

Red & Yellow Specialist Extra Care Melliss Avenue - Kew

Energy Strategy October 2018





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Table of Contents

Execu	tive Su	mmary	6
1.	Introdu	uction	11
	1.1	Proposed Development Description	11
	1.2	Planning Context	11
	1.2.1	National Policy	11
	1.2.2	Regional Policy	12
	1.2.3	Local Planning Policy	13
	1.2.3.1	ICO2	15
	1.2.3.2	2PV	15
	1.2.3.3	3CHP	15
2.	Asses	sment methodology	17
3.	Baseli	ne compliance	18
4.	'Be Le	an'- Passive Design and Energy Efficiency Measures	19
	4.1	Passive design summary	19
	4.3	Energy Efficient services summary	20
	4.4	Minimising solar gains	20
	4.5	Overheating analysis	21
	4.6	CO2 emissions summary	22
5.	'Be Cl	ean' – Low Carbon Technology Appraisal	23
	5.1	Introduction to Low Carbon Technologies	23
	5.2	Connection to Existing District Heating Schemes	23
	5.3	On-site CHP opportunities	24
	5.3.1	CHP technology	24
	5.4	'Be Clean' Summary	24
6.	'Be Green' – Renewable Energy Technologies25		
	6.1	Air Source Heat Pump (ASHP) Systems	25
	6.2	PV	25
	6.3	'Be Green' Summary	26
7.	Carbo	n Factors	28
8.	Conclusions		
	Domestic		
	Non-D	omestic	31
	Site-w	ide	31
Appen	idix A L	ist of drawings used for modelling purposes	33
Appen	idix B A	ppraisal of Non-feasible Renewable Energy Technologies	34
Appen	idix C E	Domestic Energy Calculations	36
Appen	Appendix D Non-Domestic Energy Calculations		
Appen	idix E C	Overheating Calculation	237
Appen	idix F T	M59 Results2	254

Figures

Figure 0-1 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	9
Figure 4-1: Visual Representation of a design iteration IES model used in the overheating and L2A Asses	sment21
Figure 5-1: London Heat Map extract	23
Figure 6-1 Roof Plan	
Figure 7-1 Historic Real World Carbon Factors	
Figure 8-1 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	
Figure 2. Sample units on 2 nd floor to represent the development	242
Figure 3. Sample units on 4 th floor to represent the development	243

Figure 4.	Sample units on 5 th floor to represent the development	244
Figure 5.	South view of the model after Option F	246
Figure 6.	South view of the model with yellow circles around the overhangs included in option F	253

Tables

Table 0-1 CO ₂ Emissions after Each Stage of the Energy Hierarchy	7
Table 0-2 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	7
Table 0-3 CO ₂ Emissions after Each Stage of the Energy Hierarchy	8
Table 0-4 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	8
Table 0-5 CO ₂ Emissions after Each Stage of the Energy Hierarchy	9
Table 0-6 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	9
Table 1-1 Development Schedule Summary	11
Table 3-1 Estimated Baseline CO ₂ Emissions	18
Table 4-1: Currently Adopted Passive Design Measures	19
Table 4-2: Current Fabric Specification for the Proposed Development	19
Table 4-3: Currently Adopted Energy Efficiency Measures	20
Table 4-4: Non-domestic Cooling Demand	22
Table 4-5: Estimated Regulated CO ₂ Emissions	22
Table 5-1: Estimated Regulated CO ₂ emissions	24
Table 6-1: Estimated Baseline, Be Lean, Be Clean and Be Green Regulated CO ₂ Emissions	27
Table 7-1: SAP 10 / SAP 13 Carbon Factors	29
Table 7-2: SAP 10 / SAP 13 Baseline	29
Table 7-3: SAP 10 / SAP 13 "Be Green"	29
Table 7-4: SAP 10 / SAP 13 Savings	29
Table 8-1 CO ₂ Emissions after Each Stage of the Energy Hierarchy	
Table 8-2 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	
Table 8-3 CO ₂ Emissions after Each Stage of the Energy Hierarchy	31
Table 8-4 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	31
Table 8-5 CO ₂ Emissions after Each Stage of the Energy Hierarchy	31
Table 8-6 Estimated Regulated CO ₂ Savings from Each Stage of the Energy Hierarchy	32

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 CO₂ 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 CO₂ emissions breakdown
- Non-residential CO₂ emissions breakdown
- Site-wide total CO₂ 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 CO₂ Emissions after Each Stage of the Energy Hierarchy

Assessment	Regulated CO ₂ (Tonnes p.a.)	Unregulated CO₂ (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 CO2 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% CO₂ 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 CO₂ 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 CO₂ Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO₂ 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 CO₂ emissions over Baseline	32.6	35%
Total Target Savings	32.6	35%

-

Shortfall

Site-wide

Table 0-5 CO₂ 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 CO₂ Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO₂ 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 CO₂ emissions over Baseline	70.7	35%	



Figure 0-1 Estimated Regulated CO₂ 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 (CO₂) 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.

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

Table 1-1 Development Schedule Summary

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.



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 nonresidential 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
 - o 35% carbon reduction through onsite solutions,
 - o 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 CO₂ 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 CO₂ 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 CO₂ 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.

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 4-1: Currently Adopted Passive Design Measures

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 ² K	0.18 W/m ² K
Party walls (solid or fully filled)	0.00 W/m ² K	-
Floor	-	0.12 W/m ² K
Roof	0.13 W/m ² K	0.13 W/m ² K
Windows	1.4W/m ² K	1.4W/m²K
Doors	-	2.20 W/m ² K

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	
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	Actual Cooling Demand	Improvement
	(MJ/m ²)	(MJ/m ²)	(%)
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 CO2 Emissions

	Baseline (Tonnes CO ₂ p.a.)	'Be Lean' (Tonnes CO₂ 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 Map¹ and the Combined Heat and Power Association (CHPA) district heating database², 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: <u>http://www.londonheatmap.org.uk/Content/TheManual.aspx</u>

² CHPA district heating database: <u>http://www.theade.co.uk/district-heating-installation-map_790.html</u>

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).

