Red & Yellow Specialist Extra Care

Melliss Avenue - Kew

Energy Strategy

October 2018

Quality information

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Revision History

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01	September 2018	Draft for review	CP	Colin Page	Regional Director
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Executive Summary

This Energy Statement has been prepared by AECOM on behalf of Melliss Ave Devco Limited ("the Applicant") in support of a full planning application for the new build mixed-use development located at Former Biothane Site, Melliss Avenue, Kew TW9 4BD (herein referred to as the 'Proposed Development'), in the London Borough of Richmond upon Thames (LBRT).

The strategy for reducing the energy consumption and carbon dioxide (CO2) emissions associated with the Proposed Development is guided by the Mayor's Energy Hierarchy:

- passive design and energy efficiency (i.e. 'Be Lean');
- energy efficient supply of services (i.e. 'Be Clean'); and
- on-site renewable energy technologies (i.e. 'Be Green').

The energy consumption and associated CO_2 emissions of the Proposed Development have been estimated using approved software compliant with the Building Regulations Approved Document L1A & L2A 2013 (ADLA).

The baseline scheme is defined as that which would meet the requirements of the Building Regulations ADL A 2013 using natural gas where possible. The Proposed Development's baseline CO_2 emissions for regulated and unregulated energy uses are presented in Table 3-1.

As detailed in the report the Proposed Development could achieve circa 4% savings in regulated CO_2 emissions over the site-wide baseline with the incorporation of passive design and energy efficiency measures ('Be Lean' scheme).

The potential for connection to nearby existing low carbon heat distribution networks has been investigated but is not viable. An on-site Combined Heat and Power (CHP) option is considered impractical due to the lack of gas supply to the site. This view is reinforced when considering both the upcoming changes to carbon factors (making CHP carbon inefficient) and the realization that even a rudimentary calculation of actual distribution losses to flats result much in more than the current regulations nominal 5% of heat lost.

An analysis of the feasibility of on-site renewable energy technologies has been undertaken, and two technologies have been selected.

- Rooftop PV panels, set above a green roof, with spacing to allow areas of light and shade to the roof below which will create a range of microclimates and enhance the biodiversity of the roof.
- Air source heat pumps; primary heating will be provided via air source heat pumps serving an ambient temperature water loop. This use of a low temperature water loop will reduce losses and overheating in the corridor. An electrically fuelled heat pump in each flat will produce higher temperature hot water serving underfloor heating and domestic hot water.

The following pages summarise the:

- Residential CO_2 emissions breakdown
- Non-residential CO_2 emissions breakdown
- Site-wide total CO_2 emissions breakdown

Please note that any discrepancies in the sums of the figures presented in the tables below are down to rounding.

Domestic

Table 0-1 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	108.9	13.3
After passive design and energy efficiency measures ('be lean')	106.6	13.3
After low carbon technologies ('be clean')	106.6	13.3
After renewable energy technologies ('be green')	70.8	13.3

Table 0-2 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from 'be lean'	2.3	2.1%
Estimated savings from 'be clean'	0	0%
Estimated savings from 'be green'	35.84	32.9%
Total estimated cumulative CO_2 emissions over Baseline	**38.1**	**35%**
Total Target Savings	108.9	100%
Shortfall	70.8	65%

The domestic elements of the site are required to achieve the latest zero carbon targets while meeting a 35% CO_2 reduction by on-site measures. Therefore, on the basis of the above percentage reductions achievable on site, a cash in lieu contribution would have to be made for the anticipated carbon shortfall of the domestic units. This will be lower if the more modern carbon factors are used.

Non-Domestic

Table 0-3 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	93.2	86.4
After passive design and energy efficiency measures (‘be lean’)	87.9	86.4
After low carbon technologies (‘be clean’)	87.9	86.4
After renewable energy technologies (‘be green’)	60.6	86.4

Table 0-4 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from ‘be lean’	5.3	5.7%
Estimated savings from ‘be clean’	0	0%
Estimated savings from ‘be green’	27.3	29.3%
Total estimated cumulative CO_2 emissions over Baseline	**32.6**	**35%**
Total Target Savings	32.6	35%
Shortfall	-	-

Site-wide

Table 0-5 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	202.1	99.7
After passive design and energy efficiency measures ('be lean')	194.6	99.7
After low carbon technologies ('be clean')	194.6	99.7
After renewable energy technologies ('be green')	131.4	99.7

Table 0-6 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from 'be lean'	7.5	3.7%
Estimated savings from 'be clean'	0	0%
Estimated savings from 'be green'	63.1	31.3%
Total estimated cumulative CO_2 emissions over Baseline	**70.7**	**35%**

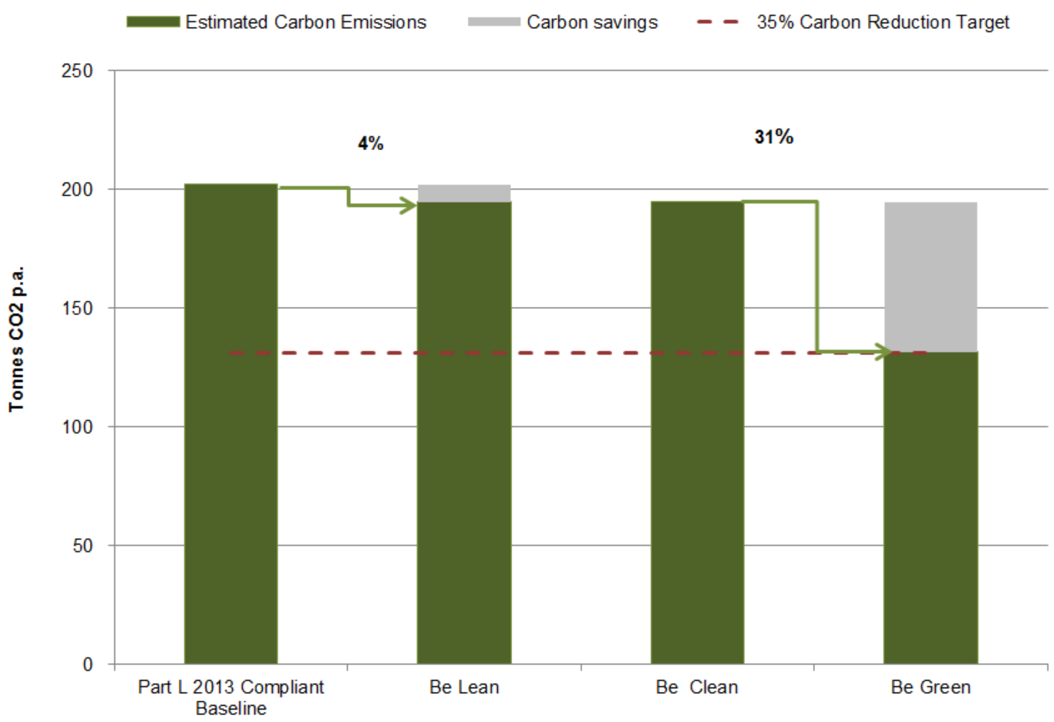


Figure 0-1 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Were the more modern/realistic SAP 10 carbon factors to be used, onsite reductions on baseline would be

- 67% for Domestic and
- 48% for non-domestic

The required offset payment would be reduced to circa 45% of the previous value.

1. Introduction

This Energy Statement has been prepared on behalf of Melliss Ave Devco Limited ("the Applicant") in support of a full planning application for the proposed development at the Former Biothane Site, Melliss Avenue, Kew TW9 4BD (herein referred to as the Proposed Development) in the London Borough of Richmond upon Thames (LBRT).

The strategy seeks to mitigate the Proposed Development's impact on climate change and to reduce its carbon dioxide (CO_2) emissions by following the principles of the 'Energy Hierarchy' outlined in the sections below.

1.1 Proposed Development Description

The site is located just to the east of the Royal Botanic Gardens, in South London. Kew Gardens station is to the West and the river Thames is to the east. To the north is the National Archives building.

The scheme involves demolition of existing buildings and structures and redevelopment of the site to provide a Specialist Extra Care facility (C2 Use Class) for the elderly with existing health conditions. Comprising, 89 units, with extensive private and communal healthcare, therapy, leisure and social facilities set within a building of ground plus 3 to 5 storeys including set backs. Provision of car and cycle parking, associated landscaping and publicly accessible amenity spaces including a children's play area. For additional information, please refer to the Design and Access Statement (DAS).Table 1-1 1 below includes a breakdown of the number of units in the domestic part of the development.

Table 1-1 Development Schedule Summary

Type	Number of units
Total Units	**89**
1b	11
2b	6
2b+	46
2b++	18
2b+s	8

1.2 Planning Context

The main drivers of this energy statement are summarised below:

1.2.1 National Policy

The latest policies implemented by the Government with respect to combatting global warming and climate change include *The Energy Act 2013, The National Planning Policy Framework (NPPF) 2012* and *The Carbon Plan (2011)*.

It should be noted that at this point in time, national policies are considered unclear, due to the recent release of the *Deregulation Act 2015* and the *Productivity Plan, Fixing the Foundations*. As such, there remains uncertainty around the future direction of Government policy.

Recently announced proposals to update SAP, the approved assessment tool for part L1A of the building regulations England will also be considered here. These will have a material impact on technical solutions chosen to meet local and national planning policy objectives. The most important change is as a result of electricity grid decarbonisation, and is reflected in the gas and electricity carbon factors. Where-as previously using gas was comparatively clean compared to electricity, this will not be the case.

