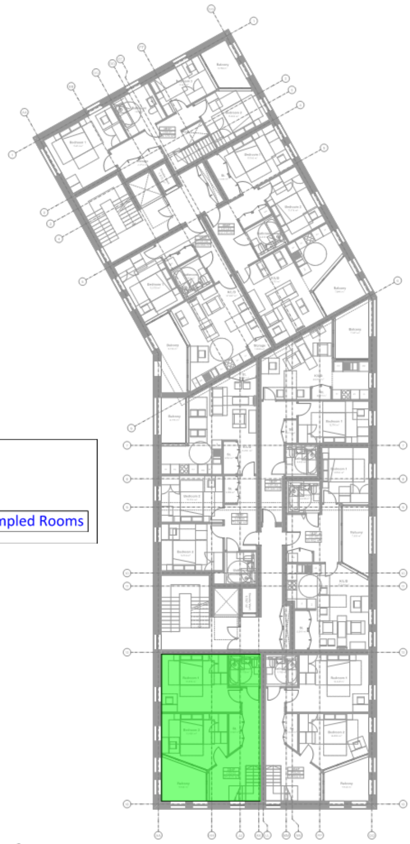
The results for the future climate adaptation show the need for further discussion on the best approach to mitigate this, whether that is by installing underfloor heating for the ability to adapt this to underfloor cooling later on; to enhancing passive design features now or ensuring the possibility of retrofitting these should the predicted climate become reality.