	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%

Table 5-1: Estimated Regulated CO₂ emissions

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 CO₂ Emissions

	Baseline (Tonnes CO ₂ p.a.)	'Be Lean' (Tonnes CO₂ 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 CO₂/kWh
- Electricity 0.519 kg CO₂/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 CO₂/kWh
- Electricity 0.233 kg CO₂/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 CO₂ 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 CO₂ 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 CO2 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 CO2 Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO₂ 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 CO₂ 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% CO₂ 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 CO₂ 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 CO₂ Savings from Each Stage of the Energy Hierarchy

Assessment	Regulated CO₂ 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 CO₂ emissions over Baseline	32.6	35%
Total Target Savings	32.6	35%

Shortfall

Site-wide

Table 8-5 CO₂ 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

-

Assessment	Regulated CO₂ 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 CO₂ emissions over Baseline	70.7	35%

Table 8-6 Estimated Regulated CO₂ Savings from Each Stage of the Energy Hierarchy

Figure 8-1 Estimated Regulated CO₂ 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	Fe	easibil	ity	Comments
	Н	м	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	Fe	asibil	ity	Comments
	н	М	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			v	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 NO₂ and Particulate Matter (PM₁₀) 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

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 AECON	1 Planner					ł	ssessor nu	mber	101		
Client	Default Clie	ent					L	ast modifie	ed	30/0	08/2018	
Address	2.2 redYell	ow 42, Lo	ndon									
1. Overall dwelling dimens	ions											
					Area (m²)		Ave	erage store leight (m)	Y	١	/olume (m ⁱ	3)
Lowest occupied					104.56	(1a) x		2.62	(2a) =		273.95	(3a)
Total floor area	(1a) +	(1b) + (1c	:) + (1d)(1n) = 🗌	104.56	(4)			10			222
Dwelling volume							(3a	n) + (3b) + (3c) + (3d)(3n) =	273.95	(5)
2. Ventilation rate	Wa - T	di Ba	cir di			i sqii s						цđ
										r	n³ per hou	r
Number of chimneys		91						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						2		0	x 10	-	0	(7b)
Number of flueless gas fires								0	x 40	-	0	(7c)
										Air	changes p hour	er
nfiltration due to chimneys.	flues, fans, P	SVs		(6a) + (6b) + (7	7a) + (7b) +	(7c) =	0	→ (5) :	-	0.00	(8)
f a pressurisation test has be	en carried o	ut or is in	tended. pi	roceed to ((17). otherv	vise continu	e from (9)	to (16)		1000	0.00	(0)
Air permeability value, g50, e	xpressed in	cubic me	tres per h	our ner sa	uare metre	ofenvelon	e area	()			3.00	(17)
f based on air permeability v	alue, then (1	8) = [(17)	(22) + (20) + (20)	3) otherwi	se(18) = (1)	6)	c arca				0.15	(19)
Number of sides on which the	e dwelling is	sheltered	1	, other m	50 (10) = (1	.07					2	(10)
Shelter factor	a arrennig is	Shareeree						1	- [0 075 v (1		0.85	(20)
nfiltration rate incorporating	shelter fact	or			19			1	(18) v (1	20) - [0.12	(20)
nfiltration rate modified for	monthly win	d speed:				8			(10) X (20) - [0.15	(21)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sen	Oct	Nov	Dec	
Aonthly average wind speed	from Table I	U2					He B	Sch			Det	
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)
Vind factor (22)m ÷ 4	0.00	1100	4.40	4.50	5.00	5.00	3.70	4.00	4.50	4.50	4.70	(22)
1.28	125	1 23	1 10	1.08	0.95	0.95	0.93	1.00	1 08	1 1 3	1 1 2	1/220
diusted infiltration rate (allo	wing for she	lter and	wind facto	r) (21) x (2	2a)m	0.55	0.55	1.00	1.00	1.15	1.10	(220
0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(22h
alculate effective air change	rate for the	applicabl	e case*	0.11	0.12	0.12	0.12	0.15	0.14	0.14	0.15	1 (220
If mechanical ventilation:	air change ra	te throug	th system							- (-	0.50	(22-
If balanced with beat reco	venu: efficier	nce throug	llowing fo	r in uso fa	ctor from T	able 4b					76.50	(230
a) If halanced mechanical	ventilation u	ith heat	nowing to		$2hm \pm (22)$	able 411 $h = 122$	(100)			L	70.50	(230)
		0 or	o ac		C 24	0.24	- 100j	0.05	0.35	0.20	0.07	1/24
U.28	0.20	U.27	U.20	U.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(24a
and the ar change rate onto	eriz4alor C	2401 OF (2	4C) or (24	a) in (25)								
nective all change rate - ent		0.07	0.00	e ==		1		1			-	

