BEAM PARK

Energy Addendum – Addressing Condition 27 of Planning Permission GLA/2933a/05 Relative to Phase 2A

Phase 2A Reserved Matters Application (Works within the London Borough of Havering) - Submission to the GLA

July 2019

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SUPPORTED BY MAYOR OF LONDON

Mendick Waring Limited

Beam Park Phase 2A (RMA LBH GLA)

July 2019

Energy Strategy Addendum – Addressing Condition 27 of Planning Permission GLA/2933a/05 Relative to Phase 2A

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Checked By ..... Jon Harris

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1.0	25/07/2019	For RMA LBH GLA Application	Energy Strategy Addendum	JF	JH

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1.0 Executive Summary

This Energy Strategy has been prepared by MWL as an addendum to the consented outline hybrid planning application and AECOM's Energy Strategy Addendum dated August 2018, in a support to the RMA LBH GLA application for Beam Park phase 2A.

The Phase 2A consists of two apartment blocks of T and I and two house-blocks of 13 and 16. Block T is a total seven-storey height block and Block I a total eight-storey height block. The terrace houses are two/three-storey height.

This report seeks to illustrate and address that the measures of site wide energy strategy agreed in the Planning Permission GLA/2933a/05 are being satisfied and carried forwards in phase 2A. It also demonstrates the design intention in relation to policies at National, Regional and Local level as agreed in the planning application.

Requirements and Approach

In accordance with Building Regulations Part L1A 2013 the residential units of the development are required to achieve a Dwelling CO2 Emission Rate (DER) below the notional Target CO2 Emission Rate (TER) and a Dwelling Fabric Energy Efficiency (DFEE) rate below the notional Target Fabric Energy Efficiency (TFEE) rate.

New developments, particularly those of large scale, should be assessed for their potential to contribute to the local community, and to ensure that they provide a sufficient and balanced contribution across each of the social, economic and environmental sectors to underpin the necessary integration required to ensure the sustained success of the development, and quality of life for the people it is designed to support. The scheme implements the Mayors Energy Hierarchy by using passive design and energy efficient features such as insulation, low air permeability and high-performance glazing.

The proposed strategy follows a best practice approach, based on the Mayor of London's Energy Hierarchy:

- Use less energy 'Be Lean'
- Supply energy efficiently 'Be Clean'
- Use Renewable Energy 'Be Green'

The development is subject to Zero Carbon Policy for the residential units and 35% CO_2 reduction for the commercial units.

A fabric first approach will be followed, incorporating passive design measures such as low u-values, low air leakage and low thermal bridging.

Active design measures have been incorporated via energy efficient building services, such as 100% low energy lighting, and mechanical ventilation with heat recovery for the apartments with acoustic issues and mechanical extract ventilation for all the other units (without any acoustic issues).

There are two energy centres have been proposed in the hybrid planning application, called East side and West Side energy respectively. Both consist of CHP units in combination with efficient gas boilers providing space heating and hot water to the block of flats. The Phase 2A's flats are covered by East side energy centre. The houses will be heated by efficient individual gas fired boilers.

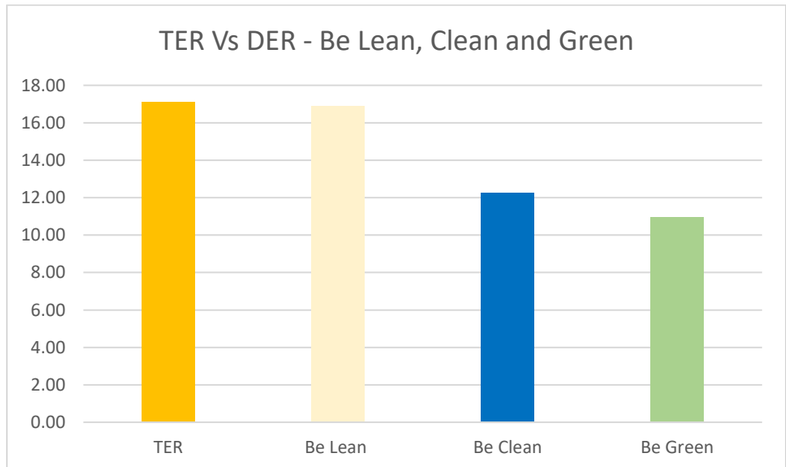
Roof mounted photovoltaic panels have also been considered as an option to generate a portion of the electricity demand for the residential units.

The SAP methodology will be used to calculate the energy consumption and resultant CO_2 emissions for the proposed development.

By implementing a combination of energy efficiency measures along with the selected LZC technologies, the development will achieve over 35% CO_2 reduction against Part L of the Building Regulations, 2013.

Results

By incorporating a combination of all the feasible passive measures alongside with the application of CHP and highly efficient boilers to the energy centre and 53 kWP of PVs, the CO2 emissions of the residential units cross the site Phase 2A has been reduced by 36%, whish fulfils the planning requirement of 35% target.



2.0 Site Location and Development Proposal

Site and planning application description

The Beam Park site (31.54 ha) is situated on the border between the London Borough of Havering and the London Borough of Barking and Dagenham, it is a post-industrial brownfield site with the River Beam running North-South through the site centre and which also forms the boundary between London Borough of Havering (LBH) and London Borough of Barking and Dagenham (LBBD).

The development is planned to be delivered over eight phases up to 2030. Planning permission is sought in detail for phase 1, which is entirely within LBH whist phase 2 is divided between LBH and LBBD with the River Beam running thorough the centre.

The original proposal hybrid planning application for the redevelopment of the site to include up to 2900 homes was submitted on July 2017, its master plan is shown below:

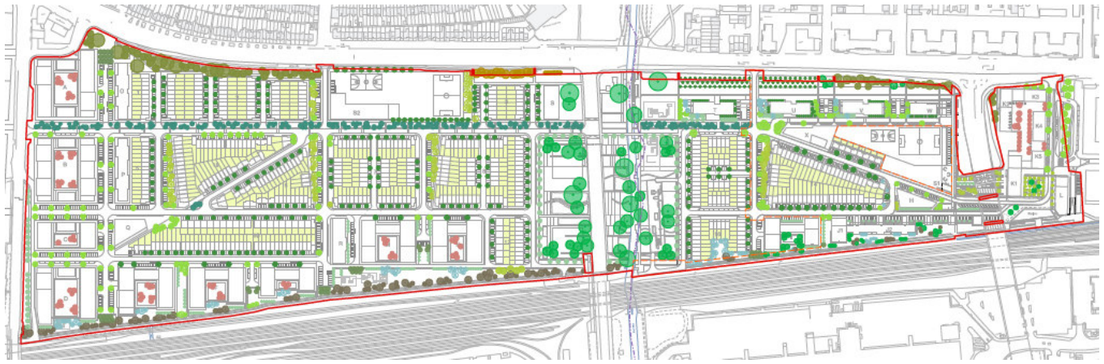


Figure 1: Original hybrid planning application master plan – July 2017

In the revisions February 2018, the main changes included increasing affordable housing from 35% to 50% and increasing height by two floors to block K3 to accommodate the medical centre whilst maintaining the same number of residential units.

Further revisions were made afterwards to the planning application during the GLA Call-In period. The changes related to ES addendum August 2018 (produced by AECOM) covered an increase of 100 homes from 2900 to 3000 in phase 1 and increase of building height in Phase 1 of up to 16 storeys.