1.2.2 Regional Policy

The regional policy consists of *The London Plan (The Spatial Development Strategy for London Consolidated with Alterations since 2011, March 2016)*, *Energy Planning – Greater London Authority Guidance on Preparing Energy Assessment (March 2016)* and a number of supplementary documents such as:

a. *Sustainable Design and Construction Supplementary Planning Guidance (2014)*;

b. *Delivering London's Energy Future: The Mayor's Climate Change Mitigation and Energy Strategy (2011);* and

c. *London Heat Network Manual (2014)*.

For energy purposes, the regional policy requires that developments reduce their CO_2 emissions in accordance with the Energy Hierarchy and make the fullest contribution to London's adaptation to climate change. All residential developments should meet the 'Zero carbon' target, which requires an on-site reduction in regulated CO_2 emissions of 35% against 2013 Building Regulation and the remaining carbon emissions to be off-set to 100%.

The regional policy also seeks:

- Minimization of the overheating risk and the demand for cooling;
- On-site renewable energy generation;
- Commitment to site wide networks with a single energy centre, where possible; and
- Allowance for connection to existing or planned district heating networks identified in the area.

The emerging London Plan will set out a framework for development of London over the next 20-25 years; it is likely to be adopted in 2019, and therefore proposed policies have not been specifically addressed in this Energy Statement. For context, some key proposed policies of the emerging London include the requirement that all major developments are net zero-carbon; in meeting the zero-carbon target a minimum on-site reduction of at least 35 per cent beyond Building Regulations is expected.

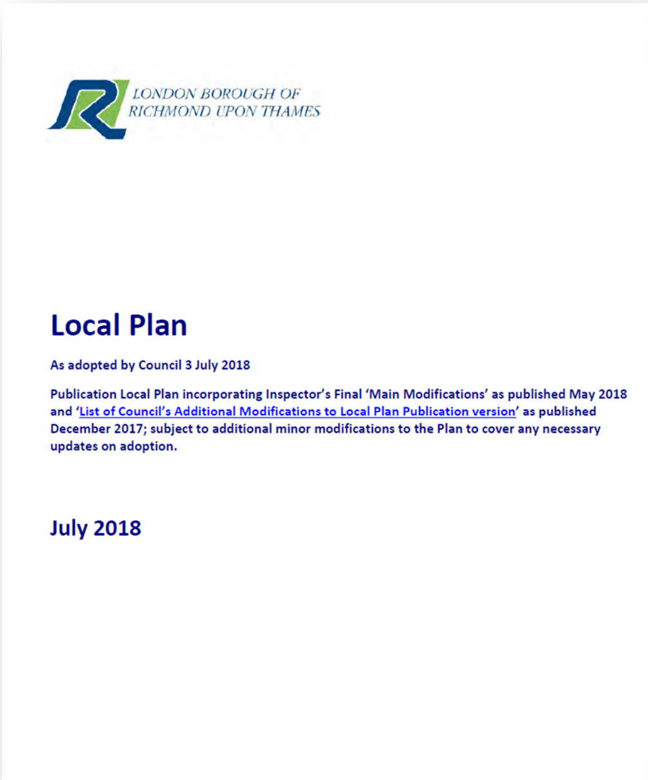
Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be offset either through a cash in lieu contribution to the relevant borough's carbon offset fund, and/or by providing an alternative proposal off-site.

Also notably, the emerging London Plan proposes that residential development should aim to achieve 10%, and non-residential development should aim to achieve 15% reduction in CO_2 emissions through energy efficiency measures alone.

In addition, the emerging London Plan requires energy masterplans to be developed for large-scale development locations, which establish the most effective energy supply options.

1.2.3 Local Planning Policy

A new local plan was adopted by the RBRT Council on the 3rd July 2018.



LONDON BOROUGH OF RICHMOND UPON THAMES

Local Plan

As adopted by Council 3 July 2018

Publication Local Plan incorporating Inspector's Final 'Main Modifications' as published May 2018 and 'List of Council's Additional Modifications to Local Plan Publication version' as published December 2017; subject to additional minor modifications to the Plan to cover any necessary updates on adoption.

July 2018

Of particular importance is Policy LP 22, reproduced below:

Policy LP 22

Sustainable Design and Construction

A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:

1. Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.
2. Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).
3. New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.
4. Proposals for change of use to residential will be required to meet BREEAM Domestic Refurbishment 'Excellent' standard (where feasible).

Reducing Carbon Dioxide Emissions

B. Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:

1. All new major residential developments (10 units or more) should achieve zero carbon standards in line with London Plan policy.
2. All other new residential buildings should achieve a 35% reduction.
3. All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non-residential buildings should achieve zero carbon standards in line with London Plan policy.

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations.

C. This should be achieved by following the Energy Hierarchy:

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

Decentralised Energy Networks

D. The Council requires developments to contribute towards the Mayor of London target of 25% of heat and power to be generated through localised decentralised energy (DE) systems by 2025. The following will be required:

1. All new development will be required to connect to existing DE networks where feasible. This also applies where a DE network is planned and expected to be operational within 5 years of the development being completed.
2. Development proposals of 50 units or more, or new non-residential development of 1000sqm or more, will need to provide an assessment of the provision of on-site decentralised energy (DE) networks and combined heat and power (CHP).
3. Where feasible, new development of 50 units or more, or new non-residential development of 1000sqm or more, as well as schemes for the Proposal Sites identified in this Plan, will need to provide on-site DE and CHP; this is particularly necessary within the clusters identified for DE opportunities in the borough-wide Heat Mapping Study. Where on-site provision is not feasible, provision should be made for future connection to a local DE network should one become available.

Applicants are required to consider the installation of low, or preferably ultra-low, NOx boilers to reduce the amount of NOx emitted in the borough.

Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where appropriate.

Retrofitting

E. High standards of energy and water efficiency in existing developments will be supported wherever possible through retrofitting. Householder extensions and other development proposals that do not meet the thresholds set out in this policy are encouraged to complete and submit the Sustainable Construction Checklist SPD as far as possible, and opportunities for micro-generation of renewable energy will be supported in line with other policies in this Plan.

1.2.3.1 CO2

6.3.12 Major residential developments (10 units or more) should achieve zero carbon standards in line with the London Plan. A zero carbon home is one where at least 35% of regulated CO2 emissions reductions are achieved on-site, with the remaining emissions (up to 100%) to be offset through a contribution into the Council's Carbon Offset Fund. The Council has adopted the London Plan price of carbon which is £60 per tonne x 30 years equalling £1,800 per tonne of carbon. Zero carbon standards will apply to major non-residential schemes from 2019. Where development viability is a concern, affordable housing will be prioritised over zero carbon contributions.

In summary,

- the residential part of the development should meet at least
  - 35% carbon reduction through onsite solutions,
  - with further reduction to zero carbon through a payment to the council.

- The non-residential part of the development should meet at least
  - 35% carbon reduction through onsite solutions.

1.2.3.2 PV

There is a target for each development to have areas of green roof, and specific guidance that green roof and PV panels should coexist.

5.6.4 A green roof is defined as having a minimum of 70% soil/vegetation coverage, with a minimum substrate depth of 85mm, and a maximum of 30% hard surface. Green roofs are not roof terraces. Green roofs can be installed on any pitch of roof; however, as the pitch increases, additional specific design measures will be required in order to retain the substrate across the roof surface, which will result in increased costs. The appearance of the green roof also needs to be compatible with the surrounding area. The aim should be to use at least 70% of any potential roof plate area as a green roof; that is, the total roof plate area including space for renewable energy solutions such as photovoltaic panels and solar thermal but excluding non-green roof solutions such as air conditioning units. The Council will take into account relevant viability information.

5.6.5 Green roofs do not preclude the use of renewable energy technologies. Green roofs and photovoltaic panels or solar thermal units can be used together and green roofs may increase the efficiency of solar photovoltaic panels by regulating temperature. An applicant will have to provide evidence and justification if a green roof cannot be incorporated for major development proposals with roof plate areas of 100sqm or more.

1.2.3.3 CHP

Combined Heat and Power (CHP) is referenced, with the desire for applicants to consider CHP, while being mindful of both location and NOx emission problems.

6.3.17 The Mayor has set a target for London to generate 25% of its heat and power requirements through the use of district heating networks and other forms of decentralised energy systems by 2025. There is an expectation that the provision and availability of DE networks for developments to connect to, will increase during the lifetime of this Plan. As such, all new development will be required to connect to existing DE networks where feasible. This also applies where a DE network is planned and expected to be operational within 5 years of the development being completed.

6.3.18 Applicants for development proposals of 50 units or more, or new non-residential development of 1000sqm or more, will be required to provide an assessment of the provision of on-site decentralised energy (DE) networks and combined heat and power (CHP). In addition, all applications for developments of 50 units or more, or new non-residential development of 1000sqm or more, should assess the feasibility of providing Decentralised Energy (DE) and Combined Heat and Power (CHP) on their site.

6.3.19 The borough-wide Heat Mapping Study identified the following 7 clusters with opportunities for DE networks in the borough (maps of these areas are set out in the Study, which is available on the Council's website):

- Richmond Centre
- Teddington
- Mortlake
- Twickenham Centre
- Richmond-Wandsworth
- Richmond-Kingston
- Richmond-Hounslow

6.3.20 Fuel combustion as part of CHPs can potentially give rise to air pollutants, particularly oxides of nitrogen (NOx), which can have a negative impact on health. Therefore, developers are required to consider the installation of low, or preferably ultra-low, NOx boilers to reduce the amount of NOx emitted in the borough. Further details and guidance can be obtained from the Council.