3. Heat losses and he	at loss parame	ter		يلي الكون							
Element		а	Gross rea, m ²	Openings m ²	Net : A, i	area m²	U-value W/m²K	A x U W/	К к-valı kJ/m	ue, Axi ².K kJ/	к, К
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 e	elements ∑A, m	1 ²			56.	45					(31)
Fabric heat loss, W/K =	Σ(A × U)							(26))(30) + (32)	= 38.69	(33)
Heat capacity Cm = ∑(A	λ x к)						(28)	.(30) + (32) +	(32a)(32e)	= N/A	(34)
Thermal mass paramet	ter (TMP) in kJ/	′m²K								100.00	(35)
Thermal bridges: ∑(L x	Ψ) calculated ι	using Appen	dix K							8.47	(36)
Total fabric heat loss									(33) + (36)	= 47.16	(37)
Ja	n Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov De	с
Ventilation heat loss ca	alculated mont	hly 0.33 x (2	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 24.1	17 (38)
Heat transfer coefficie	nt, 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 71.3	32
	- 19 - 19 - 19 - 19 - 19 - 19 - 19 - 19							Average = ∑	(39)112/12	= 70.39	(39)
Heat loss parameter (H	ILP), W/m²K (3	39)m ÷ (4)									
0.6	0.69	0.69	0.67	0.67	0.66	0.66	0.65	0.66	0.67	0.68 0.6	8
	1.							Average = ∑	(40)112/12	= 0.67	(40)
Number of days in mo	nth (Table 1a)										
31.	00 28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00 31.0	00 (40)
4. Water heating ene	rgy requireme	nt									(40)
Assumed occupancy, N	5			191						2.78	(42)
Annual average hot wa	iter usage in lit	res per day	Vd,average	e = (25 x N) +	36			6	0.4	100.18	(43)
Ja	n Feb	Mar	Apr	May	Jun	Jui	Aug	Sep	UCE	Nov De	C
Hot water usage in litre	es per day for e	each month	Vd,m = fac	tor from Tab	le 1c x (43)	1 01 17	1 00 17 1	102.10	106.10 1110	10
110	.19 106.19	102.18	98.17	94.17	90.16	90.16	94.17	98.17	102.18	1205.19 110.	19 (10)
			_ (T	4 4 1)		2(44)112	= 1202.1	L (44)
Energy content of hot	water used = 4	.18 x Vd,m x	nm x Im/	3600 kWh/m	ionth (see	Tables In), IC ID)	1 44456 1	122 54 1	145 70 1 150	26
163	.41 142.92	147.48	128.58	123.37	106.46	98.65	113.21	114.56	133.51	145.73 158.	26
									2(45)112	= 15/6.15	(45)
Distribution loss 0.15	k (45)m	1				1100	10.00	1 17 10 1	20.02	21.05 2.22	74 (46)
24.	51 21.44	22.12	19.29	18.51	15.97	14.80	16.98	17.18	20.03	21.86 23.	(46)
Storage volume (litres)	including any	solar or WW	HRS storage	ge within san	ne vessel					180.00	(47)
Water storage loss										1.05	(40)
a) If manufacturer's de	clared loss fact	tor is known	(kWh/day)						1.85	(48)
Temperature factor	from Table 2b									0.60	(49)
Energy lost from wa	ater storage (k)	Wh/day) (48	3) x (49)								(50)
Enter (50) or (54) in (5	5)									1.11	(55)
Water storage loss cale	ulated for eac	h month (55	5) x (41)m				1			22.20	
34.	41 31.08	34.41	33.30	34.41	33.30	34.41	34.41	33.30	34.41	33.30 34.4	41 (56)
If the vessel contains d	edicated solar	storage or d	ledicated V	VWHRS (56)r	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 34.4	41 (57)
Primary circuit loss for	each month fr	om Table 3				×					1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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	e 3a, 3b or 3	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 requ	ired for wat	er heating	calculated f	for each m	onth 0.85 >	x (45)m + (4	16)m + (57)	m + (59)m +	+ (61)m	30	9). 		7212 - 73
	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 inpu	ut calculated	l using App	endix G or /	Appendix F	1					1			
	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 wa	ater heater l	for each mo	onth (kWh/	month) (6	2)m + (63)n	n	- 14 - 14						
14	221.09	195.01	205.16	184.39	181.05	162.28	156.33	170.88	170.37	191.18	201.55	215.93	1
					1.00					∑(64)1	.12 = 2	255.20	(64)
Heat gains from	n water heat	ing (kWh/n:	nonth) 0.29	5 × [0.85 ×	(45)m + (61	1)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)
			-	_				1					52.1
5. Internal gair	ns	in the second			and the second								
	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 (c	alculated in	Appendix l	∟, equation	L9 or L9a),	also see Ta	able 5	-						1
1	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 Appendi	x L, equatio	n L13 or L1	13a), also se	ee 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 (c	alculated in	Appendix l	., equation	L15 or L15	a), 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 ga	ains (Table 5	ia)											
	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. evapo	oration (Tab	ole 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 ga	ains (Table 5	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 gai	ins (66)m +	(67)m + (68	8)m + (69)n	n + (70)m +	- (71)m + (7	'2)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	MA STREET	I IN P								Seller de		-	
or solar Gams			Access fa	ector	Area	Fola			SVI -				
			- ACCC33 10	ICLUI	Alca		ar flow		22			Calina	
			Table 6	5d	m²	W	ar flux /m²	specif	g ic data	FF specific da	ata	Gains W	
West			Table (5d	m²	W	ar flux /m²	specif or Ta	g ic data ble 6b	FF specific da or Table	ata 6c	Gains W	
			Table (5d	m² 11.76	301a W] x 19	ar flux /m ²	specif or Ta	g ic data ble 6b 45 x	FF specific da or Table	ata 6c	Gains W 57.62	(80)
North			Table (0.77 0.77	6d	m ² 11.76 13.14	W] x 19] x 10	ar flux /m ²).64 x 0 1.63 x 0	specif or Ta .9 x 0.	g ic data ble 6b 45 x 45 x	FF specific da or Table 0.80	ata 6c = =	Gains W 57.62 34.86	(80) (74)
North Solar gains in wat	tts ∑(74)m	(82)m	Table (0.77 0.77	5d	m ² 11.76 13.14	W] x <u>19</u>] x <u>10</u>	9.64 × 0 2.63 × 0	specif or Ta 9 x 0. 9 x 0.	g ic data ble 6b 45 x 45 x	FF specific da or Table 0.80 0.80	ata 6c = =	Gains W 57.62 34.86	(80) (74)
North Solar gains in wat	tts ∑(74)m 92.48	(82)m 179.34	Table (0.77 0.77 298.83	6d x x 452.56	m ² 11.76 13.14 576.73	Sola W] x 19] x 10 601.86	ar flux /m ²).64 x 0).63 x 0 568.17	specif or Ta 0.9 x 0. 0.9 x 0.	g ic data ble 6b 45 x 45 x 352.00	FF specific da or Table 0.80 0.80 213.05	ata 6c = = 114.85	Gains 57.62 34.86 76.45	(80) (74) (83)