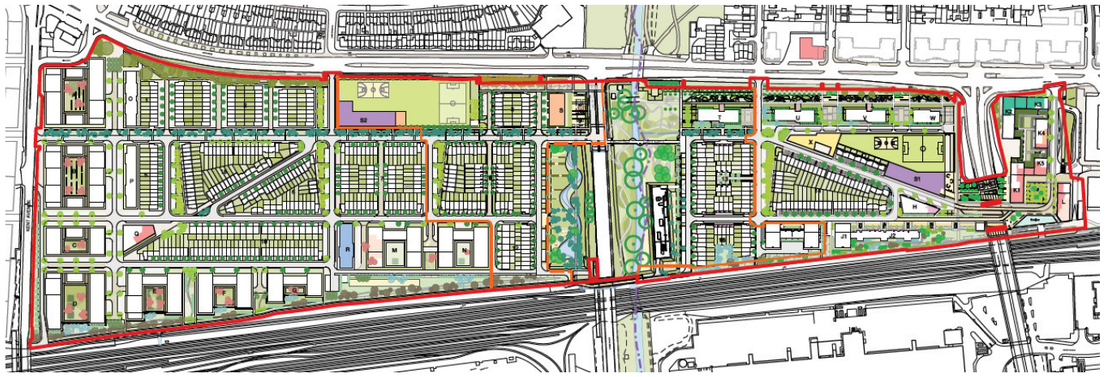


Figure 2: Revised planning application master plan – August 2018

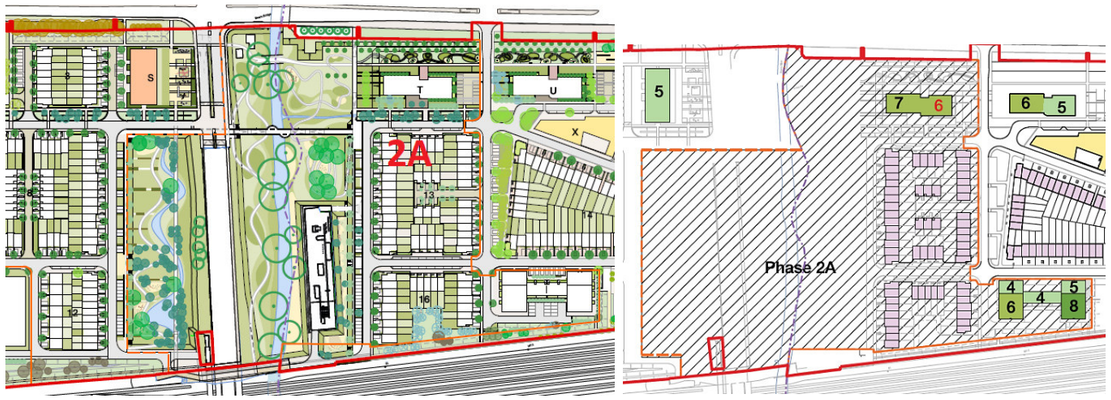


Figure 3: Revised planning application master plan – details of phase 2A

Figure 3 shows the outline details of the phase 2A including the height change of block T, which east part was changed from five storeys to six storeys and which highest point stays seven storeys. Phase 2A includes total 120 apartments and 64 houses, providing 50% affordable homes.

3.0 Policy Context

In this section of the report, National, Regional and Local planning policies and requirements are presented. This energy strategy addendum has been prepared in accordance with these policies which are illustrated below:

National Planning Policy Framework (February 2019)

Policy 14. Meeting the challenge of climate change, flooding and coastal change:

151. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

152. Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in local plans or other strategic policies that are being taken forward through neighbourhood planning.

153. In determining planning applications, local planning authorities should expect new development to:

a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and

b) take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

London Plan 2016

- Mayor of London SPD on Sustainable Design and Construction
- Policy 5.2 – Minimising Carbon Dioxide Emissions
- Policy 5.5, 5.6 – Decentralised Energy Networks
- Policy 5.7 – Renewables
- Policy 5.9 – Overheating & Cooling

London Plan - Policy 5.2 Minimising Carbon Dioxide emissions

Policy and Planning decisions:

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

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

London Plan - Policy 5.5, 5.6: Decentralised Energy in Developments Proposal

This policy enquires proposal to evaluate the feasibility of the Combined Heat and Power (CHP) systems and where a new CHP system is appropriate, examine opportunities to extend the system beyond the site boundary.

Developments should select energy systems on the following hierarchy:

- Connection to existing heating or cooling networks;
- Site wide CHP network: and
- Communal heating and cooling

London Plan - Policy 5.7 Renewable Energy

This policy states that major development proposals should provide a reduction in expected CO_2 emissions through the use of the maximum possible (based on available roof area) on-site renewable energy technology, where feasible.

London Plan - Policy 5.9 Overheating and Cooling

This policy states that the development reduces potential overheating and reliance on air conditioning systems, demonstrated in consideration of the following hierarchy;

- Minimisation of the internal heat generation through efficient design;
- Reduction of the external heat gains through consideration of orientation, shading, albedo, fenestration, insulation, and roofs and walls;
- Management of the internal heat gains through exposed thermal mass;
- Passive ventilation
- Mechanical ventilation; and

- Active cooling

Development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs.

Zero Carbon Policy from October 2016

For the period 2016 to 2031, London Plan policy 5.2B sets a 'zero carbon' target for residential development. This target was to align with the then expected introduction of 'zero carbon homes' through Part L of the Building Regulations.

The London Plan policy seeking 'zero carbon' homes remains in place and was not changed by the recent Minor Alterations to the London Plan. However, together with other standards 'zero carbon' was tested through the needs and viability assessment for the Alteration which indicated that the standards would not compromise housing viability. This approach will also help ensure the development industry in London is prepared for the introduction of 'Nearly Zero Energy Buildings' by 2020.

Zero carbon' homes are homes forming part of major development applications where the residential element of the application achieves at least a 35 per cent reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site (in line with policy 2.5B). The remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere (in line with policy 5.2 E).

The carbon price has been set as £1,800 per tonne for a fixed period of 30 years.

In line with the implementation date for previous increases in the London Plan carbon dioxide targets and improvements to Part L of the Building Regulations, 'zero carbon' housing is implemented for Stage 1 schemes from 1st October 2016.

Draft New London Plan (August 2018)

A draft new London Plan was published by the Mayor for consultation in December 2017. The consultation period ended on Friday 2 March 2018. The latest update of the Draft New London Plan showing Minor Suggested Changes, which includes clarifications, corrections and factual updates to the Consultation Draft Plan that will help inform the Examination in Public, was published on 13th August 2018.

However, this report is an addendum to the original application made in 2017 therefore the current 2016 London plan is the adopted development plan and the basis of the planning decisions.

London Borough of Havering (LBH)

The following key guidance from the London Borough of Havering (LBH) has been reviewed and addressed:

- Core Strategy (2008): The Core Strategy sets out the council's overall approach to the planning of the
  Borough and sets the framework for action plans and other topic-specific planning documents.
  — CP15: Environmental Management
  — DC49: Sustainable Design and Construction
  — DC50: Renewable Energy

- Rainham and Beam Park Planning Framework (2016): This document lays out the planning framework specific to the development areas of Rainham and Beam Park.
  — Policy PG27: Energy

4.0 Methodology

The energy strategy is based on the GLA energy hierarchy

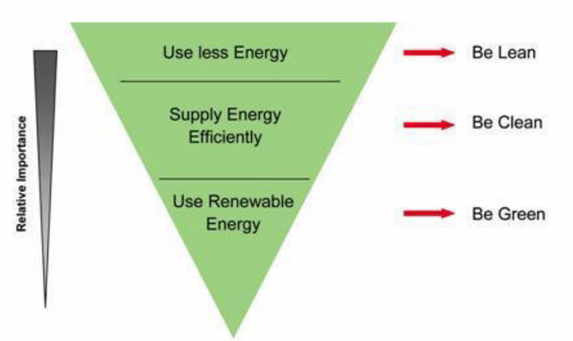


Figure 4: GLA Energy Hierarchy Schematic

For the residential units, Government Approved Software **NHER Plan Assessor** is used to calculate energy consumption and resultant CO_2 emissions

From this, the Target Emissions Rate (TER) and the potential improvement through energy efficiency, the Dwellings Emissions Rate (DER), is established.

The representative samples SAPs have been produced, including:

- One Bedroom flat: ground, Mid & top floor and a range of orientations
- Two Bedroom flat: ground, Mid & top floor and a range of orientations
- Three Bedroom flat: ground, Mid & top floor and a range of orientations
- Two Bedroom house: ground, Mid & top floor and a range of orientations
- Three Bedroom house: Mid & end-terrace and alternative orientations
- Four Bedroom house: Mid & end-terrace and alternative orientations

5.0 Energy Efficient Design

Carbon reduction and energy performance have been maximised through measures developed in line with the energy hierarchy.

Given the development of the scheme in line with the Energy Hierarchy, consideration should be first made to design through passive measures by using less energy.

Passive Design: Facades developed to find balance between daylight and reducing heat losses. Elevations therefore have a reasonable window to wall area ratio. Low U-values will reduce the heat loss through the building envelope.

Energy Efficient Fabric: Opaque elements will target excellent U-values, whilst envelope air permeability is reduced (compared to the limiting value of building regulations) to a target rate of 5 m^3/hm^2 at 50 Pa through an airtight layer on the warm side of the insulation, and efficient windows are currently proposed for all residential facades.

Once energy demand has been addressed, the next steps is to supply energy efficiently. In the case of heat, this relates to heat source efficiency, distribution losses, control system and heat emitters.

Energy Efficient Lighting: All lighting will be energy efficient: all the residential units will be equipped with 100% energy efficient lighting.

Efficient Ventilation Systems: For the apartments, which have acoustic issues, a Mechanical Ventilation system with Heat Recovery (MVHR) will be used. This in combination with reduced air tightness seeks to maximise recoverable heat gains and reduce overall energy consumption accordingly. The proposed specification includes an 91% Heat Recovery efficiency and a reduced energy consumption associated with fans through low velocity ductwork and reduced pressure drops (target Specific Fan Power of 0.83 W/l/s).

Low and Zero Carbon Technologies: The development will achieve carbon offsetting through a connection to the proposed energy centres (two energy centres cross phase 1 – 8, east site energy centre and west side energy centre) which includes CHP units and efficient gas fired boilers. Efficient individual Air Source Heat Pumps will provide the heating & cooling for the commercial units.

Renewable Technologies: Photovoltaic panels will offset electricity demands and further reducing the carbon emissions of the development.

6.0 Decentralised energy/Renewable Energy

District Heating Investigation and Proposed Energy Centres

The London Plan requires that major development proposals should prioritise connections to existing heating/cooling network where feasible. AECOM's energy strategy report showed that investigations were made, including contact with representatives from LBH and LBBD, into the existing and planned heat networks in the area. Whiles there are no existing networks to which the scheme can connect, it is understood that there are aspirations for wider networks in the area and that the ability for future connection should be considered. Provision will therefore be made in the design of heat network infrastructure on the site for connection to be a potential area wide heat network that may be developed in the future.