2. Assessment methodology

The strategy has been undertaken with a view to reducing the regulated energy consumption and associated CO_2 emissions of the Proposed Development in order to ensure compliance with the Building Regulations and with local policies relating to:

- Passive design and energy efficiency (i.e. 'Be Lean');
- Energy efficient and low carbon supply of services (i.e. 'Be Clean'); and
- On-site renewable energy technologies (i.e. 'Be Green').

Generally, the strategy is undertaken on the following manner:

- Calculation of the ADL 2013 compliant regulated baseline energy demand and associated CO_2 emissions;
- Determination of the most appropriate energy efficiency and passive design measures. These are then incorporated into the energy calculations, representing an enhanced scheme.
- Identification of clean energy supply technologies (e.g. CHP and/or District Heating network) and incorporation of them into the energy calculations, in accordance with local policies;
- Identification of the most applicable 'Be Green' renewable energy technologies to further reduce the CO_2 emissions of the development through on-site renewable sources.

The regulated energy consumption and associated CO_2 emissions of the Proposed Development have been estimated using:

- Non-residential areas: Dynamic Simulation Modelling (DSM) software IES v2017.04.0.8; and
- Residential areas (sample dwellings): Standard Assessment Procedure (SAP) 2012 Plan Assessor v6.3.4.

In addition to the basic overheating compliance tests under Criterion 3, dynamic thermal modelling has also been undertaken, as part of the adopted 'Be Lean' measures, to assess the overheating risk. A number of sample apartments most affected by solar gains (worst case scenarios) were selected for the overheating analysis, in accordance with guidance and data sets from Design Summer Years for London (CIBSE TM49, 2014).

3. Baseline compliance

The baseline scheme adopted for the purposes of this strategy is calculated by reference to compliance with Part L 2013 Criterion 1 of the Building Regulations. This sets out a target that defines the maximum permissible emissions (i.e. TER) with which a development must comply.

The estimated baseline regulated and unregulated CO_2 emissions for the Proposed Development are shown below. As required by the Building Regulations, the regulated CO_2 emissions of the Proposed Development will not exceed the target emissions as presented in the table below.

Table 3-1 Estimated Baseline CO_2 Emissions

	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Domestic	108.9	13.3
Non-domestic	93.2	86.4
Site-wide Proposed Development	**202.1**	**99.7**

Sample worksheets for typical residential units have been included in Appendix C, for reference.

4. 'Be Lean'- Passive Design and Energy Efficiency Measures

The objective of this section is to describe the potential opportunities that have been identified in order to reduce the CO_2 footprint of the Proposed Development through the incorporation of passive design and energy efficiency measures. This step is referred to as 'Be Lean' in the Energy Hierarchy.

4.1 Passive design summary

Table 4-1 summarises the passive design measures that have been incorporated in the current design of the Proposed Development.

Table 4-1: Currently Adopted Passive Design Measures

Technology	Method of CO_2 reduction
Building Envelope	Improved U-values of the thermal elements and controlled fittings, over the minimum Building Regulations ADL A 2013 requirements. Improved building air-tightness beyond the Building Regulations ADL A 2013 minimum requirements; the air tightness currently modelled is 3 m/h for the domestic areas and 5 m/h for the commercial spaces.
Thermal Bridging	The current approach assumes a conservative default performance for the y-value (y-value = 0.15). It is recommended that a detailed thermal bridging calculation is performed at the next stage of design. This will likely improve the CO2 emissions and provide a larger buffer for the fabric energy efficiency standard.
Promoting Natural Daylight	Promotion of natural lighting throughout the design to minimise the use of artificial lighting. Large windows through the development allow good penetration of daylight. This is of particular importance for older residents, who have higher lux requirements.

Table 4-2 outlines the current fabric specification for the Proposed Development. The U-values stated below provide compliance and constitute significant improvement over the Building Regulations limiting and default values.

The U-values that have been used for the planning modelling purposes have been discussed and are in accordance with the architects' current assumptions. However, in order to allow for design flexibility, the final specification is expected to be agreed upon later in the design process.

Table 4-2: Current Fabric Specification for the Proposed Development

	Domestic	Non Domestic
External walls	0.18 W/m^2K	0.18 W/m^2K
Party walls (solid or fully filled)	0.00 W/m^2K	-
Floor	-	0.12 W/m^2K
Roof	0.13 W/m^2K	0.13 W/m^2K
Windows	1.4W/m^2K	1.4W/m^2K
Doors	-	2.20 W/m^2K

4.3 Energy Efficient services summary

Table 4-3 lists all the energy efficiency measures that have been incorporated in the current design of the Proposed Development. These are mainly associated with the servicing strategy of the building.

Table 4-3: Currently Adopted Energy Efficiency Measures

Technology	Method of CO_2 reduction
Efficient Lighting	The following measures have been incorporated: • use of energy efficient lights (e.g. residential units); • Passive Infrared (PIR) sensors; • dimmable and zoned lighting; and • lighting control modules such as daylight sensors in appropriate areas where applicable.
Efficient Heating, Ventilation and Air Conditioning (HVAC) Systems	Thermal comfort in the flats and domestic corridors will be maintained via high efficiency Mechanical Ventilation with Heat Recovery (MVHR) units and openable windows for natural ventilation. Windows will partly open allowing blinds/curtains to be drawn across the remainder of the glazed areas, minimising solar gains. Fan speed control has been specified to match air supply rates, alongside improved SFP (Specific Fan Power) for mechanically ventilated areas. Thermal comfort in the ground floor non-residential elements will be maintained via mechanical cooling where required. Efficient centralised gas fired boilers will provide supply and resilience for the domestic hot water demand for all areas of the building (these will be removed as part of the be green study)
Vertical Transportation	Energy efficient lifts will be specified.
Power Factor Correction	Power factor correction will be provided, this will reduce the electrical energy lost in the grid.
Energy Efficient Equipment	Energy efficient white goods and equipment can be provided in order to reduce the CO_2 emissions associated with non-regulated energy uses.
Building User Guide	Provision of Home User Guides to residents and Building User Guides to the commercial staff (in line with BREEAM requirements) will be promoted so that users are aware of how to operate them effectively.

The L2A evidence has been included in Appendix D for information.

4.4 Minimising solar gains

The potential for overheating and reliance on air conditioning systems has been reduced in line with the Mayor's Cooling Hierarchy. The following measures were introduced in order to limit the effects of solar gains in summer, following Policy 5.9 Overheating and Cooling:

1. Minimise internal heat generation through energy efficient design
   - Specifying low energy lighting and encouraging the use of low energy equipment to reduce internal heat generation; and
   - Insulating all heat distribution infrastructure to high standards to minimise heat losses.
2. Reduce the amount of heat entering the building

- Incorporating high performance glass throughout the scheme in general and in the non-residential elements in particular (g-value = 0.45), to minimise solar gains in summer.
- Incorporating internal shading devices, such as blinds, and ensuring they are able to operate with opening window.
- The provision of a large brise soleil on the upper floors of the building. This will extend 1.5m from the wall, and will consist of fins aligned to block all sun falling through the device and onto windows.

3. Passive ventilation / Mechanical ventilation

- Specifying Natural ventilation strategy with high efficiency Mechanical Ventilation with Heat Recovery (MVHR) system throughout the scheme.

4. Active cooling

- Specifying active cooling for the non-residential units, which will include a high efficiency cooling system in the form of Air Source Heat Pumps (ASHPs) to allow for enhanced thermal comfort. The system will be detailed further in the design stage MEP Services Report.

4.5 Overheating analysis

Figure 4-1: Visual Representation of a design iteration IES model used in the overheating and L2A Assessment

The potential for overheating of the residential units has been modelled under the SAP methodology and tested against criteria set in SAP (Appendix P): Assessment of internal temperature in summer. In addition to the above, further investigation has been conducted through thermal modelling analysis using CIBSE TM59 methodology. The full Overheating Report is presented in Appendix E.

To help mitigate the overall risk of overheating to all rooms, while keeping beneficial thermal gains, it was recommended that glass with a g-value of 0.45 is used, in conjunction with internal shading devices with properties similar to those described in Overheating Report (Appendix E).

As part of the analysis presented in the Overheating report, nine apartments were modelled to evaluate the overheating risk. These were selected to give a representative range of apartments, including the highly glazed apartments on the south side of the upper floor.

The report concluded that with small changes, which have been accepted into the current design, no rooms would overheat. This was achieved by:

- g-value of 45% or lower for the glass
- floor to ceiling windows can open, with light coloured blinds behind windows users choose not to open
- spandrel panels to floor to ceiling windows in bathrooms, and a small number of corner rooms
- increasing the opacity of the 1.5m wide high level bries soleil using louvres, so all direct sun is blocked from passing through it and onto the façade.

The non-domestic areas are anticipated to require air-conditioning to ensure good thermal comfort levels for the occupants. Table 4-4 below shows the cooling requirement for these areas is actually slightly above the notional building, however the CO_2 used for cooling in the final design is only predicted to be 14% of total CO2 use.

Table 4-4: Non-domestic Cooling Demand

	Notional Cooling Demand (MJ/m^2)	Actual Cooling Demand (MJ/m^2)	Improvement (%)
Non-domestic	81.2	101.7	-25%

4.6 CO2 emissions summary

The results of the calculations set out in Table 4-5 illustrate that the additional energy efficiency and passive design measures alone (i.e. adopted 'Be Lean' scheme) have the potential to reduce the Proposed Development's regulated CO_2 emissions by circa 4% beyond the baseline scheme.