North Solar gains in wa [Total gains - inter	tts ∑(74)m 92.48 rnal and sola	(82)m 179.34 ar (73)m + (Table (0.77 0.77 298.83 83)m	6d X	m ² 11.76 13.14 576.73	W X 19 X 10 601.86	ar flux /m ²).64 x 0).63 x 0 568.17	specif or Ta 9 x 0. .9 x 0. '471.99	g ic data ble 6b 45 x 45 x 352.00	FF specific da or Table 0.80 0.80 213.05	ata 6c = = 114.85	Gains 57.62 34.86 76.45	(80) (74) (83)
North Solar gains in wa [Total gains - inter	tts ∑(74)m 92.48 rnal and sola 579.18	(82)m 179.34 ar (73)m + (663.83	Table (0.77 0.77 298.83 83)m 767.73	5d x x 452.56 896.14	m ² 11.76 13.14 576.73 994.31	994.57	ar flux /m ²).64 x 0).63 x 0 568.17 944.83	specif or Ta 0.9 x 0. 0.9 x 0. 471.99 855.04	g ic data ble 6b 45 x 45 x 352.00 748.15	FF specific da or Table 0.80 0.80 213.05 634.75	ata 6c =	Gains 57.62 34.86 76.45 549.87	(80) (74) (83) (84)
North Solar gains in wa [Total gains - inter [tts ∑(74)m 92.48 rnal and sola 579.18	(82)m 179.34 ar (73)m + (663.83	Table (0.77 0.77 298.83 83)m 767.73	6d X	m ² 11.76 13.14 576.73 994.31	994.57	ar flux /m ²).64 x 0).63 x 0 568.17 944.83	specif or Ta .9 x 0. .9 x 0. '471.99 4 855.04	g ic data ble 6b 45 x 45 x 352.00 748.15	FF specific da or Table 0.80 213.05 634.75	ata 6c = = = 114.85 565.95	Gains 57.62 34.86 76.45 549.87	(80) (74) (83) (84)
North Solar gains in war Total gains - inter 7. Mean interna	tts ∑(74)m 92.48 rnal and sola 579.18 al temperatu	(82)m 179.34 ar (73)m + (663.83	Table (0.77 0.77 298,83 83)m 767.73 g season)	5d x [x] 452.56] 896.14]	m ² 11.76 13.14 576.73 994.31	994.57	ar flux /m ²).64 x 0).63 x 0 568.17 944.83	specif or Ta 0.9 x 0. 0.9 x 0. 471.99 4 855.04	g ic data ble 6b 45 x 45 x 352.00 748.15	FF specific da or Table 0.80 0.80 213.05 634.75	ata 6c = = 114.85 565.95	Gains 57.62 34.86 76.45 549.87	(80) (74) (83) (84)
North Solar gains in war Total gains - inter 7. Mean interna Temperature dur	tts ∑(74)m 92.48 rnal and sola 579.18 al temperatu	(82)m 179.34 ar (73)m + (663.83 ure (heating periods in t	Table (0.77 0.77 298.83 83)m 767.73 g season) the living an	6d X (X (452.56) 896.14) ea from Ta	m ² <u>11.76</u> <u>13.14</u> <u>576.73</u> <u>994.31</u> uble 9, Th1(Sola W] x 19] x 10 601.86 994.57 °C)	ar flux /m ²).64 x 0).63 x 0 568.17 944.83	specif or Ta .9 x 0. .9 x 0. '471.99 4 855.04	g ic data ble 6b 45 x 45 x 352.00 [748.15	FF specific da 0.80 0.80 213.05 634.75	ata 6c = = 114.85 565.95	Gains 57.62 34.86 76.45 549.87 1.00	(80) (74) (83) (84) (85)
North Solar gains in wa Total gains - inter 7. Mean interna Temperature dur	tts ∑(74)m 92.48 rnal and sola 579.18 al temperatu ring heating Jan	(82)m 179.34 ar (73)m + (663.83 ure (heating periods in t Feb	Table (0.77 0.77 298,83 83)m 767.73 g season) the living an Mar	6d X X 452.56 896.14 ea from Ta Apr	m ² 11.76 13.14 576.73 994.31 994.31 ible 9, Th1(May	Sola W] x 19] x 10 601.86 [994.57] °C) Jun	ar flux /m ²).64 x 0).63 x 0 568.17 944.83 Jul	specif or Ta .9 x 0. .9 x 0. '471.99 855.04	g ic data ble 6b 45 x 45 x 352.00 748.15 Sep	FF specific da or Table 0.80 213.05 634.75	ata 6c = = 114.85 565.95 2 Nov	Gains 57.62 34.86 76.45 549.87 1.00 Dec	(80) (74) (83) (84) (85)
North Solar gains in wa Total gains - inter 7. Mean interna Temperature dur Utilisation factor	tts ∑(74)m 92.48 rnal and sola 579.18 al temperatu ing heating Jan for gains for	(82)m 179.34 [ar (73)m + (663.83] ure (heating periods in t Feb fliving area	Table (0.77 0.77 298.83 83)m 767.73 g season) the living an Mar n1,m (see	6d X 452.56 896.14 ea from Ta Apr Table 9a)	m ² <u>11.76</u> <u>13.14</u> <u>576.73</u> <u>994.31</u> <u>994.31</u> <u>1006</u> <u>994.31</u>	Sola W] × 19] × 10 601.86 994.57 994.57 ℃) Jun	ar flux /m ²).64 x 0).63 x 0 568.17 944.83 Jul	specif or Ta 0.9 x 0. 0.9 x 0. 471.99 4 855.04 4 Aug	g ic data ble 6b 45 x 45 x 352.00 748.15 Sep	FF specific da or Table 0.80 213.05 634.75	ata 6c = = = 114.85 565.95 2 Nov	Gains 57.62 34.86 76.45 549.87 1.00 Dec	(80) (74) (83) (84) (85)
North Solar gains in wa Total gains - inter 7. Mean interna Temperature dur Utilisation factor	tts ∑(74)m 92.48 rnal and sola 579.18 al temperatu ing heating Jan for gains for 0.96	(82)m 179.34 ar (73)m + (663.83 periods in t Feb fliving area 0.94	Table (0.77 0.77 298,83 83)m 767.73 g season) the living an Mar n1,m (see 0.89	5d x [x [452.56] 896.14 ea from Ta Apr Table 9a) 0.77	m ² 11.76 13.14 576.73 994.31 ble 9, Th1(May 0.60	Sola W X 19 X 10 601.86 994.57 994.57 Sun 0.43	ar flux /m ²).64 x 0).63 x 0 568.17 944.83 Jul Jul	specif or Ta 0.9 x 0. .9 x 0. .471.99 855.04 Aug 0.36	g ic data ble 6b 45 × 45 × 352.00 748.15 Sep 0.59	FF specific da or Table 0.80 213.05 634.75 Oct 0.84	ata 6c = = 114.85 565.95 2 Nov 0.94	Gains W 57.62 34.86 76.45 549.87 1.00 Dec 0.97	(80) (74) (83) (84) (85)
North Solar gains in wa Total gains - inter 7. Mean interna Temperature dur Utilisation factor	tts $\Sigma(74)$ m 92.48 rnal and sola 579.18 al temperaturing heating Jan for gains for 0.96 mp of living	(82)m 179.34 ar (73)m + (663.83 periods in t Feb · living area 0.94 area T1 (ste	Table (0.77 0.77 298.83 83)m 767.73 g season) the living an Mar n1,m (see 0.89 aps 3 to 7 in	6d x [x [452.56] 896.14 896.14 ea from Ta Apr Table 9a) 0.77 Table 9c)	m ² <u>11.76</u> <u>13.14</u> <u>576.73</u> <u>994.31</u> <u>994.31</u> <u>1006</u> <u>0,60</u>	<pre>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>></pre>	ar flux /m ² 3.64 x 0 3.63 x 0 568.17 944.83 Jul 0.32	specif or Ta 0.9 x 0. 0.9 x 0. 471.99 4 855.04 4 Aug 0.36	g ic data ble 6b 45 x 45 x 352.00 748.15 Sep 0.59	FF specific da or Table 0.80 213.05 634.75 0ct 0.84	ata 6c = = 114.85 565.95 2 Nov 0.94	Gains 57.62 34.86 76.45 549.87 1.00 Dec 0.97	(80) (74) (83) (84) (85) (86)