AECOM's energy strategy report also showed, due to the size of whole scheme and scale of anticipated heat demands, incorporating heat network infrastructure and gas-CHP technology on the scheme was deemed to be feasible. Due to the nature of the site, comprising two distinct areas of development either side of the large park around the Beam River with a significant number of constrains within this zone, the proposed approach is to provide two energy centres serving networks on each side of the site. They are the East side energy centre and West side energy centre. The Phase 2A is within the East Site energy centre covering area.

Low and Zero Carbon Technologies

There is no change to the prior Low and Zero Carbon Technologies feasibility study included within the approved Energy Strategy by AECOM.

The Approved Energy Strategy explored the London Plan's approved LZC technologies including:

- Photovoltaics
- Solar Water systems
- Biomass Heating
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Wind

The approved report identified the most suitable technology was photovoltaic (PV) panels, for the following reasons:

- Ability to meet the target CO2 emission reductions required by the London Plan;
- As an electrical generating technology PV does not compete with CHP heat and is therefore a compatible technology;
- High confidence in long-term delivery of the predicted carbon savings relative to other technologies that rely on long term operation and maintenance;
- Installation does not have significant implications for the design of the buildings or the other services;
- Better long-term financial benefits; and
- Good value for money in terms of the cost per tonne of carbon saved.

In addition, it is proposed that the commercial units will incorporate Air Source Heat Pumps to provide heating cooling.

7.0 Energy and CO_2 Calculation Results

This section of the report shows how the proposed scheme will meet the building regulations and its CO_2 target based on the GLA energy hierarchy:

- Be Lean
- Be Clean
- Be Green

This section of the report shows how the proposed scheme will meet the energy hierarchy, the building requirements and CO2 emission reduce target, in consistence with consented outline hybrid planning application.

Passive measures

A combination of all feasible passive measures has been incorporated into the development.

- Low fabric values
- Low air permeability
- 100% energy efficient lighting
- Double glazing window with high G-value
- Acoustic windows facing the road
- Mechanical ventilation with heat recovery where there is acoustic issue, otherwise central whole house mechanical ventilation

The advanced passive design measures have reduced the space heating demand of each of the dwellings.

The following specification is proposed for the residential units of Beam Park Phase 2A development:

The energy centre, as communal heating system, contributes further benefit to the overall energy efficiency. The high energy performant boilers with 95% efficiency would produce heat source for both space heating and domestic hot water. A heat interface unit will be installed to each property.

Passive Design

Residential Units - Flats:

Building Element	Limiting Fabric Parameters Part L1A 2013	Proposed Fabric Parameters
External Walls	0.30 W/m²K	0.19 W/m²K
Sheltered Walls	0.30 W/m²K	0.20 W/m²K
Party Walls	0.20 W/m²K	0 W/m²K (Fully Filled Cavity)
Roofs	0.20 W/m²K	0.13 W/m²K
Floors	0.25 W/m²K	0.13 W/m²K
Windows: U-value/G-value	2.00 W/m²K	1.30 W/m²K / 40%
Doors	2.00 W/m²K	1.50 W/m²K
Air permeability	10.00 m³/m².h @ 50pa	5.00 m³/m².h @ 50pa

Residential Units - Houses:

Building Element	Limiting Fabric Parameters Part L1A 2013	Proposed Fabric Parameters
External Walls	0.30 W/m²K	0.19 W/m²K
Sheltered Walls	0.30 W/m²K	0.20 W/m²K
Party Walls	0.20 W/m²K	0 W/m²K (Fully Filled Cavity)
Roofs	0.20 W/m²K	0.13 W/m²K
Floors	0.25 W/m²K	0.13 W/m²K
Windows: U-value/G-value	2.00 W/m²K	1.30 W/m²K / 63%
Doors	2.00 W/m²K	1.50 W/m²K
Air permeability	10.00 m³/m².h @ 50pa	5.00 m³/m².h @ 50pa

Active Design

Residential Units - Flats

Services	Proposals
Space Heating	Communal System – CHP + Natural Gas Boilers (Be Lean scenario) CHPs Model – Bosch 850kWe Boilers Model - Hoval UltraGas
Hot Water	Plate Heat Exchangers
Mechanical Cooling	None
Renewables	PV Panels (slight increase, the figure will be specified in the RMA application based on the detail SAP calculations)
Ventilation	MVHR (Mechanical Ventilation Heat Recovery) for the units with acoustic issues. Model: Greenwood Vireo HR155CM MEV (Mechanical Extract Ventilation) for the units without any acoustic issues. Model: Greenwood CMEV.4e
Lighting	100% have luminous efficacy ≥ 45 lm/W

Residential Units - Houses

Services	Proposals
Space Heating	Individual Natural Gas Boilers Model: Potterton Promax 32kW
Hot Water	Indirect Hot Water Cylinders Model: Telford
Mechanical Cooling	None
Renewables	None
Ventilation	MEV (Mechanical Extract Ventilation) Model: Greenwood CMEV.4e
Lighting	100% have luminous efficacy ≥ 45 lm/W

Be Lean results

For the Be Lean scenario, a combination of all feasible passive measures has been incorporated to all units of the phase 2A in the development.

In this scenario study, highly efficient boilers have been used in the energy centre.

The result of SAP calculations for the residential units is illustrated in figure 5, which compares the Dwelling Emission Rate (DER) against Target Emission Rate (TER).

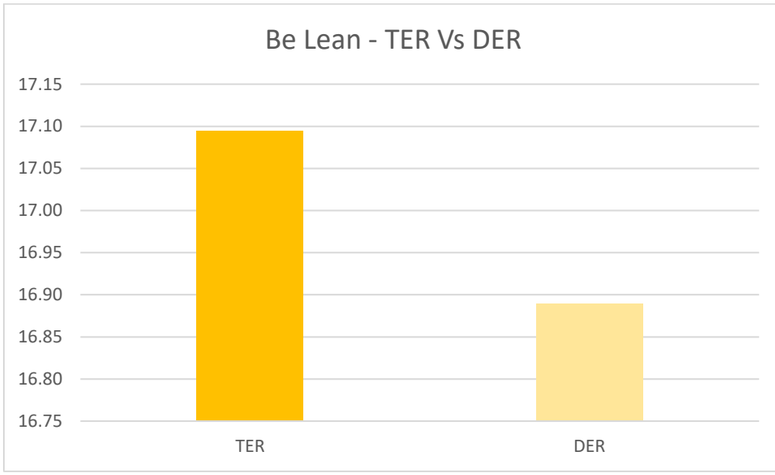


Figure 5: "Be Lean" – DER Vs TER

A result of 1.2% in CO2 emission reduction over the Building Regulations Part L1A 2013 Baseline has been achieved for the residential units including apartments and houses.

Be Clean results

For the Be Clean scenario study, a combination of all feasible passive measures has been incorporated to all units and a combination of CHP units and highly efficient boilers are applied to the energy centre.

The figure 6 shows that 28.3% CO2 reductions could be achieved with the through the energy centre scheme that includes CHP units and highly efficient boilers providing heat source to space heating and domestic hot water of apartment units.

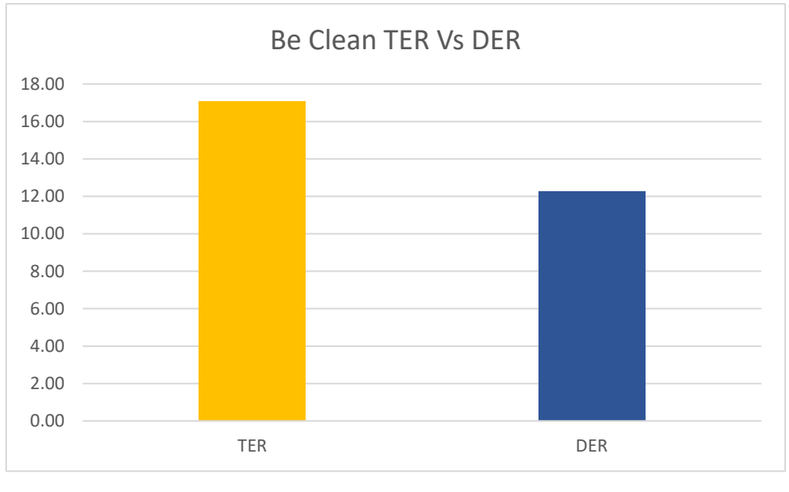


Figure 6: "Be Clean" – DER Vs TER

Be Green results

In order to achieve the 35% carbon reduction target that was set up in the original planning application, the last step of Energy Hierarchy (Be Green) is to incorporate renewable technology to reduce the carbon dioxide emission further.

53 kWp of photovoltaic panels (PVs) are incorporated in the SAP calculations for the apartment residential units. The result is illustrated in figure 7 below, which demonstrates the Dwelling Emission Rate against Target Emission Rate showing a 36% carbon emission reduction comparing to TER of Part L 2013.