Table 4-5: Estimated Regulated CO_2 Emissions

	Baseline (Tonnes CO_2 p.a.)	'Be Lean' (Tonnes CO_2 p.a.)	Improvement over Baseline (%)
Domestic	108.9	106.6	2.1%
Non-domestic	93.2	87.9	5.7%
Site-wide Proposed Development	**202.1**	**194.6**	**3.7%**

5. 'Be Clean' – Low Carbon Technology Appraisal

The following sections outline potentially adoptable measures to support meeting regional and local policies.

5.1 Introduction to Low Carbon Technologies

The following three options have been considered for the Proposed Development:

1. connecting to existing/potential District Heating (DH) networks;
2. site wide Combined Heat and Power (CHP) network; and
3. site wide Combined Cooling Heat and Power (CCHP).

A DH network is a system for distributing heat generated in a centralised location. The energy centre serving the area often includes a CHP plant. CHP is considered a low carbon technology which effectively uses waste heat from the electricity generation process to provide useful heat for space and water heating.

5.2 Connection to Existing District Heating Schemes

Based on the data included in the London Heat Map[1] and the Combined Heat and Power Association (CHPA) district heating database[2], there are no existing or proposed networks in the immediate vicinity of the site.

As a result, a DH connection option was not further considered. The new building, however, will be future-proofed to enable a connection to be made should one becomes possible for the Proposed Development, by providing pipework from a central plant room to the dwellings. This will be used for the ambient temperature water loop.

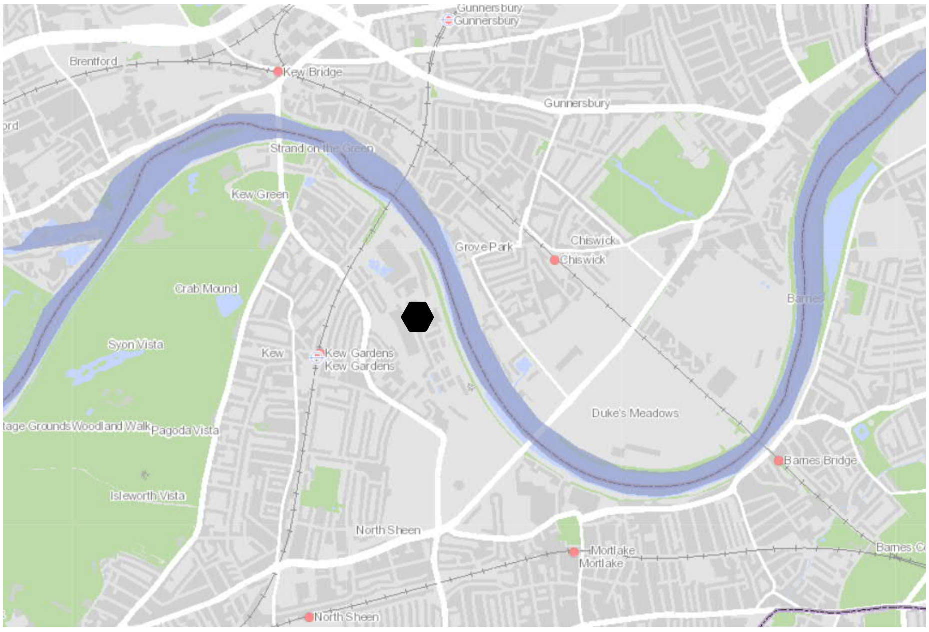


Figure 5-1: London Heat Map extract

[1] The London Heat Network Manual: http://www.londonheatmap.org.uk/Content/TheManual.aspx
[2] CHPA district heating database: http://www.theade.co.uk/district-heating-installation-map_790.html

5.3 On-site CHP opportunities

5.3.1 CHP technology

An on-site Combined Heat and Power (CHP) option is considered impractical due to the lack of gas supply to the site. This view is reinforced when considering both the upcoming changes to carbon factors (making CHP carbon inefficient) and the realization that calculated distribution losses to flats result much more than the current nominal 5% of heat lost, with typical theoretical values of 40% even on good practice schemes.

Bio fuel, for example wood chip fired CHP has been discounted due to both the difficulty of supplying woodchip and the increased lorry traffic this would generate, but also the in practice air quality problems associated with these technologies.

5.4 'Be Clean' Summary

The provision of polluting CHP engines as proposed under the "Be Clean" part of these proposals has been discounted. District heating connection is not possible at this time.

The results set out in Table 5-1 below illustrate the carbon performance of the domestic and non-domestic elements after the introduction of low carbon technologies (i.e. adopted 'Be Clean' scheme).

Table 5-1: Estimated Regulated CO_2 emissions

	Baseline (Tonnes CO_2 p.a.)	'Be Lean' (Tonnes CO_2 p.a.)	'Be Clean' (Tonnes CO_2 p.a.)	Improvement over Baseline from 'Be Clean' (%)
Domestic	108.9	106.6	106.6	2.1%
Non-domestic	93.2	87.9	87.9	5.7%
Site-wide Proposed Development	**202.1**	**194.6**	**194.6**	**3.7%**

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6. 'Be Green' – Renewable Energy Technologies

Consideration has been given to the inclusion of renewable energy technologies within the Proposed Development, in accordance with relevant planning policies.

The renewable energy technology which has been found technically feasible for the Proposed Development is described in the following section. Site specific analysis of those technologies not considered feasible is included in Appendix G, together with the reasons for their rejection.

The adopted technologies are Photo Voltaic Electricity Generation (PV) and Air Source Heat Pumps (ASHP).

6.1 Air Source Heat Pump (ASHP) Systems

A heat pump is a device for transferring heat from a lower temperature heat source to a higher temperature heat sink. Apart from the high efficiencies that ASHPs can achieve in heating mode, their main advantage is that they do not require gas supply, ventilation and flue arrangements. Unlike a traditional boiler or CHP engine, they do not contribute to local NOx pollution. Air source heat pumps are a good option for saving carbon with the current regulations based on out of date carbon factors. With the decarbonisation of the electricity grid they are even better.

ASHP systems are an appropriate technology to serve the space conditioning and Domestic Hot Water (DHW) demands of both the commercial and domestic areas of the development.

Only ASHP in heating mode is considered a renewable technology (Directive 2009/28/EC of the European Parliament and of the Council of the European Union, 2009). Therefore, for the purposes of this report, only heat associated with the ASHP will be included under the 'renewable energy' scheme, whilst the benefits associated with cooling mode have been included under the 'Be Lean' scheme.

The air source heat pumps heat rejection and gathering units will form a roof mounted central system. To remove many of the problems of corridor overheating and heat wastage seen on many modern schemes, the heat will be supplied to the apartments via an ambient temperature water loop. This ambient temperature water will then be boosted up to a more useful temperature by equipment residing in each dwelling. The overall efficiency of the combined central and distributed system has been entered as 300%, following the manufacturer's methodology that has been developed with BRE.

6.2 PV

PV panels are devices for converting sunlight and diffuse light into electrical energy. The price of PV panels has seen rapid reductions in recent years, with installed prices for larger systems falling the most dramatically.

As set out in paragraph 5.6.5 of the local plan, PV and green roof can coexist happily. The green roof provides some marginal benefit to the PV panel by providing a slight cooling, thereby increasing the efficiency of the panel. The PV panel provides a great benefit to the number of species which can exist on the green roof. By creating patches of shade, and areas of shelter a much greater number of habitats can be formed.

These initial calculations were performed using the LG NeONr panels. The final selection may be different as PV remains a fast evolving field. This panel has:

- module efficiency of 20.8%,
- NOCT 44C
- Pmax -3%/C

90kW peak of PV is proposed.

The site is not over shaded by other buildings, and good solar access is expected from the upper roof. Figure 6-1 below shows the large area available for Bio-Solar roof, a total of up to 974m^2.

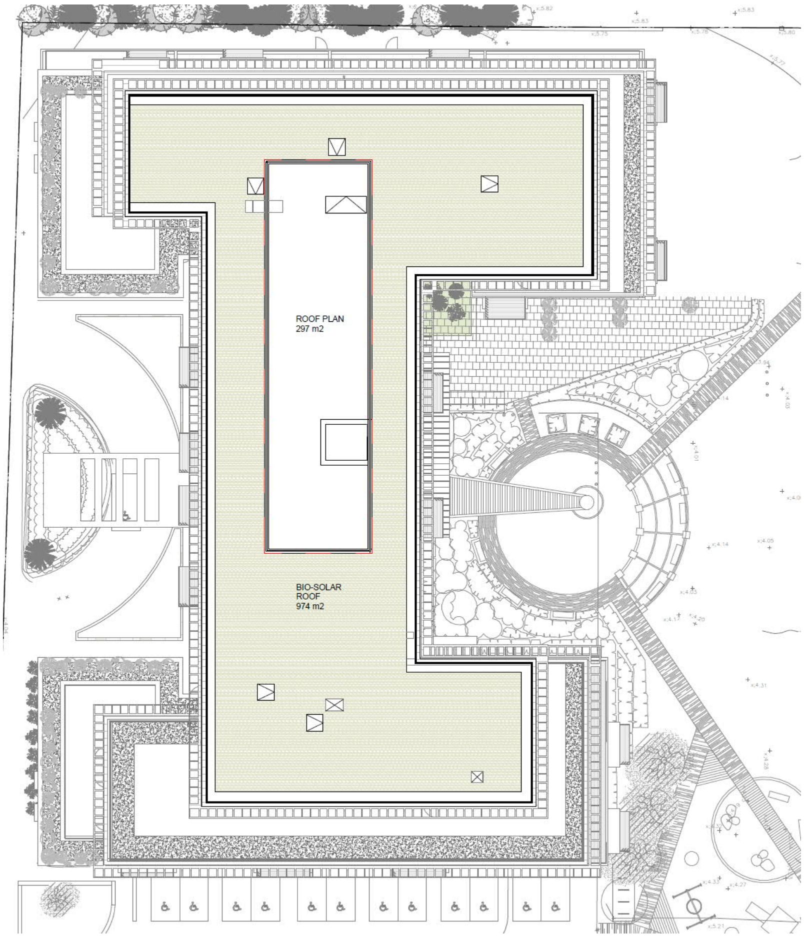


Figure 6-1 Roof Plan

It is anticipated many of the panels will be angled close to the horizontal. This will allow the panels to be placed closer together, and form bigger areas of shade / shelter providing a greater range of species with habitats.