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 90	:)						
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			Liv	ving 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 appropria	ate						
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)
					6	()	
8. Space heating requirement			7107-51		ALCONO.		
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			а.				
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	1058.0	6 (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	
			Σ(9	B)15, 10	.12 =	1800.13	(98)
							1 4
Space heating requirement kWh/m²/year				(98)	÷ (4)	17.22	(99)
Space heating requirement kWh/m²/year				(98)	÷ (4)	17.22	(99)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme			<u>instru</u>	(98)	÷ (4)	17.22	(99)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11)				(98) '0' if	÷ (4)	0.00	(99)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system				(98) '0' if 1 - (3	÷ (4) none 01) =	0.00	(99) (301) (302)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump				(98) '0' if 1 - (3	÷ (4)	17.22 0.00 1.00 1.00	(99) (301) (302) (303a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump			11 11 	(98) '0' if 1 - (3 (302) × (30	+ (4)	17.22 0.00 1.00 1.00 1.00	(99) (301) (302) (303a) (304a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating				(98) '0' if 1 - (3 (302) x (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00	(99) (301) (302) (303a) (304a) (305)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating				(98) '0' if 1 - (3 (302) × (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00	(99) (301) (302) (303a) (304a) (305) (305a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system				(98) '0' if 1 - (3 (302) x (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.05	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system				(98) '0' if 1 - (3 (302) x (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	(99) (301) (302) (303a) (304a) (305) (305a) (306)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating				(98) '0' if 1 - (3 (302) x (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.05	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement			800.13	(98) '0' if 1 - (3 (302) × (30	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	(99) (301) (302) (303a) (304a) (305) (305a) (306) (98)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump		1 	800.13 2) x (304a)	(98) '0' if 1 - (3 (302) × (30 x (305) × (3	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1.05	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump		 (98	800.13 2) x (304a)	(98) '0' if 1 - (3 (302) x (30) x (305) x (3	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.05 1.05	(99) (301) (302) (303a) (304a) (305) (305a) (306) (98) (98) (307a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump		<u>1</u> (98	800.13 3) x (304a)	(98) '0' if 1 - (3 (302) x (30 x (305) x (3	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.05 1.890.14	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heat from heat pump Water heating Annual water heating requirement		 (98	800.13 a) x (304a) 255.20	(98) '0' if 1 - (3 (302) x (30) x (305) x (3	÷ (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1.890.14	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a)
Space heating requirement KWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heat from heat pump Water heating Annual water heating requirement		1 (98 (64)	800.13 3) x (304a) 255.20 x (303a) x	(98) '0' if 1 - (3 (302) × (30 x (305) × (3 (305a) × (3	\div (4) none 01) = 13a) = 06) =	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1.05 1.890.14	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (305a) (306) (306) (307a) (64) (310a)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heat from heat pump Water heating requirement Space heating Annual water heating requirement Water heat from heat pump Electricity used for heat distribution	0.01 ×	1 (98 (64) < [(307a)	800.13 255.20 x (303a) x .(307e) + ((98) '0' if 1 - (3 (302) × (30 x (305) × (3 x (305) × (3 310a)(310	$ \div (4) $ none $ 01) = $ $ 03a) = $ $ 06) = $ $ 06) = $ $ 006 = $ $ 00$	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1.05 1.890.14 2367.96 42.58	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a) (307a) (64) (310a) (313)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Fraction of total space heat from community heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Pactor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heating Mater heating requirement Water heating requirement Water heat from heat pump Electricity used for heat distribution	0.01 ×	1 (98 (64) < [(307a)	800.13 3) x (304a) 255.20 x (303a) x .(307e) + (.	(98) '0' if 1 - (3 (302) × (30 (302) × (30) x (305) × (3 (305a) × (3 310a)(310	\div (4) none 01) = (3a) =(3a) = _	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.05 1.05	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a) (64) (310a) (313)
Space heating requirement kWh/m²/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Praction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Fraction of total space heat from community heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump Water heating Annual water heating requirement Water heat from heat pump Electricity used for heat distribution Electricity for pumps, fans and electric keep-hot (Table 4f)	0.01 ×	[] (98 [] (64) ∢ [(307a)	800.13 	(98) '0' if 1 - (3 (302) × (30 x (305) × (3 x (305a) × (3 310a)(310	\div (4) none 01) = (3a) =(3a)	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1890.14 2367.96 42.58	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a) (307a) (64) (310a) (313)
 Space heating requirement kWh/m*/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump Water heating requirement Water heat from heat pump Electricity used for heat distribution Electricity for pumps, fans and electric keep-hot (Table 4f) mechanical ventilation fans - balanced, extract or positive input from outside 	0.01 ×	1 (98 (64) < [(307a)	800.13 3) x (304a) 255.20 x (303a) x .(307e) + (3 229.77	(98) '0' if 1 - (3 (302) × (30 x (305) × (3] (305a) × (3 310a)(310	$ \div (4) $ none $ (01) = $ $ (3a) = $	17.22 0.00 1.00 1.00 1.00 1.00 1.05 1.05 1.05 2367.96 42.58	(99) (301) (302) (303a) (304a) (305) (305a) (305a) (306) (98) (307a) (64) (310a) (313)
 Space heating requirement kWh/m*/year 9b. Energy requirements - community heating scheme Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from community system Fraction of community heat from heat pump Fraction of total space heat from community heat pump Factor for control and charging method (Table 4c(3)) for community space heating Factor for charging method (Table 4c(3)) for community water heating Distribution loss factor (Table 12c) for community heating system Space heating Annual space heating requirement Space heat from heat pump Water heating Annual water heating requirement Water heat from heat pump Electricity used for heat distribution Electricity for pumps, fans and electric keep-hot (Table 4f) mechanical ventilation fans - balanced, extract or positive input from outside Total electricity for the above, kWh/year 	0.01 ×	1 (98 (64) < [(307a)	800.13 3) x (304a) 255.20 x (303a) x .(307e) + (1)	(98) '0' if 1 - (3 (302) × (30 x (305) × (3] (305a) × (3 310a)(310	\div (4)	17.22 0.00 1.00 1.00 1.00 1.00 1.00 1.05 1.05 1.05 42.58 42.58	(99) (301) (302) (303a) (304a) (305a) (305a) (305a) (306) (98) (307a) (307a) (64) (310a) (313) (330a) (331)