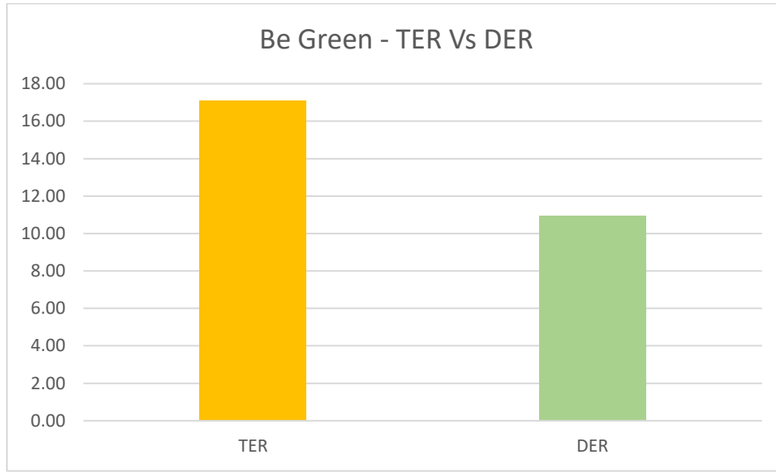


Figure 7: "Be Green" – DER Vs TER

8.0 Overheating Analysis

Based on Policy 5.9 of the London Plan 2016, an overheating study needs to be carried out following CIBSE TM59: 2017 "Design Methodology for the Assessment of Overheating risk in Homes" which is directly associated with CIBSE TM52: 2013 '"The limits of thermal comfort: avoiding overheating in European buildings''. They provide guidance for thermal comfort for buildings that are not mechanically cooled with assessment criteria as follows:

Criterion A: For Kitchens, Living rooms and Bedrooms
CIBSE TM52 criterion 1: *Hours of Exceedance* The number of hours (He) that delta T is greater than or equal to one degree (K) during the period between May and September, shall not be more than 3% of occupied hours

Criterion B: For Bedrooms Only
To guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10pm to 7am shall not exceed 26 °C for more than 1% of annual hours (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail)

In order to demonstrate the proposed units are not at risk of overheating, these two criteria must be met.

For communal corridors, where heating pipework runs through, the overheating test should be based on the number of annual hours for which an operative temperature of 28°C is exceeded for more than 3% of the total annual hours.

The residential units and communal corridors will be modelled in IES-VE software and will be simulated for current & future London weather data. However, this study is not part of this submission and will be part of the RMA applications, as it is a condition requirement for each of these applications.

9.0 Conclusion

The proposed strategy follows a best practice approach to the reduction of carbon emissions, based on the London Plan hierarchy of:

- Use less energy 'Be Lean'
- Supply energy efficiently 'Be Clean'
- Use Renewable Energy 'Be Green'

The SAP methodology is used to calculate the energy consumption and resultant CO2 emissions for the proposed dwellings.

A fabric first approach will be followed, incorporating passive design measures such as low u-values, low air leakage and low thermal bridging. Active design measures have been incorporated via a CHP based community heating system, 100% low energy lighting, and mechanical ventilation with heat recovery (MVHR) for the flats with acoustic issues and mechanical extract ventilation (MEV) for all the other ones.

Roof mounted photovoltaic panels have also been considered as an option to generate a portion of the electricity demand for the residential units.

By incorporating a combination of all the feasible passive measures alongside with the application of CHP and highly efficient boilers to the energy centre and 53 kWp of PVs, the CO2 emissions of the residential units cross the site Phase 2A has been reduced by 36% against Buildign Regulations Part L1A 2013, whish fulfils the consented planning requirement of 35% target.

The above results have accorded with the agreed site wide energy strategy in Planning Permission GLA/2933a/05 and therefore it shows that the agreed energy strategy is being satisfied and carried forwards.

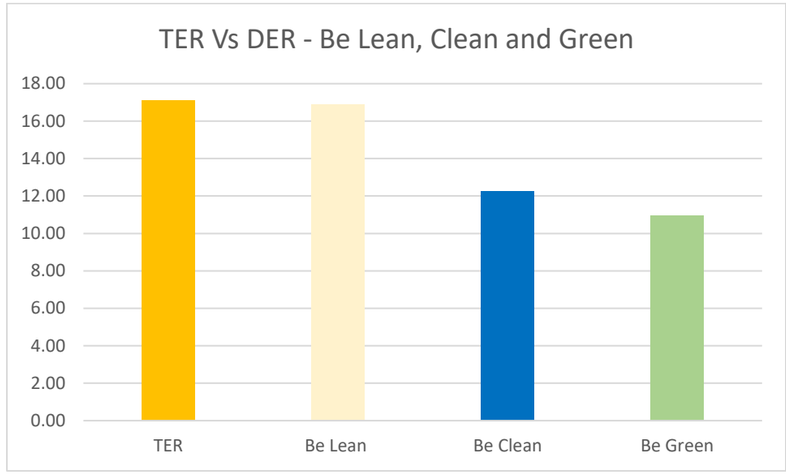


Figure 8: The energy hierarchy and targets based on the London Plan policy

ENERGY HIERACHY	RESIDENTIAL	
	CO2 EMISSION/AMNNUM (TONES)	% IMPROVEMENT
BE LEAN	265.6	1.20%
BE CLEAN	192.7	28.3%
BE GREEN	172.0	36.0%

Appendix A - Sample SAPs

Be Lean Sample SAPs

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Dr Polytimi Sofotasiou	Assessor number	1234
Client		Last modified	12/07/2019
Address	5 Block N Flr3 5 Beam Park Phase 2, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)		Volume (m³)	
Lowest occupied		94.21	(1a)	x	2.65	(2a) =	249.66	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	94.21	(4)					
Dwelling volume						(3a) + (3b) + (3c) + (3d)...(3n) =	249.66	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	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, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.21	(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 U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

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3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			21.12	x	1.24	=	26.10			(27)
Door			2.28	x	1.50	=	3.42			(26)
External wall			32.94	x	0.19	=	6.26			(29a)
External wall			10.02	x	0.20	=	2.00			(29a)
Party wall			39.62	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			66.36							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	37.78 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		5.05 (36)
Total fabric heat loss	(33) + (36) =	42.83 (37)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
42.92	42.48	42.04	41.19	41.19	41.19	41.19	41.19	41.19	41.19	41.19	41.19	(38)

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

85.74	85.31	84.87	84.02	84.02	84.02	84.02	84.02	84.02	84.02	84.02	84.02	

Average = ∑(39)1...12/12 = 84.34 (39)

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

0.91	0.91	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	

Average = ∑(40)1...12/12 = 0.90 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N		2.68 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		97.83 (43)

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	
107.61	103.70	99.78	95.87	91.96	88.05	88.05	91.96	95.87	99.78	103.70	107.61	

∑(44)1...12 = 1173.94 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

159.58	139.57	144.03	125.57	120.48	103.97	96.34	110.55	111.87	130.38	142.32	154.55	

∑(45)1...12 = 1539.22 (45)

Distribution loss 0.15 x (45)m

23.94	20.94	21.60	18.83	18.07	15.60	14.45	16.58	16.78	19.56	21.35	23.18	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel		1.00 (47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.03 (51)
Volume factor from Table 2a		4.93 (52)
Temperature factor from Table 2b		1.00 (53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)		0.17 (54)
Enter (50) or (54) in (55)		0.17 (55)

Water storage loss calculated for each month (55) x (41)m

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(57)

Primary circuit loss for each month from Table 3

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 for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

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

188.04	165.27	172.48	153.10	148.94	131.50	124.79	139.01	139.41	158.83	169.85	183.00	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

188.04	165.27	172.48	153.10	148.94	131.50	124.79	139.01	139.41	158.83	169.85	183.00	

∑(64)1...12 = 1874.23 (64)

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

75.82	66.97	70.65	63.78	62.82	56.60	54.80	59.52	59.23	66.11	69.35	74.15	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	160.74	160.74	160.74	160.74	160.74	160.74	160.74	160.74	160.74	160.74	160.74	160.74	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	54.96	48.82	39.70	30.06	22.47	18.97	20.50	26.64	35.76	45.40	52.99	56.49	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	368.08	371.90	362.27	341.78	315.92	291.61	275.37	271.55	281.17	301.66	327.53	351.84	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	53.75	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	-107.16	(71)
Water heating gains (Table 5)	101.91	99.65	94.96	88.58	84.44	78.61	73.65	80.00	82.26	88.86	96.32	99.66	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	632.29	627.71	604.27	567.76	530.16	496.52	476.85	485.53	506.52	543.26	584.17	615.33	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	1.00	x	15.36	x	19.64	x 0.9 x	0.40	x	0.80	=	86.88	(76)
North	1.00	x	5.76	x	10.63	x 0.9 x	0.40	x	0.80	=	17.64	(74)

Solar gains in watts ∑(74)m...(82)m

104.52	203.67	337.18	500.23	624.23	644.82	611.45	517.10	394.41	241.80	130.09	86.15	(83)

Total gains - internal and solar (73)m + (83)m

736.82	831.38	941.45	1067.98	1154.39	1141.34	1088.30	1002.62	900.93	785.06	714.27	701.48	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C) 21.00 (85)