The projected carbon savings from PV are 13.3 tonnes per year for the domestic and 25.8 tonnes per year from the commercial.

6.3 'Be Green' Summary

Following the potential for incorporating ASHPs ('Be Green' scheme) into the 'Be Clean' scheme, a summary of the estimated CO_2 emissions associated with each stage of the energy assessment and the percentage improvement over the baseline scheme is shown in Table 6-1 below.

Table 6-1: Estimated Baseline, Be Lean, Be Clean and Be Green Regulated CO_2 Emissions

	Baseline (Tonnes CO_2 p.a.)	'Be Lean' (Tonnes CO_2 p.a.)	'Be Clean' (Tonnes CO_2 p.a.)	'Be Green' (Tonnes CO_2 p.a.)	Improvement over Baseline from 'Be Green' (%)
Domestic	108.9	106.6	106.6	70.8	35%
Non-domestic	93.2	87.9	87.9	60.6	35%
Site-wide Proposed Development	**202.1**	**194.6**	**194.6**	**131.4**	**35%**

7. Carbon Factors

The proposed scheme has been assessed under the current regulations. These use an outdated carbon factor for electricity generation. The carbon factors under the current regulations are:

- Gas 0.216 kg CO_2/kWh
- Electricity 0.519 kg CO_2/kWh

Figure 7-1 below, shows national grid data for carbon emissions (in grams) from 2013 to mid-2018. As can be seen the retirement of much of the coal generation capacity, together with the increase in renewable energy generation has seen a dramatic reduction in the carbon intensity of electricity.

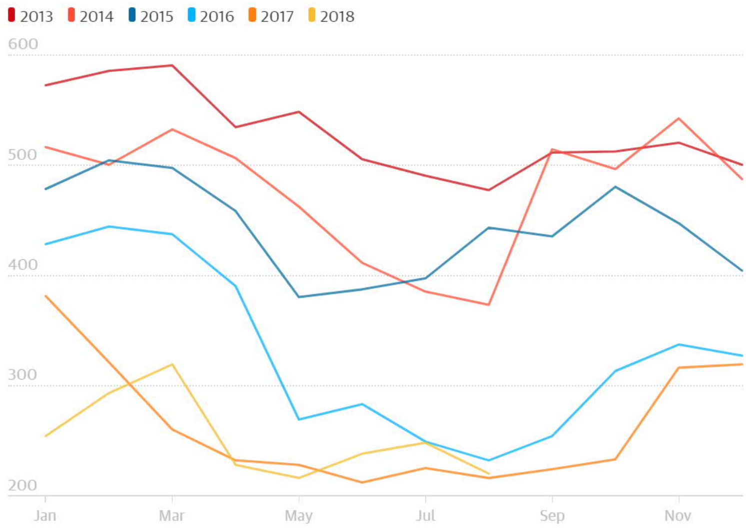


Figure 7-1 Historic Real World Carbon Factors

In response to these facts, the emerging Part L methodology (SAP 10) shows a much reduced carbon factor for electricity. SAP 10 has been published, but not yet adopted as current regulations, and contains these up to date carbon factors:

- Gas 0.210 kg CO_2/kWh
- Electricity 0.233 kg CO_2/kWh

Gas is little changed, but the electricity carbon factor has reduced to 45% of the previous value.

While heat pumps schemes such as this one are already in practice low carbon, this change will have a large impact by allowing this to be seen in theory.

The following sections will present domestic and non-domestic emissions as already calculated, but with the modern carbon factors applied.

Table 7-1: SAP 10 / SAP 13 Carbon Factors

	SAP 2013	SAP 10
Carbon Factors kg CO2/kWh		
Electric	0.519	0.233
Gas	0.216	0.21

Table 7-2: SAP 10 / SAP 13 Baseline

	SAP 2013	SAP 10
Baseline CO2 Tonnes/year		
Domestic	108.9	95.4
Commercial	93.2	52.1
Total	**202.1**	**147.4**

Table 7-3: SAP 10 / SAP 13 “Be Green”

	SAP 2013	SAP 10
"Be Green" CO2 Tonnes/year		
Domestic	70.8	31.8
Commercial	60.6	27.2
Total	**131.4**	**59.0**

Table 7-4: SAP 10 / SAP 13 Savings

	SAP 2013	SAP 10
Saving		
Domestic	35%	67%
Commercial	35%	48%
Total	**35%**	**60%**

Using the modern SAP 13 carbon factors, the onsite CO_2 emissions from the domestic part is reduced from 70.8 tonnes per year to 31.8 tonnes per year. This would result in a reduction in carbon offset payments of circa 45%.

8. Conclusions

From the analysis presented in the previous sections, the following energy strategy has been identified for the Proposed Development:

- Energy efficiency and passive design measures, with associated savings in CO_2 emissions of seven and a half tonnes over the baseline scheme (equivalent to 3.7% saving over the Baseline); and
- Incorporation of ASHP units and PV panels with anticipated CO_2 savings of circa sixty three tonnes over the 'Be Lean' scheme (equivalent to an additional 31.3% saving over the Baseline).

In total, the current strategy offers the opportunity to reduce the regulated CO_2 emissions of the Proposed Development by circa 35% over the Part L 2013 baseline scheme.

The strategy outlined in this report including energy efficiency measures, PV and ASHP are considered feasible at this time. A review of this strategy will be undertaken prior to construction to take into account the rapid pace of product innovation and development in this sector. This approach aims to capture the most appropriate and advantageous solution at time of construction.

The tables included below and overleaf present the estimated regulated and unregulated CO_2 emissions after each stage of the Energy Hierarchy for domestic, non-domestic elements and for the site as a whole.

Domestic

Table 8-1 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	108.9	13.3
After passive design and energy efficiency measures ('be lean')	106.6	13.3
After low carbon technologies ('be clean')	106.6	13.3
After renewable energy technologies ('be green')	70.8	13.3

Table 8-2 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from 'be lean'	2.3	2.1%
Estimated savings from 'be clean'	0	0%
Estimated savings from 'be green'	35.84	32.9%
Total estimated cumulative CO_2 emissions over Baseline	**38.1**	**35%**
Total Target Savings	108.9	100%
Shortfall	70.8	65%

The domestic elements of the site are required to achieve the latest zero carbon targets while meeting a 35% CO_2 reduction by on-site measures. Therefore, on the basis of the above percentage reductions achievable on site, appropriate carbon offset payments are expected to be required for the anticipated carbon shortfall (70.8 tonnes per annum) of the domestic units.

Non-Domestic

Table 8-3 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	93.2	86.4
After passive design and energy efficiency measures ('be lean')	87.9	86.4
After low carbon technologies ('be clean')	87.9	86.4
After renewable energy technologies ('be green')	60.6	86.4

Table 8-4 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from 'be lean'	5.3	5.7%
Estimated savings from 'be clean'	0	0%
Estimated savings from 'be green'	27.3	29.3%
Total estimated cumulative CO_2 emissions over Baseline	**32.6**	**35%**
Total Target Savings	32.6	35%
Shortfall	-	-

Site-wide

Table 8-5 CO_2 Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 (Tonnes p.a.)	Unregulated CO_2 (Tonnes p.a.)
Building Regulations ADL A 2013 Compliant Baseline	202.1	99.7
After passive design and energy efficiency measures ('be lean')	194.6	99.7
After low carbon technologies ('be clean')	194.6	99.7
After renewable energy technologies ('be green')	131.4	99.7

Table 8-6 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO_2 savings (Tonnes p.a.)	Improvement over baseline (%)
Estimated savings from 'be lean'	7.5	3.7%
Estimated savings from 'be clean'	0	0%
Estimated savings from 'be green'	63.1	31.3%
Total estimated cumulative CO_2 emissions over Baseline	**70.7**	**35%**

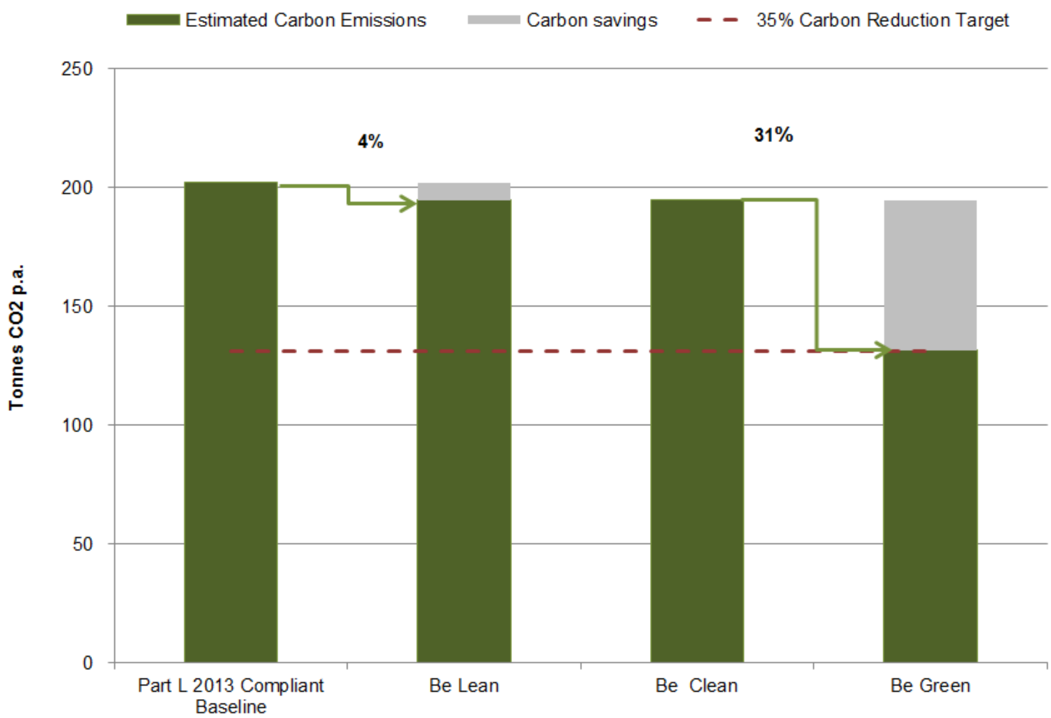


Figure 8-1 Estimated Regulated CO_2 Savings from Each Stage of the Energy Hierarchy

Appendix A List of drawings used for modelling purposes

The tables below include a list of drawings used for the modelling exercise.