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electricity generated	by PV	(Appendix	M)
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414.86 (332)

59.09	(333)
43.64	(338)

Energy saving/generation technologies	24					
electricity generated by PV (Appendix M)					-259.09	(333)
Total delivered energy for all uses	(307) + (309) +	(310) + (3	12) + (315) + (331) +	(332)(337b) =	4643.64	(338)
10b. Fuel costs - community heating scheme						
	Fuel		Fuel price		Fuel	
	kWh/year				cost £/year	
Space heating from heat pump	1890.14	×	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	×	13.19	x 0.01 =	30.31	(349)
Electricity for lighting	414.86	×	13.19	x 0.01 =	54.72	(350)
Additional standing charges			<i>*</i> i		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					and the	100 M
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					В	
12h CO emissions commute to store the	Sector Sector Sector		-		-	
120. CO ₂ emissions - community neating scheme						
	-					
	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)	Energy kWh/year		Emission factor		Emissions (kg/year)	(3675)
Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) = 100$	Energy kWh/year 300.00		Emission factor		Emissions (kg/year)	(367a)
Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution	Energy kWh/year 300.00 1419.36	×	Emission factor		Emissions (kg/year) 736.65	(367a)] (367)] (372)
Emissions from other sources (space heating) Efficiency of heat pump [CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems	Energy kWh/year 300.00 1419.36 42.58	x x	Emission factor	a [= [Emissions (kg/year) 736.65 22.10 758.75	(367a)] (367)] (372)] (373)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating	Energy kWh/year 300.00 1419.36 42.58	x x	Emission factor 0.519 0.519	= [[Emissions (kg/year) 736.65 22.10 758.75 758.75	(367a)] (367)] (372)] (373)] (376)
Emissions from other sources (space heating) Efficiency of heat pump [CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans	Energy kWh/year 300.00 1419.36 42.58	x x	Emission factor	= [[Emissions (kg/year) 736.65 22.10 758.75 758.75 110.25	(367a)] (367)] (372)] (373)] (376)] (279)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting	Energy kWh/year 300.00 1419.36 42.58 229.77 414.85	x x x	0.519 0.519 0.519	= [= [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31	(367a)] (367)] (372)] (373)] (376)] (378)] (379)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution [Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31	(367a) (367) (372) (373) (376) (378) (379)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies py savings	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31	(367a) (367) (372) (373) (376) (376) (378) (379) (380)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution [Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies pv savings [Total CO2, kg/year	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [= [= [(376) (382) = [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47	(367a) (367) (372) (373) (376) (378) (379) (380)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting Energy saving/generation technologies pv savings [Total CO ₂ , kg/year Dwelling CO ₂ emission rate	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [= [(376)(382) = [(382) ÷ (4) = [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85	(367a) (367) (372) (373) (376) (378) (379) (380) (380) (383) (384)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution [Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies pv savings [Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85 9.17	(367a) (367) (372) (373) (376) (378) (379) (380) (383) (384)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution [Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies pv savings [Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value [El rating (section 14)]	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85 9.17 91.41	(367a) (367) (372) (373) (376) (378) (379) (380) (383) (384)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting Energy saving/generation technologies pv savings Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14)	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85 9.17 91.41 91	(367a) (367) (372) (373) (376) (378) (379) (380) (383) (383) (384) (385)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution [Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies pv savings [Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [[Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85 9.17 91.41 91 8	(367a) (367) (372) (373) (376) (378) (378) (380) (383) (383) (384) (385)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting Energy saving/generation technologies pv savings Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13b. Primary energy - community heating scheme	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [[Emissions (kg/year) 736.65 22.10 758.75 758.75 119.25 215.31 -134.47 958.85 9.17 91.41 91 8	(367a) (367) (372) (373) (376) (378) (378) (380) (383) (383) (384) (385)
Emissions from other sources (space heating) Efficiency of heat pump [(307a)+(310a)] × 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans [Electricity for lighting [Energy saving/generation technologies pv savings Total CO ₂ , kg/year Dwelling CO ₂ emission rate El value El rating (section 14) El band 13b. Primary energy - community heating scheme	Energy kWh/year 300.00 1419.36 42.58 229.77 414.86 -259.09 Energy kWh/year	* * * *	Emission factor 0.519 0.519 0.519 0.519 0.519 0.519	= [= [= [(376)(382) = [(383) ÷ (4) = [[Emissions (kg/year) 736.65 22.10 758.75 119.25 215.31 -134.47 958.85 9.17 91.41 91 8 Primary energy (kWh/year)	(367a) (367) (372) (373) (376) (378) (378) (383) (383) (383) (384) (385)

Efficiency of heat pump	300.00					(367a)
Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [1419.36	×	3.07	=	4357.45	(367)
Electrical energy for community heat distribution	42.58	x	3.07	-	130.72	(372)

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NHER Plan Assessor version 6.3.4

SAP version 9.92

Total primary energy associated with community systems					4488.17	(373)
Total primary energy associated with space and water heatin	g				4488.17	(376)
Pumps and fans	229.77	×	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	×	3.07	199	-795.39	(380)
Primary energy kWh/year					5671.79	(383)
Dwelling primary energy rate kWh/m2/year					54.24	(384)

DER Worksheet Design - Draft

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

Assessor name	Mr AECON	1 Planner						Assessor number			101		
Client	Default Cli	ent						Last modified	ł	30/0	30/08/2018		
Address	2.5 redYell	ow 42, Lo	ndon										
1. Overall dwelling dimens	sions				3.112 V			-				201	
					Area (m²)		А	verage storey height (m)		v	olume (m	3)	
owest occupied					97.18	(1a) x		2.62	(2a) =		254.61	(3a)	
otal floor area	(1a) +	(1b) + (1c) + (1d)(1n) = 🗌	97.18	(4)							
welling volume							(3a) + (3b) + (3	c) + (3d)(3n) =	254.61	(5)	
2. Ventilation rate		i sett					11.017		A TERM				
141										m	³ per hou	r	
lumber of chimneys								0	x 40	-	0	(6a)	
lumber of open flues							L	0	x 20		0	(6b)	
lumber of intermittent fans	5							0	× 10 -		0	(7a)	
lumber of passive vents								0	x 10 =	• L	0	(7b)	
umber of flueless gas fires							L	0	x 40 -		0	(7c)	
										Air	changes p hour	er	
ifiltration due to chimneys.	flues, fans, F	SVs		(6	a) + (6b) + (2	7a) + (7b) + ((7c) =	0	÷ (5) ;	_	0.00	(8)	
a pressurisation test has be	een carried o	ut or is in	tended, pr	oceed to	(17), otherv	vise continu	e from (e) to (16)	1 . (3)		0.00	(0)	
ir permeability value, q50,	expressed in	cubic met	res per ho	our per se	uare metre	of envelop	e area	y (3.00	(17)	
based on air permeability v	value, then (:	.8) = [(17)	; ÷ 20] + (8). otherw	/ise (18) = (1	16)					0.15	(18)	
umber of sides on which th	e dwelling is	sheltered		,,		,					2	(10)	
helter factor								1-	[0 075 x (1	9)] -	0.85	(20)	
filtration rate incorporating	g shelter fact	or						-	(18) v (1	20) - [0.03	(21)	
filtration rate modified for	monthly win	d speed:							(10) / (2		0.15		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
onthly average wind speed	from Table	J2											
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)	
/ind factor (22)m ÷ 4												12	
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)	
justed infiltration rate (allo	owing for she	lter and v	vind facto	r) (21) x (22a)m	N7.1					1		
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)	
Iculate effective air change	e rate for the	applicabl	e case:								1.11		
If mechanical ventilation:	air change ra	te throug	h system								0.50	(23a)	
If balanced with heat reco	overv: efficier	ncv in % al	lowing for	r in-use fa	actor from 1	able 4h					76 50	(23c)	
a) If balanced mechanical	ventilation w	ith heat r	ecoverv (I	MVHR) (2	22b)m + (23	b) x [1 - (23c	;) ÷ 1001			L	. 0.00	(230)	
0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(24-)	
fective air change rate - ent	ter (24a) or (24b) or (2	4c) or (24)	1) in (25)	0.27	0.24	0.24	0.63	0.23	0.20	0.27	(24d)	
0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.25	0.20	0.27		
0.28	0.20	0.2/	0.20	0.25	0.24	0.24	0.24	0.25	0.25	0.26	0.27	(25)	