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

Utilisation factor for gains for living area n1,m (see Table 9a)

	0.99	0.98	0.95	0.84	0.66	0.47	0.34	0.38	0.63	0.90	0.98	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

	20.27	20.42	20.65	20.87	20.97	21.00	21.00	21.00	20.99	20.83	20.51	20.25	(87)

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

	20.16	20.16	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	(88)

Utilisation factor for gains for rest of dwelling n2,m

	0.99	0.98	0.93	0.80	0.60	0.41	0.28	0.32	0.56	0.87	0.97	0.99	(89)

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

	19.20	19.41	19.74	20.04	20.15	20.17	20.17	20.17	20.16	19.99	19.56	19.18	(90)

Living area fraction — Living area ÷ (4) = 0.36 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

	19.58	19.77	20.06	20.34	20.44	20.47	20.47	20.47	20.46	20.29	19.90	19.56	(92)

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

	19.58	19.77	20.06	20.34	20.44	20.47	20.47	20.47	20.46	20.29	19.90	19.56	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.97	0.93	0.81	0.62	0.43	0.30	0.34	0.58	0.88	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	726.93	808.60	875.87	866.74	717.78	491.27	324.81	341.43	525.27	687.70	694.14	694.05	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1309.87	1268.49	1150.71	960.82	734.73	492.82	324.94	341.72	534.01	813.91	1075.15	1290.80	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	433.71	309.05	204.48	67.73	12.61	0.00	0.00	0.00	0.00	93.90	274.32	443.98	

∑(98)1...5, 10...12 = 1839.79 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 19.53 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		1.00	(303a)
Fraction of total space heat from community boilers	(302) x (303a) =	1.00	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1839.79		(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	1931.78	(307a)

Water heating

Annual water heating requirement	1874.23		(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1967.94	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	39.00	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	63.35		(330a)
Total electricity for the above, kWh/year		63.35	(331)
Electricity for lighting (Appendix L)		388.28	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	4351.34	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	1931.78	x	4.24	x 0.01 =	81.91	(340a)
Water heating from boilers	1967.94	x	4.24	x 0.01 =	83.44	(342a)
Pumps and fans	63.35	x	13.19	x 0.01 =	8.36	(349)
Electricity for lighting	388.28	x	13.19	x 0.01 =	51.21	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		344.92	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.04	(357)
SAP value	85.48	
SAP rating (section 13)	85	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	94.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4148.63	x	0.216	=	896.11	(367)
Electrical energy for community heat distribution	39.00	x	0.519	=	20.24	(372)
Total CO2 associated with community systems					916.34	(373)
Total CO2 associated with space and water heating					916.34	(376)
Pumps and fans	63.35	x	0.519	=	32.88	(378)
Electricity for lighting	388.28	x	0.519	=	201.52	(379)
Total CO_2, kg/year				(376)..(382) =	1150.74	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	12.21	(384)
EI value					88.92	
EI rating (section 14)					89	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	94.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4148.63	x	1.22	=	5061.33	(367)
Electrical energy for community heat distribution	39.00	x	3.07	=	119.72	(372)
Total primary energy associated with community systems					5181.06	(373)
Total primary energy associated with space and water heating					5181.06	(376)

Pumps and fans	63.35	x	3.07	=	194.49	(378)
Electricity for lighting	388.28	x	3.07	=	1192.01	(379)
Primary energy kWh/year					6567.55	(383)
Dwelling primary energy rate kWh/m2/year					69.71	(384)

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Dr Polytimi Sofotasiou	Assessor number	1234
Client		Last modified	12/07/2019
Address	1 Block T Flr0 1, London		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		52.50	(1a) x	2.65	(2a) =	139.13	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	52.50	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	139.13	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		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, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.21	(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 U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

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3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			13.32	x	1.24	=	16.46			(27)
Door			1.95	x	1.40	=	2.73			(26)
Ground floor			52.50	x	0.13	=	6.83			(28a)
External wall			24.80	x	0.19	=	4.71			(29a)
External wall			3.71	x	0.20	=	0.74			(29a)
Party wall			26.21	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			96.28							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	31.47 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		6.29 (36)
Total fabric heat loss	(33) + (36) =	37.76 (37)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
23.92	23.67	23.43	22.96	22.96	22.96	22.96	22.96	22.96	22.96	22.96	22.96	(38)

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

61.67	61.43	61.18	60.71	60.71	60.71	60.71	60.71	60.71	60.71	60.71	60.71	

Average = ∑(39)1...12/12 = 60.89 (39)

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

1.17	1.17	1.17	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	

Average = ∑(40)1...12/12 = 1.16 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.76	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	76.09	(43)

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	
83.70	80.66	77.61	74.57	71.53	68.48	68.48	71.53	74.57	77.61	80.66	83.70	

∑(44)1...12 = 913.09 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

124.12	108.56	112.02	97.67	93.71	80.87	74.93	85.99	87.02	101.41	110.70	120.21	

∑(45)1...12 = 1197.20 (45)

Distribution loss 0.15 x (45)m

18.62	16.28	16.80	14.65	14.06	12.13	11.24	12.90	13.05	15.21	16.60	18.03	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	4.93	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.12	(54)
Enter (50) or (54) in (55)	0.12	(55)

Water storage loss calculated for each month (55) x (41)m

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(57)

Primary circuit loss for each month from Table 3

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 for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

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

151.05	132.88	138.95	123.72	120.64	106.92	101.86	112.92	113.07	128.34	136.75	147.13	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

151.05	132.88	138.95	123.72	120.64	106.92	101.86	112.92	113.07	128.34	136.75	147.13	

∑(64)1...12 = 1514.25 (64)

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

62.81	55.55	58.79	53.32	52.70	47.73	46.46	50.13	49.78	55.26	57.65	61.51	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	34.26	30.43	24.75	18.74	14.01	11.82	12.78	16.61	22.29	28.30	33.03	35.21	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	229.44	231.82	225.82	213.05	196.92	181.77	171.65	169.26	175.26	188.04	204.16	219.31	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	(71)
Water heating gains (Table 5)	84.43	82.67	79.02	74.06	70.83	66.30	62.44	67.38	69.14	74.27	80.07	82.68	(72)

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

430.75	427.54	412.21	388.46	364.38	342.51	329.49	335.88	349.31	373.24	399.89	419.83	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	1.00	x	13.32	x	19.64	x 0.9 x	0.40	x	0.80	=	75.34	(80)

Solar gains in watts ∑(74)m...(82)m

75.34	147.39	242.73	354.00	433.84	444.11	422.81	363.19	282.30	174.89	93.94	61.96	(83)

Total gains - internal and solar (73)m + (83)m

506.09	574.93	654.93	742.46	798.23	786.63	752.30	699.07	631.61	548.12	493.83	481.78	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C) 21.00 (85)

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

Utilisation factor for gains for living area n1,m (see Table 9a)

	0.98	0.97	0.93	0.83	0.67	0.49	0.35	0.40	0.63	0.89	0.97	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

	20.05	20.23	20.50	20.79	20.94	20.99	21.00	21.00	20.96	20.74	20.35	20.03	(87)

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

	19.94	19.94	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.96	19.96	19.96	(88)

Utilisation factor for gains for rest of dwelling n2,m

	0.98	0.96	0.91	0.79	0.60	0.41	0.27	0.31	0.55	0.85	0.96	0.98	(89)

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

	18.72	18.98	19.36	19.73	19.90	19.95	19.95	19.95	19.93	19.68	19.15	18.69	(90)

Living area fraction — Living area ÷ (4) = 0.61 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

	19.53	19.74	20.06	20.37	20.53	20.58	20.59	20.59	20.56	20.33	19.88	19.50	(92)

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

	19.53	19.74	20.06	20.37	20.53	20.58	20.59	20.59	20.56	20.33	19.88	19.50	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.96	0.91	0.81	0.64	0.46	0.32	0.36	0.60	0.86	0.96	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	494.81	551.83	598.62	598.24	509.84	359.04	241.63	253.25	377.65	472.96	473.78	472.94	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	939.27	911.55	829.40	696.56	536.35	363.16	242.19	254.28	392.18	590.51	775.90	929.14	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	330.68	241.74	171.70	70.79	19.72	0.00	0.00	0.00	0.00	87.46	217.53	339.42	

∑(98)1...5, 10...12 = 1479.03 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 28.17 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		1.00	(303a)
Fraction of total space heat from community boilers	(302) x (303a) =	1.00	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1479.03		(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	1552.98	(307a)