- 17093 - KEW_ARC-Plano - PA1-04 - SITE PLAN.dwg
- 17093 - KEW_ARC-Plano - PA2-01 - OVERVIEW PLAN LEVEL GROUND.dwg
- 17093 - KEW_ARC-Plano - PA2-02 - OVERVIEW PLAN TYPICAL LEVEL 1 - 3.dwg
- 17093 - KEW_ARC-Plano - PA2-03 - OVERVIEW PLAN LEVEL 4.dwg
- 17093 - KEW_ARC-Plano - PA2-04 - OVERVIEW PLAN LEVEL 5.dwg
- 17093 - KEW_ARC-Plano - PA2-05 - OVERVIEW PLAN LEVEL ROOF.dwg
- 17093 - KEW_ARC-Plano - PA2-10 - GENERAL ARRANGEMENT- LEVEL GROUND NORTH.dwg
- 17093 - KEW_ARC-Plano - PA2-11 - GENERAL ARRANGEMENT- LEVEL GROUND SOUTH.dwg
- 17093 - KEW_ARC-Plano - PA2-12 - GENERAL ARRANGEMENT- LEVEL 1 NORTH.dwg
- 17093 - KEW_ARC-Plano - PA2-13 - GENERAL ARRANGEMENT- LEVEL 2-3 NORTH.dwg
- 17093 - KEW_ARC-Plano - PA2-14 - GENERAL ARRANGEMENT- LEVEL 2-3 SOUTH.dwg
- 17093 - KEW_ARC-Plano - PA2-15 - GENERAL ARRANGEMENT - LEVEL 4 NORTH.dwg
- 17093 - KEW_ARC-Plano - PA2-16 - GENERAL ARRANGEMENT- LEVEL 4 SOUTH.dwg
- 17093 - KEW_ARC-Plano - PA3-03 - PROPOSE ELEVATIONS - MELLIS AVE (WEST).dwg
- 17093 - KEW_ARC-Plano - PA3-04 - PROPOSE ELEVATIONS - SOUTH.dwg
- 17093 - KEW_ARC-Plano - PA3-05 - PROPOSE ELEVATIONS - RIVER THAMES (EAST).dwg
- 17093 - KEW_ARC-Plano - PA3-06 - PROPOSE ELEVATIONS - NORTH.dwg
- 17093-KEW_ARC-EAST-5103228.png
- 17093-KEW_ARC-NORTHPNG-5103392.png
- 17093-KEW_ARC-SOUTHAPNG-5103007.png
- 17093-KEW_ARC-WESTApng-5102851.png

Appendix B Appraisal of Non-feasible Renewable Energy Technologies

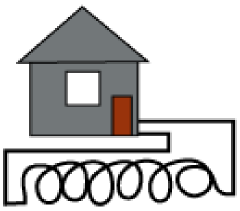
In line with the Mayor's Energy Hierarchy a feasibility of renewable energy technologies has been carried out for the Proposed Development. Overall there are a number of constraints associated with the application of renewable energy technologies on the site.

The following table presents a summary of the technologies considered unsuitable for the site alongside their constraints. The technologies have been considered as:

H – High feasibility;

M – Medium feasibility; significant issues would need to be addressed; and

L – Low feasibility; Application site not suitable to support the technology.

Technology	Feasibility			Comments
	H	M	L	
1. Ground Source Heat Pump (GSHP) 		✔		GSHP technology exploits seasonal temperature differences between ground and air temperatures to provide heating in the winter and air conditioning in the summer. GSHP systems use some electricity to run the heat pump, but as most of the energy for heating is taken from the ground, they produce less greenhouse gas than conventional heating systems. Pipe work is placed either horizontally or vertically in the ground. Fluid pumped through the pipes takes up heat which is then extracted by the heat pump and released at a higher temperature to drive a space heating system. A detailed geological survey, including test boreholes, would be required to verify the suitability of ground conditions and accurately estimate the potential capacity of GSHP scheme. An initial assessment was carried out to assess the number of boreholes needed, but the site was unable to meet the full needs of the building. Ground source works best when cooling and heating demands are balanced. By careful design, use of shading and high quality glass the need for cooling has been eliminated in most areas of the development. For these reasons, an air source heat pump has been selected, in place of ground source.

Technology	Feasibility			Comments
	H	M	L	
2. Solar Hot Water (SHW) Systems 		✔		Active solar hot water technology uses the Sun's energy to heat fluid passing through a collector in an active process. Solar hot water technologies will compete for roof space with PV, and for thermal load with the air source heat pumps. Therefore a solar hot water system is not proposed for the site.
3. Wind Power 			✔	Micro wind turbines can be fitted on the roof of a building (given appropriate structural measures). Mast-mounted wind turbines can be located in an open area away from obstructions such as buildings and tall trees. A report by BRE[4] highlighted inherent problems and the poor performance to date of urban micro wind installations. Both technologies are considered marginally viable in built environments by the majority of small wind turbine manufacturers[5] due to the relatively low (and turbulent) wind speed prevailing in an urban environment. Due to the relatively low wind speed and lack of suitable space in this built environment, the use of these technologies is not considered feasible.
4. Biomass Heating 			✔	Biomass boilers work on the principle that the combustion of wood chip or pellets can create heat for space heating and hot water loads. There are several factors that disadvantage this technology, namely: • On-site fuel storage space requirements; • The impact on local air quality (concerns exist over the level of NO_2 and Particulate Matter (PM_{10}) from biomass boiler installations particularly in Air Quality Management Areas (AQMAs)); • Traffic movement and access arrangements for regular fuel deliveries; • Space requirements for storage of the wood pellets/chips; and • Regular ash removal and maintenance requirements. Biomass boilers are therefore not further considered for the Proposed Development.

[4] Micro wind turbine in urban environments, Richard Phillips, Paul Blackmore, Jane Anderson, Michael Clift, Antonio Aguiló-Rullán and Steve Pester, BRE 2007 ISBN 978-1-84806-021-0.
[5] A report by Poyry on behalf of *Department for Energy and Climate Change* concludes that a wind system of 1.5-15 kW would require an average wind speed of 5.5 m/s to achieve circa 7% load factor.

Appendix C Domestic Energy Calculations

DER Worksheet
Design - Draft

NHER

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	Mr AECOM Planner	Assessor number	101
Client	Default Client	Last modified	30/08/2018
Address	2.2 redYellow 42, London		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		104.56	(1a)	x	2.62	(2a)	=	273.95	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	104.56	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	273.95	(5)

2. Ventilation rate

				m^3 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		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(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) =	0.13	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table 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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(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	76.50	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m^2	Openings m^2	Net area A, m^2		U-value W/m^2K		A x U W/K	κ-value, $kJ/m^2.K$	A x κ, kJ/K	
Window			24.90	x	1.33	=	33.01			(27)
External wall			31.55	x	0.18	=	5.68			(29a)
Party wall			62.13	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m^2			56.45							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	38.69	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m^2K		100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		8.47	(36)
Total fabric heat loss	(33) + (36) =	47.16	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	25.32	25.03	24.74	23.30	23.01	21.57	21.57	21.28	22.15	23.01	23.59	24.17	(38)
Heat transfer coefficient, W/K (37)m + (38)m	72.48	72.19	71.90	70.46	70.17	68.73	68.73	68.44	69.31	70.17	70.75	71.32	
Average = ∑(39)1...12/12 =												70.39	(39)
Heat loss parameter (HLP), W/m^2K (39)m ÷ (4)	0.69	0.69	0.69	0.67	0.67	0.66	0.66	0.65	0.66	0.67	0.68	0.68	
Average = ∑(40)1...12/12 =												0.67	(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	2.78	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	100.18	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	110.19	106.19	102.18	98.17	94.17	90.16	90.16	94.17	98.17	102.18	106.19	110.19	
∑(44)1...12 =												1202.11	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	163.41	142.92	147.48	128.58	123.37	106.46	98.65	113.21	114.56	133.51	145.73	158.26	
∑(45)1...12 =												1576.15	(45)
Distribution loss 0.15 x (45)m	24.51	21.44	22.12	19.29	18.51	15.97	14.80	16.98	17.18	20.03	21.86	23.74	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.85	(48)
Temperature factor from Table 2b	0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)	1.11	(50)
Enter (50) or (54) in (55)	1.11	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(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