3. Heat losses and heat loss parameter							10-14-0	
Element	Gross area, m²	Openings m ²	Net area A, m²	U-value W/m²K	A x U W/K	к-value, kJ/m².K	Ахк, kJ/K	
Window			22.74	x 1.33	= 30.15]		(27)
External wall			35.02	x 0.18	= 6.30	J		(29a)
Party wall			57.76	x 0.00	= 0.00	J		(32)
Total area of external elements ∑A, m ²			57.76			4		(31)
Fabric heat loss, W/K = $\Sigma(A \times U)$					(26)	.(30) + (32) =	36.45	(33)
Heat capacity Cm = $\Sigma(A \times \kappa)$				(28)	(30) + (32) + (3	32a)(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K							100.00	(35)
Thermal bridges: $\underline{\Sigma}(L \ x \ \Psi)$ calculated using A	ppendix K						8.66	(36)
Total fabric heat loss						(33) + (36) =	45.12	(37)
Jan Feb M	ar Apr	May	Jun Jul	Aug	Sep	Oct Nov	Dec	
Ventilation heat loss calculated monthly 0.3	3 x (25)m x (5)			1				-
23.53 23.26 23.	.00 21.66	21.39	20.05 20.0	5 19.78	20,59	21.39 21.92	22.46	(38)
Heat transfer coefficient, W/K (37)m + (38)r	n							-
68.65 68.38 68.	.11 66.77	66.50	65.17 65.1	.7 64.90	65.70	66.50 67.04	67.58	
					Average = $\sum(3$	9)112/12 = [66.70	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷	(4)						0.70	1
0.71 0.70 0.	70 0.69	0.68	0.67 0.6	7 0.67	0.68	0.68 0.69	0.70	
					Average = \geq (4	0)112/12 = [0.69	_ (40)
Number of days in month (Table 1a)						a4 aa aa aa	1 21 00	740
31.00 28.00 31	.00 30.00	31.00	30.00 31.0	0 31.00	30.00	31.00 30.00	31.00	(40)
4. Water heating energy requirement		1 10 101						
Assumed occupancy, N							2.71	(42)
Annual average hot water usage in litres per	day Vd,average	= (25 x N) + 3	36				98.61	(43)
Jan Feb M	ar Apr	May	Jun Jul	Aug	Sep	Oct Nov	Dec	
Hot water usage in litres per day for each m	onth Vd,m = fac	tor from Tabl	e 1c x (43)					
108.47 104.52 100	96.63	92.69	88.75 88.7	5 92.69	96.63	100.58 104.52	2 108.47	
						∑(44)112 = 	1183.27	(44)
Energy content of hot water used = 4.18 x V	d,m x nm x Tm/3	3600 kWh/m	onth (see Tables	1b, 1c 1d)				
160.85 140.68 145	5.17 126.56	121.44	104.80 97.1	1 111.43	112.76	131.42 143.4	5 155.78]
						∑(45)112 =	1551.46	(45)
Distribution loss 0.15 x (45)m								
24.13 21.10 21	78 18.98	18.22	15.72 14.5	7 16.71	16,91	19.71 21.52	23.37	(46)
Storage volume (litres) including any solar o	r WWHRS storag	ge within sam	e vessel				180.00	(47)
Water storage loss:			+1			_		1 .
a) If manufacturer's declared loss factor is k	nown (kWh/day))					1.85	(48)
Temperature factor from Table 2b							0.60	(49)
Energy lost from water storage (kWh/day	y) (48) x (49)						1.11	(50)
Enter (50) or (54) in (55)							1.11	_ (55)
Water storage loss calculated for each mont	h (55) x (41)m							
34.41 31.08 34	.41 33.30	34.41	33.30 34.4	1 34.41	33.30	34.41 33.30	34.41	(56)
If the vessel contains dedicated solar storage	e or dedicated V	VWHRS (56)m	n x [(47) - Vs] ÷ (4	1/), else (56)	00000			
34.41 31.08 34	.41 33.30	34.41	33.30 34.4	1 34.41	33.30	34.41 33.30	34.41	_ (57)
Primary circuit loss for each month from Tak	Die 3	1 22 25	22.51 22.5	0 22.20	22.54	22.26 2.254	22.20	(50)
23.26 21.01 23	.26 22.51	23.26	22.51 23.2	0 23.26	22.51	23.20 22.51	23.20	(59)

Combi loss for ea	ach month	from Table	3a, 3b or 3	Зc									
	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 requir	ed for wat	ter heating o	calculated	for each m	onth 0.85	x (45)m + (4	16)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	d using Appe	endix G or	Appendix H	4								
	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 wat	er heater	for each mo	nth (kWh/	month) (6	2)m + (63)r	m							
1	218.53	192.77	202.84	182.38	179.11	160.61	154.78	169.11	168.58	189.09	199.26	213.45	
							1			∑(64)1	.12 =	2230.51	(64)
Heat gains from	water heat	ting (kWh/m	onth) 0.2	5 × [0.85 ×	(45)m + (6	1)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	5												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)							1.545					
[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 (ca	lculated in	Appendix L	, equation	L9 or L9a),	, also see T	able 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, equatio	on L13 or L	13a), also s	ee Table 5		M					
Γ	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 (ca	lculated in	Appendix L	, equation	L15 or L15	ia), also see	e 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 gai	ns (Table 5	5a)	0	5									
[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. evapo	ration (Tab	ole 5)				10				14			- ALCONT IN
[-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 gai	ins (Table !	5)										_	
0	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 gair	ns (66)m +	(67)m + (68	3)m + (69)r	n + (70)m -	+ (71)m + (1	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)
C. Colon estina	-									-	-		
6. Solar gains			Assess		A	Cal	an filman						
			Table	6d	m ²	W	//m²	speci	g fic data	specific d	ata	W	
								or Ta	able 6b	or Table	6c		
North			0.77	x	10.26	x 10	0.63 x (0.9 x 0	.45 x	0.80	=	27.22	(74)
East			0.77	/ × [12.48	x 19	9.64 x (0x	.45 x	0.80	=	61.15	(76)
Solar gains in watt	ts ∑(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 - interr	nal and sol	ar (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	temperat	ure (heating	(noscos)							and the second se			
Temperature duri	ng heating	neriods in t	he living a	rea from T	able 9. Th1	(°C)						21.00	(OE)
remperature dum	lan	Feb	Mar	Anr	May	lun	hul	Διισ	San	Oct	Nov	21.00 Dec] (0)
Utilisation factor f	or gains fo	r living area	n1.m (see	Table 9a1	indy	2411	Jui	-146 	JCh	Ju	1104	Det	
	0.96	0.94	0.88	0.76	0.60	0.42	0.32	0.36	0.58	0.92	0.04	0.07	(96)
L Mean internal tem	p of living	area T1 (str	eps 3 to 7 i	n Table 9c	0.00	0.45	0.32	0.30	0.38	0.65	0.94	0.97	190)
Г	19.68	19.91	20.27	20.66	20.80	20.98	20 90 1	20.90	20.92	20.60	20.09	10.64	(87)
	10.00	13.31	20.2/	20.00	20.03	20.30	20.33	20.33	20.33	20.00	20.00	15.04	[(07)