Water heating

Annual water heating requirement	1514.25		(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1589.96	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	31.43	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	37.51		(330a)
Total electricity for the above, kWh/year		37.51	(331)
Electricity for lighting (Appendix L)		242.03	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3422.47	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	1552.98	x	4.24	x 0.01 =	65.85	(340a)
Water heating from boilers	1589.96	x	4.24	x 0.01 =	67.41	(342a)
Pumps and fans	37.51	x	13.19	x 0.01 =	4.95	(349)
Electricity for lighting	242.03	x	13.19	x 0.01 =	31.92	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		290.13	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.25	(357)
SAP value	82.57	
SAP rating (section 13)	83	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	94.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3343.55	x	0.216	=	722.21	(367)
Electrical energy for community heat distribution	31.43	x	0.519	=	16.31	(372)
Total CO2 associated with community systems					738.52	(373)
Total CO2 associated with space and water heating					738.52	(376)
Pumps and fans	37.51	x	0.519	=	19.47	(378)
Electricity for lighting	242.03	x	0.519	=	125.61	(379)
Total CO_2, kg/year				(376)..(382) =	883.60	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	16.83	(384)
EI value					87.86	
EI rating (section 14)					88	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	94.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3343.55	x	1.22	=	4079.13	(367)
Electrical energy for community heat distribution	31.43	x	3.07	=	96.49	(372)
Total primary energy associated with community systems					4175.62	(373)
Total primary energy associated with space and water heating					4175.62	(376)

Pumps and fans	37.51	x	3.07	=	115.16	(378)
Electricity for lighting	242.03	x	3.07	=	743.02	(379)
Primary energy kWh/year					5033.80	(383)
Dwelling primary energy rate kWh/m2/year					95.88	(384)

Be Clean Sample SAPs

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Dr Polytimi Sofotasiou	Assessor number	1234
Client		Last modified	12/07/2019
Address	4 Block N Flr1 4 Beam Park Phase 2, London		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		49.64	(1a) x	2.65	(2a) =	131.55	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	49.64	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	131.55	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		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, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.21	(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 U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(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	κ-value, kJ/m².K	A x κ, kJ/K	
Window			9.60	x	1.24	=	11.86			(27)
Door			2.28	x	1.50	=	3.42			(26)
External wall			11.87	x	0.19	=	2.26			(29a)
External wall			57.05	x	0.20	=	11.41			(29a)
Total area of external elements ∑A, m²			80.80							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	28.95 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		2.67 (36)
Total fabric heat loss	(33) + (36) =	31.62 (37)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
22.61	22.38	22.15	21.71	21.71	21.71	21.71	21.71	21.71	21.71	21.71	21.71	(38)

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

54.23	54.00	53.77	53.32	53.32	53.32	53.32	53.32	53.32	53.32	53.32	53.32	

Average = ∑(39)1...12/12 = 53.49 (39)

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

1.09	1.09	1.08	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	

Average = ∑(40)1...12/12 = 1.08 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.68 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.09 (43)

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	
81.50	78.53	75.57	72.61	69.64	66.68	66.68	69.64	72.61	75.57	78.53	81.50	

∑(44)1...12 = 889.06 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

120.86	105.70	109.08	95.10	91.25	78.74	72.96	83.73	84.73	98.74	107.78	117.04	

∑(45)1...12 = 1165.70 (45)

Distribution loss 0.15 x (45)m

18.13	15.86	16.36	14.26	13.69	11.81	10.94	12.56	12.71	14.81	16.17	17.56	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00 (47)
Water storage loss:	
b) Manufacturer's declared loss factor is not known	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.03 (51)
Volume factor from Table 2a	4.93 (52)
Temperature factor from Table 2b	1.00 (53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17 (54)
Enter (50) or (54) in (55)	0.17 (55)

Water storage loss calculated for each month (55) x (41)m

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(57)

Primary circuit loss for each month from Table 3

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 for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

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

149.31	131.40	137.53	122.63	119.70	106.27	101.42	112.18	112.26	127.19	135.32	145.50	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

149.31	131.40	137.53	122.63	119.70	106.27	101.42	112.18	112.26	127.19	135.32	145.50	

∑(64)1...12 = 1500.71 (64)

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

62.95	55.71	59.03	53.65	53.10	48.21	47.02	50.60	50.20	55.59	57.87	61.68	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.61	28.96	23.55	17.83	13.33	11.25	12.16	15.80	21.21	26.93	31.44	33.51	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	218.36	220.62	214.91	202.76	187.41	172.99	163.36	161.09	166.80	178.96	194.30	208.72	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	(71)
Water heating gains (Table 5)	84.61	82.90	79.34	74.51	71.37	66.96	63.20	68.01	69.72	74.72	80.37	82.90	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	415.92	412.83	398.15	375.44	352.46	331.55	319.06	325.25	338.08	360.96	386.45	405.48	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	1.00	x	9.60	x	19.64	x 0.9 x	0.40	x	0.80	=	54.30	(76)

Solar gains in watts ∑(74)m...(82)m

54.30	106.23	174.94	255.14	312.68	320.08	304.73	261.76	203.46	126.04	67.71	44.65	(83)

Total gains - internal and solar (73)m + (83)m

470.22	519.05	573.09	630.58	665.14	651.63	623.80	587.01	541.54	487.01	454.16	450.14	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.98	0.97	0.94	0.85	0.70	0.52	0.37	0.42	0.65	0.89	0.97	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.15	20.30	20.54	20.79	20.94	20.99	21.00	21.00	20.97	20.77	20.42	20.13

(87)

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

20.01	20.01	20.01	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02

(88)

Utilisation factor for gains for rest of dwelling n2,m

0.98	0.96	0.92	0.81	0.64	0.44	0.29	0.33	0.57	0.85	0.96	0.98

(89)

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

18.91	19.13	19.46	19.80	19.97	20.02	20.02	20.02	20.00	19.78	19.31	18.89

(90)

Living area fraction — Living area ÷ (4) = 0.57 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

19.61	19.79	20.07	20.36	20.52	20.57	20.57	20.57	20.55	20.34	19.94	19.60

(92)

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

19.61	19.79	20.07	20.36	20.52	20.57	20.57	20.57	20.55	20.34	19.94	19.60

(93)

8. Space heating requirement

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

Utilisation factor for gains, ηm

0.98	0.96	0.92	0.83	0.67	0.48	0.34	0.38	0.61	0.87	0.96	0.98

(94)

Useful gains, ηmGm, W (94)m x (84)m

459.54	499.34	528.98	522.12	445.58	314.48	211.43	221.70	331.86	422.34	435.46	441.58

(95)

Monthly average external temperature from Table U1

4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20

(96)

Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

830.45	804.10	729.55	611.07	470.18	318.14	211.88	222.50	343.78	519.26	684.62	820.89

(97)

Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

275.96	204.80	149.22	64.04	18.30	0.00	0.00	0.00	0.00	72.11	179.39	282.21

∑(98)1...5, 10...12 = 1246.04 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 25.10 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		0.30	(303a)
Fraction of community heat from CHP		0.70	(303b)
Fraction of total space heat from community CHP	(302) x (303a) =	0.70	(304a)
Fraction of total space heat from community boilers	(302) x (303b) =	0.30	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1246.04		(98)
Space heat from CHP	(98) x (304a) x (305) x (306) =	915.84	(307a)
Space heat from boilers	(98) x (304b) x (305) x (306) =	392.50	(307b)

Water heating

Annual water heating requirement	1500.71		(64)
Water heat from CHP	(64) x (303a) x (305a) x (306) =	1103.02	(310a)

Water heat from boilers	(64) x (303b) x (305a) x (306) =	472.72	(310b)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	28.84	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)		
mechanical ventilation fans - balanced, extract or positive input from outside	35.47	(330a)
Total electricity for the above, kWh/year	35.47	(331)
Electricity for lighting (Appendix L)	230.34	(332)
Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3149.89	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from CHP	915.84	x	2.97	x 0.01 =	27.20	(340a)
Space heating from boilers	392.50	x	4.24	x 0.01 =	16.64	(340b)
Water heating from CHP	1103.02	x	2.97	x 0.01 =	32.76	(342a)
Water heating from boilers	472.72	x	4.24	x 0.01 =	20.04	(342b)
Pumps and fans	35.47	x	13.19	x 0.01 =	4.68	(349)
Electricity for lighting	230.34	x	13.19	x 0.01 =	30.38	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		251.71	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.12	(357)
SAP value	84.42	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

		Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	1827.3744	x	0.2160	=	394.7129	(363)
less credit emissions for electricity		-688.5986	x	0.5190	=	-357.3827	(364)
Water heated by CHP		2200.8672	x	0.2160	=	475.3873	(365)
less credit emissions for electricity		-829.3397	x	0.5190	=	-430.4273	(366)
Emissions from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
CO2 emissions from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	930.35	x	0.216	=	200.96	(368)
Electrical energy for community heat distribution		28.84	x	0.519	=	14.97	(372)
Total CO2 associated with community systems						298.21	(373)
Total CO2 associated with space and water heating						298.21	(376)
Pumps and fans		35.47	x	0.519	=	18.41	(378)
Electricity for lighting		230.34	x	0.519	=	119.55	(379)
Total CO_2, kg/year					(376)..(382) =	436.17	(383)
Dwelling CO_2 emission rate					(383) ÷ (4) =	8.79	(384)
EI value						93.82	

EI rating (section 14)	94	(385)
EI band	A	

13b. Primary energy - community heating scheme

		Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary Energy from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	1827.37	x	1.22	=	2229.40	(363)
less credit energy for electricity		-688.60	x	3.07	=	-2114.00	(364)
Water heated by CHP		2200.87	x	1.22	=	2685.06	(365)
less credit energy for electricity		-829.34	x	3.07	=	-2546.07	(366)
Primary energy from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
Primary energy from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	930.35	x	1.22	=	1135.03	(368)
Electrical energy for community heat distribution		28.84	x	3.07	=	88.54	(372)
Total primary energy associated with community systems						1477.95	(373)
Total primary energy associated with space and water heating						1477.95	(376)
Pumps and fans		35.47	x	3.07	=	108.89	(378)
Electricity for lighting		230.34	x	3.07	=	707.14	(379)
Primary energy kWh/year						2293.97	(383)
Dwelling primary energy rate kWh/m2/year						46.21	(384)