221.09	195.01	205.16	184.39	181.05	162.28	156.33	170.88	170.37	191.18	201.55	215.93	(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

221.09	195.01	205.16	184.39	181.05	162.28	156.33	170.88	170.37	191.18	201.55	215.93

∑(64)1...12 = 2255.20 (64)

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

100.47	89.19	95.18	87.40	87.16	80.05	78.94	83.78	82.74	90.53	93.11	98.76	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	138.90	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	23.49	20.86	16.97	12.85	9.60	8.11	8.76	11.39	15.28	19.40	22.65	24.14	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	263.50	266.23	259.34	244.67	226.15	208.75	197.13	194.39	201.28	215.95	234.47	251.87	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89	36.89	(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)	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	-111.12	(71)
Water heating gains (Table 5)	135.04	132.73	127.92	121.39	117.15	111.18	106.10	112.61	114.92	121.68	129.31	132.74	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	486.70	484.49	468.90	443.58	417.58	392.71	376.66	383.05	396.15	421.70	451.10	473.42	(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	0.77	x	11.76	x	19.64	x 0.9 x	0.45	x	0.80	=	57.62	(80)
North	0.77	x	13.14	x	10.63	x 0.9 x	0.45	x	0.80	=	34.86	(74)

Solar gains in watts ∑(74)m...(82)m	92.48	179.34	298.83	452.56	576.73	601.86	568.17	471.99	352.00	213.05	114.85	76.45	(83)
Total gains - internal and solar (73)m + (83)m	579.18	663.83	767.73	896.14	994.31	994.57	944.83	855.04	748.15	634.75	565.95	549.87	(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)	0.96	0.94	0.89	0.77	0.60	0.43	0.32	0.36	0.59	0.84	0.94	0.97	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.68	19.91	20.27	20.67	20.89	20.98	20.99	20.99	20.93	20.60	20.08	19.64	(87)

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

20.35	20.35	20.35	20.36	20.37	20.38	20.38	20.38	20.37	20.37	20.36	20.36	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.96	0.93	0.88	0.75	0.57	0.39	0.27	0.32	0.55	0.82	0.93	0.97	(89)

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

18.54	18.88	19.39	19.95	20.24	20.36	20.37	20.37	20.30	19.87	19.14	18.50	(90)

Living area fraction — Living area ÷ (4) = 0.47 (91)

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

19.07	19.36	19.80	20.28	20.55	20.65	20.66	20.66	20.59	20.21	19.58	19.03	(92)

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

19.07	19.36	19.80	20.28	20.55	20.65	20.66	20.66	20.59	20.21	19.58	19.03	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.95	0.92	0.86	0.74	0.58	0.41	0.29	0.34	0.56	0.81	0.92	0.96	(94)
Useful gains, ηmGm, W (94)m x (84)m	549.65	611.94	663.12	666.36	576.33	406.81	277.46	288.58	421.38	516.13	522.02	525.54	(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]	1070.61	1043.70	956.14	802.09	620.72	415.59	279.34	291.73	449.93	674.39	882.69	1058.06	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	387.60	290.15	218.01	97.73	33.02	0.00	0.00	0.00	0.00	117.74	259.68	396.20	

∑(98)1...5, 10...12 = 1800.13 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 17.22 (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 heat pump		1.00	(303a)
Fraction of total space heat from community heat pump	(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	1800.13		(98)
Space heat from heat pump	(98) x (304a) x (305) x (306) =	1890.14	(307a)

Water heating

Annual water heating requirement	2255.20		(64)
Water heat from heat pump	(64) x (303a) x (305a) x (306) =	2367.96	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	42.58	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside	229.77		(330a)
Total electricity for the above, kWh/year		229.77	(331)

Electricity for lighting (Appendix L)		414.86	(332)
Energy saving/generation technologies			
electricity generated by PV (Appendix M)		-259.09	(333)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	4643.64	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1890.14	x	4.24	x 0.01 =	80.14	(340a)
Water heating from heat pump	2367.96	x	4.24	x 0.01 =	100.40	(342a)
Pumps and fans	229.77	x	13.19	x 0.01 =	30.31	(349)
Electricity for lighting	414.86	x	13.19	x 0.01 =	54.72	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-259.09	x	13.19	x 0.01 =	0.00	(352)
Total energy cost			(340a)...(342e) + (345)...(354) =		385.57	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.08	(357)
SAP value	84.90	
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 heat pump	300.00					(367a)
CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	1419.36	x	0.519	=	736.65	(367)
Electrical energy for community heat distribution	42.58	x	0.519	=	22.10	(372)
Total CO2 associated with community systems					758.75	(373)
Total CO2 associated with space and water heating					758.75	(376)
Pumps and fans	229.77	x	0.519	=	119.25	(378)
Electricity for lighting	414.86	x	0.519	=	215.31	(379)
Energy saving/generation technologies						
pv savings	-259.09	x	0.519	=	-134.47	(380)
Total CO_2, kg/year				(376)..(382) =	958.85	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	9.17	(384)
EI value					91.41	
EI rating (section 14)					91	(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 heat pump	300.00					(367a)
Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	1419.36	x	3.07	=	4357.45	(367)
Electrical energy for community heat distribution	42.58	x	3.07	=	130.72	(372)

Total primary energy associated with community systems					4488.17	(373)
Total primary energy associated with space and water heating					4488.17	(376)
Pumps and fans	229.77	x	3.07	=	705.40	(378)
Electricity for lighting	414.86	x	3.07	=	1273.61	(379)
Energy saving/generation technologies						
Electricity generated - PVs	-259.09	x	3.07	=	-795.39	(380)
Primary energy kWh/year					5671.79	(383)
Dwelling primary energy rate kWh/m2/year					54.24	(384)

DER Worksheet
Design - Draft

NHER

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	Mr AECOM Planner	Assessor number	101
Client	Default Client	Last modified	30/08/2018
Address	2.5 redYellow 42, London		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		97.18	(1a)	x	2.62	(2a)	=	254.61	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	97.18	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	254.61	(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		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(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) =	0.13	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table 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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(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	76.50	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			22.74	x	1.33	=	30.15			(27)
External wall			35.02	x	0.18	=	6.30			(29a)
Party wall			57.76	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			57.76							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	36.45	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		8.66	(36)
Total fabric heat loss	(33) + (36) =	45.12	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	23.53	23.26	23.00	21.66	21.39	20.05	20.05	19.78	20.59	21.39	21.92	22.46	(38)
Heat transfer coefficient, W/K (37)m + (38)m	68.65	68.38	68.11	66.77	66.50	65.17	65.17	64.90	65.70	66.50	67.04	67.58	
Average = ∑(39)1...12/12 =												66.70	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.71	0.70	0.70	0.69	0.68	0.67	0.67	0.67	0.68	0.68	0.69	0.70	
Average = ∑(40)1...12/12 =												0.69	(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	2.71	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	98.61	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	108.47	104.52	100.58	96.63	92.69	88.75	88.75	92.69	96.63	100.58	104.52	108.47	
∑(44)1...12 =												1183.27	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	160.85	140.68	145.17	126.56	121.44	104.80	97.11	111.43	112.76	131.42	143.45	155.78	
∑(45)1...12 =												1551.46	(45)
Distribution loss 0.15 x (45)m	24.13	21.10	21.78	18.98	18.22	15.72	14.57	16.71	16.91	19.71	21.52	23.37	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.85	(48)
Temperature factor from Table 2b	0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)	1.11	(50)
Enter (50) or (54) in (55)	1.11	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(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

218.53	192.77	202.84	182.38	179.11	160.61	154.78	169.11	168.58	189.09	199.26	213.45	(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

218.53	192.77	202.84	182.38	179.11	160.61	154.78	169.11	168.58	189.09	199.26	213.45

∑(64)1...12 = 2230.51 (64)

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

99.62	88.45	94.41	86.73	86.52	79.49	78.43	83.19	82.14	89.83	92.35	97.93	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	135.59	135.59	135.59	135.59	135.59	135.59	135.59	135.59	135.59	135.59	135.59	135.59	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	22.44	19.93	16.21	12.27	9.17	7.74	8.37	10.88	14.60	18.53	21.63	23.06	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	251.69	254.30	247.72	233.71	216.02	199.40	188.29	185.68	192.26	206.27	223.96	240.58	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.56	36.56	36.56	36.56	36.56	36.56	36.56	36.56	36.56	36.56	36.56	36.56	(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)	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	-108.47	(71)
Water heating gains (Table 5)	133.90	131.62	126.89	120.46	116.29	110.41	105.41	111.81	114.09	120.74	128.26	131.63	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	471.70	469.53	454.49	430.12	405.16	381.23	365.75	372.05	384.62	409.23	437.53	458.95	(73)

6. Solar gains

	Access factor Table 6d		Area m^2		Solar flux W/m^2		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.77	x	10.26	x	10.63	x 0.9 x	0.45	x	0.80	=	27.22	(74)
East	0.77	x	12.48	x	19.64	x 0.9 x	0.45	x	0.80	=	61.15	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	88.37	171.64	285.39	429.29	543.36	565.19	534.31	446.43	335.39	203.86	109.82	72.98	(83)
Total gains - internal and solar (73)m + (83)m	560.07	641.16	739.88	859.40	948.52	946.41	900.06	818.47	720.01	613.09	547.35	531.93	(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)	0.96	0.94	0.88	0.76	0.60	0.43	0.32	0.36	0.58	0.83	0.94	0.97	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.68	19.91	20.27	20.66	20.89	20.98	20.99	20.99	20.93	20.60	20.08	19.64	(87)