10 Appendix

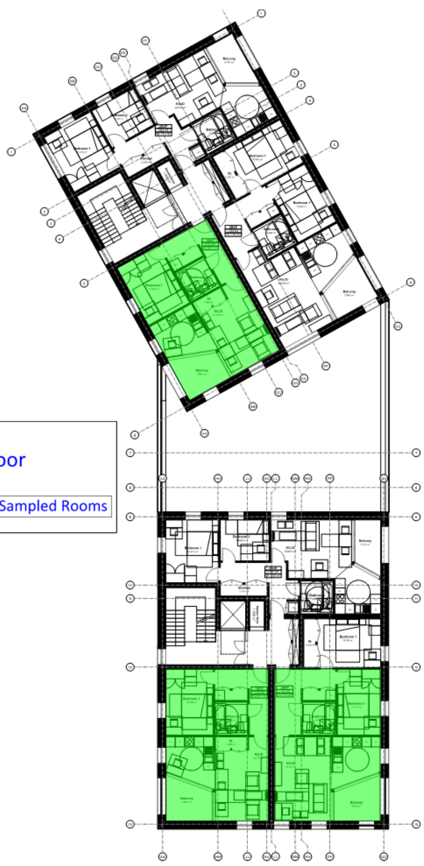
10.1 Modelled Spaces



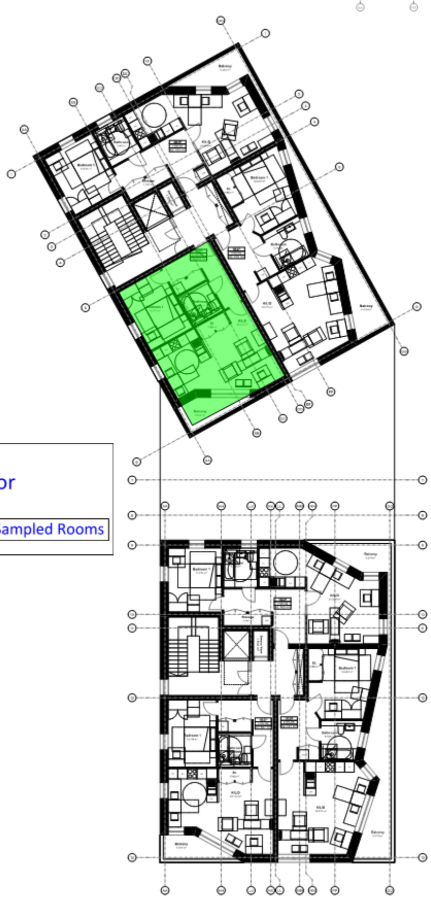
BLOCK I
Ground Floor
Sampled Rooms



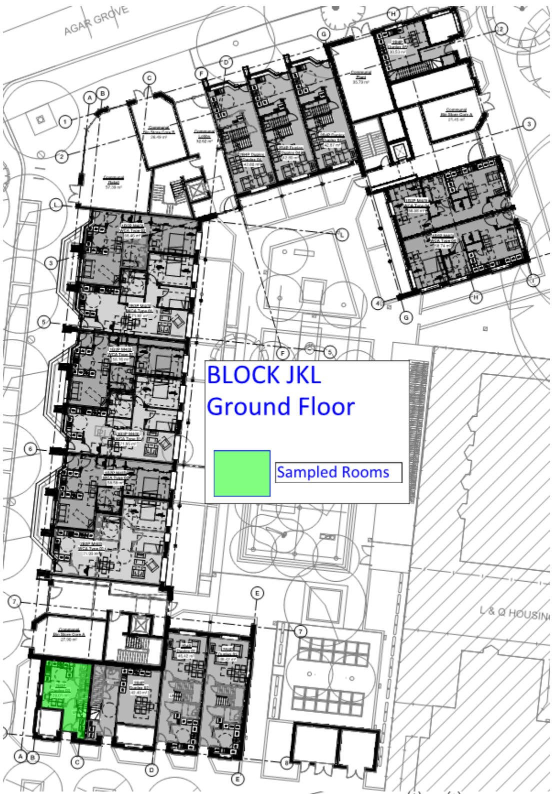
BLOCK I
First Floor
Sampled Rooms

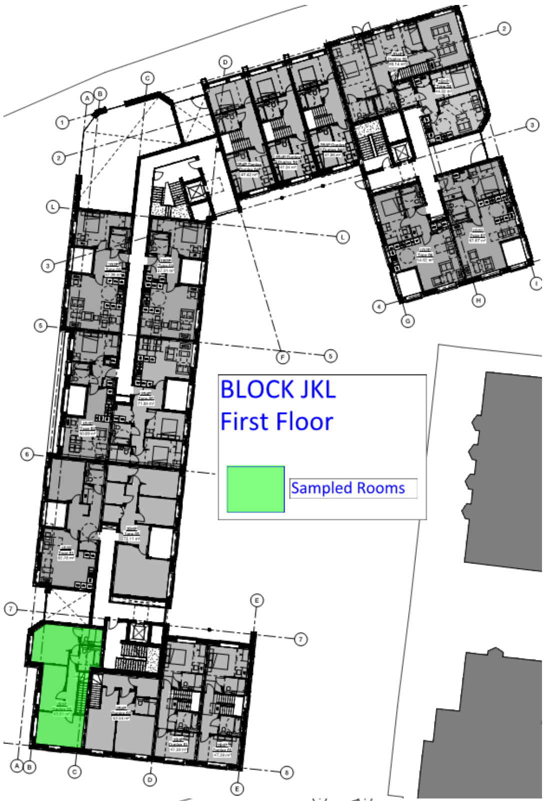


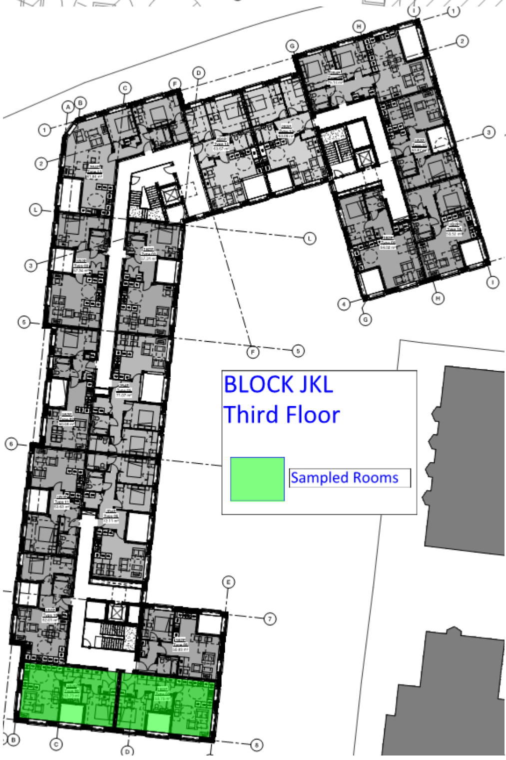
BLOCK I
Third Floor
Sampled Rooms

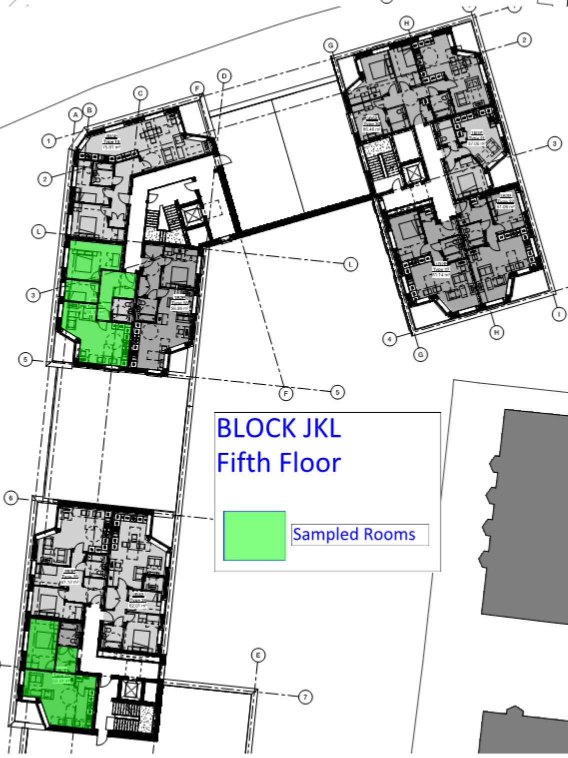


BLOCK I
Fifth Floor
Sampled Rooms


AGAR GROVE
BLOCK JKL
Ground Floor
Sampled Rooms


BLOCK JKL
First Floor
Sampled Rooms


BLOCK JKL
Third Floor
Sampled Rooms


BLOCK JKL
Fifth Floor
Sampled Rooms

10.2 TM59 Standard Internal Gains and Occupancy Profiles

Number of people	Description	Peak load (W) Sensible	Peak load (W) Latent	Period 00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	09–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24
				Hour-ending																							
				1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
1	Single bedroom occupancy	75	55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
2	Double bedroom occupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.7
2	Studio occupancy	150	110	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1-bed: living/kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1-bed: living occupancy	75	55	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
1	1-bed: kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
2	2-bed: living/kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
2	2-bed: living occupancy	150	110	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
2	2-bed: kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
3	3-bed: living/kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
3	3-bed: living occupancy	225	165	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
3	3-bed: kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
	Single bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/kitchen equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17
	Lighting profile	2 (W/m2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0

Figure 18: Heat Gain Profile, taken from TM59

10.3 Bibliography

Bastin, J.-F. (2019). Understanding climate change from a global analysis of city analogues. *PLOS*.