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Dr Polytimi Sofotasiou	Assessor number	1234
Client		Last modified	12/07/2019
Address	1 Block T Flr0 1, London		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		52.50	(1a) x	2.65	(2a) =	139.13	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	52.50	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	139.13	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		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, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.21	(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 U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

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3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			13.32	x	1.24	=	16.46			(27)
Door			1.95	x	1.40	=	2.73			(26)
Ground floor			52.50	x	0.13	=	6.83			(28a)
External wall			24.80	x	0.19	=	4.71			(29a)
External wall			3.71	x	0.20	=	0.74			(29a)
Party wall			26.21	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			96.28							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	31.47 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		6.29 (36)
Total fabric heat loss	(33) + (36) =	37.76 (37)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
23.92	23.67	23.43	22.96	22.96	22.96	22.96	22.96	22.96	22.96	22.96	22.96	(38)

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

61.67	61.43	61.18	60.71	60.71	60.71	60.71	60.71	60.71	60.71	60.71	60.71	

Average = ∑(39)1...12/12 = 60.89 (39)

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

1.17	1.17	1.17	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	

Average = ∑(40)1...12/12 = 1.16 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.76 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	76.09 (43)

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	
83.70	80.66	77.61	74.57	71.53	68.48	68.48	71.53	74.57	77.61	80.66	83.70	

∑(44)1...12 = 913.09 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

124.12	108.56	112.02	97.67	93.71	80.87	74.93	85.99	87.02	101.41	110.70	120.21	

∑(45)1...12 = 1197.20 (45)

Distribution loss 0.15 x (45)m

18.62	16.28	16.80	14.65	14.06	12.13	11.24	12.90	13.05	15.21	16.60	18.03	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00 (47)
Water storage loss:	
b) Manufacturer's declared loss factor is not known	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02 (51)
Volume factor from Table 2a	4.93 (52)
Temperature factor from Table 2b	1.00 (53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.12 (54)
Enter (50) or (54) in (55)	0.12 (55)
Water storage loss calculated for each month (55) x (41)m	

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(57)

Primary circuit loss for each month from Table 3

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 for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

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

151.05	132.88	138.95	123.72	120.64	106.92	101.86	112.92	113.07	128.34	136.75	147.13	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

151.05	132.88	138.95	123.72	120.64	106.92	101.86	112.92	113.07	128.34	136.75	147.13	

∑(64)1...12 = 1514.25 (64)

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

62.81	55.55	58.79	53.32	52.70	47.73	46.46	50.13	49.78	55.26	57.65	61.51	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	105.83	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	34.26	30.43	24.75	18.74	14.01	11.82	12.78	16.61	22.29	28.30	33.03	35.21	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	229.44	231.82	225.82	213.05	196.92	181.77	171.65	169.26	175.26	188.04	204.16	219.31	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	47.35	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	-70.55	(71)
Water heating gains (Table 5)	84.43	82.67	79.02	74.06	70.83	66.30	62.44	67.38	69.14	74.27	80.07	82.68	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	430.75	427.54	412.21	388.46	364.38	342.51	329.49	335.88	349.31	373.24	399.89	419.83	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	1.00	x	13.32	x	19.64	x 0.9 x	0.40	x	0.80	=	75.34	(80)

Solar gains in watts ∑(74)m...(82)m

75.34	147.39	242.73	354.00	433.84	444.11	422.81	363.19	282.30	174.89	93.94	61.96	(83)

Total gains - internal and solar (73)m + (83)m

506.09	574.93	654.93	742.46	798.23	786.63	752.30	699.07	631.61	548.12	493.83	481.78	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

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

Utilisation factor for gains for living area n1,m (see Table 9a)

	0.98	0.97	0.93	0.83	0.67	0.49	0.35	0.40	0.63	0.89	0.97	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

	20.05	20.23	20.50	20.79	20.94	20.99	21.00	21.00	20.96	20.74	20.35	20.03	(87)

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

	19.94	19.94	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.96	19.96	19.96	(88)

Utilisation factor for gains for rest of dwelling n2,m

	0.98	0.96	0.91	0.79	0.60	0.41	0.27	0.31	0.55	0.85	0.96	0.98	(89)

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

	18.72	18.98	19.36	19.73	19.90	19.95	19.95	19.95	19.93	19.68	19.15	18.69	(90)

Living area fraction — Living area ÷ (4) = 0.61 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

	19.53	19.74	20.06	20.37	20.53	20.58	20.59	20.59	20.56	20.33	19.88	19.50	(92)

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

	19.53	19.74	20.06	20.37	20.53	20.58	20.59	20.59	20.56	20.33	19.88	19.50	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.96	0.91	0.81	0.64	0.46	0.32	0.36	0.60	0.86	0.96	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	494.81	551.83	598.62	598.24	509.84	359.04	241.63	253.25	377.65	472.96	473.78	472.94	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	939.27	911.55	829.40	696.56	536.35	363.16	242.19	254.28	392.18	590.51	775.90	929.14	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	330.68	241.74	171.70	70.79	19.72	0.00	0.00	0.00	0.00	87.46	217.53	339.42	

∑(98)1...5, 10...12 = 1479.03 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 28.17 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		0.30	(303a)
Fraction of community heat from CHP		0.70	(303b)
Fraction of total space heat from community CHP	(302) x (303a) =	0.70	(304a)
Fraction of total space heat from community boilers	(302) x (303b) =	0.30	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1479.03		(98)
Space heat from CHP	(98) x (304a) x (305) x (306) =	1087.09	(307a)
Space heat from boilers	(98) x (304b) x (305) x (306) =	465.89	(307b)

Water heating

Annual water heating requirement	1514.25		(64)
Water heat from CHP	(64) x (303a) x (305a) x (306) =	1112.97	(310a)
Water heat from boilers	(64) x (303b) x (305a) x (306) =	476.99	(310b)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	31.43	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	37.51		(330a)
Total electricity for the above, kWh/year		37.51	(331)
Electricity for lighting (Appendix L)		242.03	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3422.47	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from CHP	1087.09	x	2.97	x 0.01 =	32.29	(340a)
Space heating from boilers	465.89	x	4.24	x 0.01 =	19.75	(340b)
Water heating from CHP	1112.97	x	2.97	x 0.01 =	33.06	(342a)
Water heating from boilers	476.99	x	4.24	x 0.01 =	20.22	(342b)
Pumps and fans	37.51	x	13.19	x 0.01 =	4.95	(349)
Electricity for lighting	242.03	x	13.19	x 0.01 =	31.92	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		262.19	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.13	(357)
SAP value	84.24	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

		Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	2169.0722	x	0.2160	=	468.5196	(363)
less credit emissions for electricity		-817.3585	x	0.5190	=	-424.2091	(364)
Water heated by CHP		2220.7175	x	0.2160	=	479.6750	(365)
less credit emissions for electricity		-836.8197	x	0.5190	=	-434.3094	(366)
Emissions from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
CO2 emissions from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	1013.85	x	0.216	=	218.99	(368)
Electrical energy for community heat distribution		31.43	x	0.519	=	16.31	(372)
Total CO2 associated with community systems						324.98	(373)
Total CO2 associated with space and water heating						324.98	(376)
Pumps and fans		37.51	x	0.519	=	19.47	(378)
Electricity for lighting		242.03	x	0.519	=	125.61	(379)
Total CO_2, kg/year					(376)..(382) =	470.06	(383)

Dwelling CO_2 emission rate	(383) ÷ (4) =	8.95	(384)
EI value		93.54	
EI rating (section 14)		94	(385)
EI band		A	

13b. Primary energy - community heating scheme

		Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary Energy from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	2169.07	x	1.22	=	2646.27	(363)
less credit energy for electricity		-817.36	x	3.07	=	-2509.29	(364)
Water heated by CHP		2220.72	x	1.22	=	2709.28	(365)
less credit energy for electricity		-836.82	x	3.07	=	-2569.04	(366)
Primary energy from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
Primary energy from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	1013.85	x	1.22	=	1236.90	(368)
Electrical energy for community heat distribution		31.43	x	3.07	=	96.49	(372)
Total primary energy associated with community systems						1610.60	(373)
Total primary energy associated with space and water heating						1610.60	(376)
Pumps and fans		37.51	x	3.07	=	115.16	(378)
Electricity for lighting		242.03	x	3.07	=	743.02	(379)
Primary energy kWh/year						2468.78	(383)
Dwelling primary energy rate kWh/m2/year						47.02	(384)

Be Green Sample SAPs

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Dr Polytimi Sofotasiou	Assessor number	1234
Client		Last modified	14/07/2019
Address	4 Block N Flr1 4 Beam Park Phase 2, London		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		49.64	(1a) x	2.65	(2a) =	131.55	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	49.64	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	131.55	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		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, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.21	(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 U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.27	0.27	0.26	0.23	0.23	0.20	0.20	0.20	0.21	0.23	0.24	0.25	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