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

20.34	20.34	20.34	20.35	20.35	20.37	20.37	20.37	20.36	20.35	20.35	20.34	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.96	0.93	0.87	0.74	0.57	0.39	0.27	0.31	0.54	0.81	0.93	0.96	(89)

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

18.54	18.87	19.38	19.94	20.23	20.34	20.36	20.36	20.29	19.86	19.13	18.49	(90)

Living area fraction — Living area ÷ (4) = 0.42 (91)

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

19.02	19.31	19.76	20.25	20.51	20.61	20.63	20.63	20.56	20.18	19.54	18.98	(92)

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

19.02	19.31	19.76	20.25	20.51	20.61	20.63	20.63	20.56	20.18	19.54	18.98	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.94	0.92	0.86	0.73	0.57	0.41	0.29	0.33	0.55	0.80	0.92	0.95	(94)
Useful gains, ηmGm, W (94)m x (84)m	528.56	586.72	632.70	631.52	543.92	383.34	260.84	271.47	398.04	491.87	501.00	505.82	(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]	1010.52	985.55	903.08	757.57	585.81	391.79	262.66	274.44	424.30	636.96	833.68	998.87	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	358.58	268.02	201.16	90.75	31.17	0.00	0.00	0.00	0.00	107.95	239.52	366.83	

∑(98)1...5, 10...12 = 1663.98 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 17.12 (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 heat pump		1.00	(303a)
Fraction of total space heat from community heat pump	(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	1663.98		(98)
Space heat from heat pump	(98) x (304a) x (305) x (306) =	1747.18	(307a)

Water heating

Annual water heating requirement	2230.51		(64)
Water heat from heat pump	(64) x (303a) x (305a) x (306) =	2342.03	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	40.89	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside	213.56		(330a)
Total electricity for the above, kWh/year		213.56	(331)

Electricity for lighting (Appendix L)	396.26	(332)
Energy saving/generation technologies		
electricity generated by PV (Appendix M)	-259.09	(333)
Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	4439.94	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1747.18	x	4.24	x 0.01 =	74.08	(340a)
Water heating from heat pump	2342.03	x	4.24	x 0.01 =	99.30	(342a)
Pumps and fans	213.56	x	13.19	x 0.01 =	28.17	(349)
Electricity for lighting	396.26	x	13.19	x 0.01 =	52.27	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-259.09	x	13.19	x 0.01 =	0.00	(352)
Total energy cost				(340a)...(342e) + (345)...(354) =	373.82	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.10	(357)
SAP value	84.60	
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 heat pump	300.00					(367a)
CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	1363.07	x	0.519	=	707.43	(367)
Electrical energy for community heat distribution	40.89	x	0.519	=	21.22	(372)
Total CO2 associated with community systems					728.66	(373)
Total CO2 associated with space and water heating					728.66	(376)
Pumps and fans	213.56	x	0.519	=	110.84	(378)
Electricity for lighting	396.26	x	0.519	=	205.66	(379)
Energy saving/generation technologies						
pv savings	-259.09	x	0.519	=	-134.47	(380)
Total CO_2, kg/year				(376)..(382) =	910.69	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	9.37	(384)
EI value					91.42	
EI rating (section 14)					91	(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 heat pump	300.00					(367a)
Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	1363.07	x	3.07	=	4184.62	(367)
Electrical energy for community heat distribution	40.89	x	3.07	=	125.54	(372)

Total primary energy associated with community systems					4310.16	(373)
Total primary energy associated with space and water heating					4310.16	(376)
Pumps and fans	213.56	x	3.07	=	655.62	(378)
Electricity for lighting	396.26	x	3.07	=	1216.53	(379)
Energy saving/generation technologies						
Electricity generated - PVs	-259.09	x	3.07	=	-795.39	(380)
Primary energy kWh/year					5386.91	(383)
Dwelling primary energy rate kWh/m2/year					55.43	(384)

DER Worksheet
Design - Draft

NHER

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	Mr AECOM Planner	Assessor number	101
Client	Default Client	Last modified	30/08/2018
Address	2.9 redYellow 42, London		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		88.30	(1a)	x	2.62	(2a)	=	231.35	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	88.30	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	231.35	(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		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
Number of sides on which the dwelling is sheltered		3	(19)
Shelter factor	1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	76.50	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.23	0.23	0.24	0.25	0.25	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.23	0.23	0.24	0.25	0.25	(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			17.21	x	1.33	=	22.82			(27)
External wall			33.56	x	0.18	=	6.04			(29a)
Party wall			77.50	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			50.77							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	28.86	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		7.62	(36)
Total fabric heat loss	(33) + (36) =	36.47	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	20.29	20.06	19.84	18.73	18.51	17.40	17.40	17.18	17.85	18.51	18.95	19.40	(38)
Heat transfer coefficient, W/K (37)m + (38)m	56.76	56.54	56.31	55.21	54.98	53.87	53.87	53.65	54.32	54.98	55.43	55.87	
Average = ∑(39)1...12/12 =												55.15	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.64	0.64	0.64	0.63	0.62	0.61	0.61	0.61	0.62	0.62	0.63	0.63	
Average = ∑(40)1...12/12 =												0.62	(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	2.60	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	95.99	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	105.59	101.75	97.91	94.07	90.23	86.39	86.39	90.23	94.07	97.91	101.75	105.59	
∑(44)1...12 =												1151.89	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	156.59	136.95	141.32	123.21	118.22	102.02	94.53	108.48	109.77	127.93	139.65	151.65	
∑(45)1...12 =												1510.31	(45)
Distribution loss 0.15 x (45)m	23.49	20.54	21.20	18.48	17.73	15.30	14.18	16.27	16.47	19.19	20.95	22.75	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.85	(48)
Temperature factor from Table 2b	0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)	1.11	(50)
Enter (50) or (54) in (55)	1.11	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	34.41	31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30	34.41	(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

214.26	189.04	198.99	179.02	175.89	157.83	152.21	166.15	165.59	185.60	195.46	209.32	(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

214.26	189.04	198.99	179.02	175.89	157.83	152.21	166.15	165.59	185.60	195.46	209.32

∑(64)1...12 = 2189.36 (64)

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

98.20	87.21	93.13	85.62	85.45	78.57	77.57	82.21	81.15	88.67	91.08	96.56	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	130.09	130.09	130.09	130.09	130.09	130.09	130.09	130.09	130.09	130.09	130.09	130.09	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	21.03	18.68	15.19	11.50	8.60	7.26	7.84	10.19	13.68	17.37	20.28	21.62	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	235.92	238.36	232.19	219.06	202.48	186.90	176.49	174.04	180.21	193.35	209.92	225.51	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.01	36.01	36.01	36.01	36.01	36.01	36.01	36.01	36.01	36.01	36.01	36.01	(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)	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	-104.07	(71)
Water heating gains (Table 5)	131.99	129.78	125.17	118.91	114.85	109.12	104.26	110.49	112.71	119.19	126.50	129.79	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	450.97	448.85	434.58	411.50	387.95	365.31	350.62	356.76	368.63	391.93	418.73	438.93	(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	0.77	x	17.21	x	19.64	x 0.9 x	0.45	x	0.80	=	84.33	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	84.33	164.96	271.67	396.21	485.57	497.07	473.23	406.50	315.96	195.74	105.15	69.35	(83)
Total gains - internal and solar (73)m + (83)m	535.29	613.81	706.25	807.71	873.52	862.38	823.85	763.25	684.59	587.67	523.88	508.28	(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)	0.95	0.92	0.85	0.72	0.55	0.39	0.29	0.32	0.52	0.79	0.92	0.96	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.92	20.15	20.47	20.78	20.93	20.99	21.00	21.00	20.96	20.73	20.28	19.88	(87)

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

20.39	20.39	20.40	20.41	20.41	20.42	20.42	20.42	20.42	20.41	20.41	20.40	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.94	0.91	0.83	0.69	0.52	0.36	0.25	0.28	0.49	0.76	0.91	0.95	(89)

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

18.92	19.25	19.70	20.13	20.33	20.41	20.42	20.42	20.38	20.08	19.46	18.88	(90)

Living area fraction — Living area ÷ (4) = 0.45 (91)

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

19.38	19.66	20.05	20.43	20.61	20.67	20.68	20.68	20.64	20.38	19.83	19.34	(92)

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

19.38	19.66	20.05	20.43	20.61	20.67	20.68	20.68	20.64	20.38	19.83	19.34	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.93	0.90	0.83	0.69	0.53	0.37	0.27	0.30	0.50	0.76	0.90	0.94	(94)
Useful gains, ηmGm, W (94)m x (84)m	499.19	550.61	583.11	560.73	466.84	323.02	219.13	228.48	342.55	447.72	469.95	478.38	(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]	855.79	834.37	763.03	636.42	489.70	327.11	219.91	229.73	355.35	537.53	705.82	845.70	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	265.31	190.69	133.86	54.50	17.01	0.00	0.00	0.00	0.00	66.82	169.83	273.29	

∑(98)1...5, 10...12 = 1171.30 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 13.27 (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 heat pump		1.00	(303a)
Fraction of total space heat from community heat pump	(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	1171.30			(98)
Space heat from heat pump		(98) x (304a) x (305) x (306) =	1229.87	(307a)

Water heating

Annual water heating requirement	2189.36			(64)
Water heat from heat pump		(64) x (303a) x (305a) x (306) =	2298.83	(310a)
Electricity used for heat distribution		0.01 × [(307a)...(307e) + (310a)...(310e)] =	35.29	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside	194.04		(330a)
Total electricity for the above, kWh/year		194.04	(331)
Electricity for lighting (Appendix L)		371.44	(332)