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

	0.52	0.52	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(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	κ-value, kJ/m².K	A x κ, kJ/K	
Window			9.60	x	1.24	=	11.86			(27)
Door			2.28	x	1.50	=	3.42			(26)
External wall			11.87	x	0.19	=	2.26			(29a)
External wall			57.05	x	0.20	=	11.41			(29a)
Total area of external elements ∑A, m²			80.80							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	28.95 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		2.67 (36)
Total fabric heat loss	(33) + (36) =	31.62 (37)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
22.61	22.38	22.15	21.71	21.71	21.71	21.71	21.71	21.71	21.71	21.71	21.71	(38)

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

54.23	54.00	53.77	53.32	53.32	53.32	53.32	53.32	53.32	53.32	53.32	53.32	

Average = ∑(39)1...12/12 = 53.49 (39)

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

1.09	1.09	1.08	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	

Average = ∑(40)1...12/12 = 1.08 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.68 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.09 (43)

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	
81.50	78.53	75.57	72.61	69.64	66.68	66.68	69.64	72.61	75.57	78.53	81.50	

∑(44)1...12 = 889.06 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

120.86	105.70	109.08	95.10	91.25	78.74	72.96	83.73	84.73	98.74	107.78	117.04	

∑(45)1...12 = 1165.70 (45)

Distribution loss 0.15 x (45)m

18.13	15.86	16.36	14.26	13.69	11.81	10.94	12.56	12.71	14.81	16.17	17.56	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00 (47)
Water storage loss:	
b) Manufacturer's declared loss factor is not known	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.03 (51)
Volume factor from Table 2a	4.93 (52)
Temperature factor from Table 2b	1.00 (53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17 (54)
Enter (50) or (54) in (55)	0.17 (55)

Water storage loss calculated for each month (55) x (41)m

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

5.19	4.69	5.19	5.02	5.19	5.02	5.19	5.19	5.02	5.19	5.02	5.19	(57)

Primary circuit loss for each month from Table 3

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 for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

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

149.31	131.40	137.53	122.63	119.70	106.27	101.42	112.18	112.26	127.19	135.32	145.50	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

149.31	131.40	137.53	122.63	119.70	106.27	101.42	112.18	112.26	127.19	135.32	145.50	

∑(64)1...12 = 1500.71 (64)

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

62.95	55.71	59.03	53.65	53.10	48.21	47.02	50.60	50.20	55.59	57.87	61.68	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	100.77	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.61	28.96	23.55	17.83	13.33	11.25	12.16	15.80	21.21	26.93	31.44	33.51	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	218.36	220.62	214.91	202.76	187.41	172.99	163.36	161.09	166.80	178.96	194.30	208.72	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	-67.18	(71)
Water heating gains (Table 5)	84.61	82.90	79.34	74.51	71.37	66.96	63.20	68.01	69.72	74.72	80.37	82.90	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	415.92	412.83	398.15	375.44	352.46	331.55	319.06	325.25	338.08	360.96	386.45	405.48	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	1.00	x	9.60	x	19.64	x 0.9 x	0.40	x	0.80	=	54.30	(76)

Solar gains in watts ∑(74)m...(82)m

54.30	106.23	174.94	255.14	312.68	320.08	304.73	261.76	203.46	126.04	67.71	44.65	(83)

Total gains - internal and solar (73)m + (83)m

470.22	519.05	573.09	630.58	665.14	651.63	623.80	587.01	541.54	487.01	454.16	450.14	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.98	0.97	0.94	0.85	0.70	0.52	0.37	0.42	0.65	0.89	0.97	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.15	20.30	20.54	20.79	20.94	20.99	21.00	21.00	20.97	20.77	20.42	20.13

(87)

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

20.01	20.01	20.01	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02

(88)

Utilisation factor for gains for rest of dwelling n2,m

0.98	0.96	0.92	0.81	0.64	0.44	0.29	0.33	0.57	0.85	0.96	0.98

(89)

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

18.91	19.13	19.46	19.80	19.97	20.02	20.02	20.02	20.00	19.78	19.31	18.89

(90)

Living area fraction — Living area ÷ (4) = 0.57 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

19.61	19.79	20.07	20.36	20.52	20.57	20.57	20.57	20.55	20.34	19.94	19.60

(92)

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

19.61	19.79	20.07	20.36	20.52	20.57	20.57	20.57	20.55	20.34	19.94	19.60

(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm	0.98	0.96	0.92	0.83	0.67	0.48	0.34	0.38	0.61	0.87	0.96	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	459.54	499.34	528.98	522.12	445.58	314.48	211.43	221.70	331.86	422.34	435.46	441.58	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	830.45	804.10	729.55	611.07	470.18	318.14	211.88	222.50	343.78	519.26	684.62	820.89	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	275.96	204.80	149.22	64.04	18.30	0.00	0.00	0.00	0.00	72.11	179.39	282.21	

∑(98)1...5, 10...12 = 1246.04 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 25.10 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		0.30	(303a)
Fraction of community heat from CHP		0.70	(303b)
Fraction of total space heat from community CHP	(302) x (303a) =	0.70	(304a)
Fraction of total space heat from community boilers	(302) x (303b) =	0.30	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1246.04		(98)
Space heat from CHP	(98) x (304a) x (305) x (306) =	915.84	(307a)
Space heat from boilers	(98) x (304b) x (305) x (306) =	392.50	(307b)

Water heating

Annual water heating requirement	1500.71		(64)
Water heat from CHP	(64) x (303a) x (305a) x (306) =	1103.02	(310a)

Water heat from boilers	(64) x (303b) x (305a) x (306) =	472.72	(310b)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	28.84	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)		
mechanical ventilation fans - balanced, extract or positive input from outside	35.47	(330a)
Total electricity for the above, kWh/year	35.47	(331)
Electricity for lighting (Appendix L)	230.34	(332)
Energy saving/generation technologies		
electricity generated by PV (Appendix M)	-228.15	(333)
Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	2921.74	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from CHP	915.84	x	2.97	x 0.01 =	27.20	(340a)
Space heating from boilers	392.50	x	4.24	x 0.01 =	16.64	(340b)
Water heating from CHP	1103.02	x	2.97	x 0.01 =	32.76	(342a)
Water heating from boilers	472.72	x	4.24	x 0.01 =	20.04	(342b)
Pumps and fans	35.47	x	13.19	x 0.01 =	4.68	(349)
Electricity for lighting	230.34	x	13.19	x 0.01 =	30.38	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-228.15	x	13.19	x 0.01 =	0.00	(352)
Total energy cost			(340a)...(342e) + (345)...(354) =		251.71	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.12	(357)
SAP value	84.42	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

		Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	1827.3744	x	0.2160	=	394.7129	(363)
less credit emissions for electricity		-688.5986	x	0.5190	=	-357.3827	(364)
Water heated by CHP		2200.8672	x	0.2160	=	475.3873	(365)
less credit emissions for electricity		-829.3397	x	0.5190	=	-430.4273	(366)
Emissions from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
CO2 emissions from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	930.35	x	0.216	=	200.96	(368)
Electrical energy for community heat distribution		28.84	x	0.519	=	14.97	(372)
Total CO2 associated with community systems						298.21	(373)
Total CO2 associated with space and water heating						298.21	(376)
Pumps and fans		35.47	x	0.519	=	18.41	(378)

Electricity for lighting	230.34	x	0.519	=	119.55	(379)
Energy saving/generation technologies						
pv savings	-228.15	x	0.519	=	-118.41	(380)
Total CO_2, kg/year				(376)..(382) =	317.76	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	6.40	(384)
EI value					95.50	
EI rating (section 14)					96	(385)
EI band					A	

13b. Primary energy - community heating scheme

		Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary Energy from community CHP (space and water heating)							
Power efficiency of CHP unit		37.68					(361)
Heat efficiency of CHP unit		50.12					(362)
Space heating from CHP	(307a) × 100 ÷ (362) =	1827.37	x	1.22	=	2229.40	(363)
less credit energy for electricity		-688.60	x	3.07	=	-2114.00	(364)
Water heated by CHP		2200.87	x	1.22	=	2685.06	(365)
less credit energy for electricity		-829.34	x	3.07	=	-2546.07	(366)
Primary energy from other sources (space heating)							
Efficiency of boilers		93.00					(367b)
Primary energy from boilers	[(307b)+(310b)] x 100 ÷ (367b) =	930.35	x	1.22	=	1135.03	(368)
Electrical energy for community heat distribution		28.84	x	3.07	=	88.54	(372)
Total primary energy associated with community systems						1477.95	(373)
Total primary energy associated with space and water heating						1477.95	(376)
Pumps and fans		35.47	x	3.07	=	108.89	(378)
Electricity for lighting		230.34	x	3.07	=	707.14	(379)
Energy saving/generation technologies							
Electricity generated - PVs		-228.15	x	3.07	=	-700.41	(380)
Primary energy kWh/year						1593.56	(383)
Dwelling primary energy rate kWh/m2/year						32.10	(384)