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 9	Əc)			
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	iate			
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	to up t			
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)15 <i>,</i> 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	(301)
Fraction of space heat from community system		1 - (3	01) = 1.00	(302)
Fraction of community heat from heat pump			1.00	(303a)
Fraction of total space heat from community heat pump		(302) x (30	3a) = <u>1.00</u>	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating	1		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	16	63.98		(98)
Space heat from heat pump	(98)	x (304a) x (305) x (3	06) = 1747.18	(307a)
Water heating				
Annual water heating requirement	22	30.51		(64)
Water heat from heat pump	(64) >	(303a) x (305a) x (3	06) = 2342.03	(310a)
Electricity used for heat distribution	0.01 × [(307a)(307e) + (310a)(310	0e)] = 40.89	(313)
			1.50	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	2	13.56		(330a)
Total electricity for the above, kWh/vear	· · · · ·		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) + (31	12) + (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	×	4.24	x 0.01 =	74.08	(340a)
Water heating from heat pump	2342.03	×	4.24	x 0.01 =	99.30	(342a)
Pumps and fans	213.56	×	13.19	x 0.01 =	28.17	(349)
Electricity for lighting	396.26	×	13.19	x 0.01 =	52.27	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-259.09	×	13.19	x 0.01 =	0.00	(352)
Total energy cost			(340a)(342e) +	(345)(354) =	373.82	(355)
11b. SAP rating - community heating scheme		1 7 12	n huite. Th		ese pin e	
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					В]
12b. CO ₂ emissions - community heating scheme	1991 - 1991 - 1992 - 19					
12b. CO ₂ emissions - community heating scheme	Energy kWh/year	3	Emission factor		Emissions (kg/year)	
12b. CO ₂ emissions - community heating scheme Emissions from other sources (space heating)	Energy kWh/year		Emission factor		Emissions (kg/year)	
12b. CO ₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump	Energy kWh/year 300.00		Emission factor		Emissions (kg/year)	(367a)
12b. CO₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Energy kWh/year 300.00 1363.07	×	Emission factor		Emissions (kg/year) 707.43	(367a) (367)
12b. CO ₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution	Energy kWh/year 300.00 1363.07 40.89	x	Emission factor		Emissions (kg/year) 707.43 21.22	(367a)] (367)] (372)
12b. CO₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems	Energy kWh/year 300.00 1363.07 40.89	x x	Emission factor		Emissions (kg/year) 707.43 21.22 728.66	(367a)] (367)] (372)] (373)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating	Energy kWh/year 300.00 1363.07 40.89	x	Emission factor 0.519 0.519		Emissions (kg/year) 707.43 21.22 728.66 728.66	(367a)] (367)] (372)] (373)] (376)
12b. CO₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans	Energy kWh/year 300.00 1363.07 40.89 213.56	* *	Emission factor 0.519 0.519	-	Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84	(367a)] (367)] (372)] (373)] (376)] (378)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26	x x x	Emission factor 0.519 0.519 0.519 0.519		Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66	(367a)] (367)] (372)] (373)] (376)] (378)] (379)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26	* * *	Emission factor 0.519 0.519 0.519 0.519	-	Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66	(367a)] (367)] (372)] (373)] (376)] (378)] (379)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519 0.519 0.519	-	Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings Total CO2, kg/year	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	* * *	Emission factor 0.519 0.519 0.519 0.519 0.519	= = = (376)(382) =	Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47 910.69	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)] (383)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings Total CO2, kg/year Dwelling CO2 emission rate	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519	= = = (376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47 910.69 9.37	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)] (383)] (384)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings Total CO2, kg/year Dwelling CO2 emission rate El value	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	* * *	Emission factor 0.519 0.519 0.519 0.519 0.519	= = = (376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47 910.69 9.37 91.42	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)] (383)] (384)
12b. CO2 emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = [Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings Total CO2, kg/year Dwelling CO2 emission rate El value El rating (section 14)	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	x x x x	Emission factor 0.519 0.519 0.519 0.519	= = = (376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47 910.69 9.37 91.42 91	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)] (383)] (383)] (384)]] (385)
12b. CO₂ emissions - community heating scheme Emissions from other sources (space heating) Efficiency of heat pump CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = Electrical energy for community heat distribution Total CO2 associated with community systems Total CO2 associated with space and water heating Pumps and fans Electricity for lighting Energy saving/generation technologies pv savings Total CO₂, kg/year Dwelling CO₂ emission rate El value El rating (section 14) El band	Energy kWh/year 300.00 1363.07 40.89 213.56 396.26 -259.09	* * * *	Emission factor 0.519 0.519 0.519 0.519	= = = (376)(382) = [(383) ÷ (4) = [Emissions (kg/year) 707.43 21.22 728.66 728.66 110.84 205.66 -134.47 910.69 9.37 91.42 91 B	(367a)] (367)] (372)] (373)] (376)] (378)] (379)] (380)] (383)] (384)] (385)]

	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 \div (367a) = [1363.07	×	3.07	=	4184.62	(367)
Electrical energy for community heat distribution	40.89	×	3.07	+	125.54	(372)
	÷					

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SAP version 9.92

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	×	3.07	=	655.62	(378)
Electricity for lighting	396.26	×	3.07	2 H 🖬	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

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 AEC	OM Planne	er					Assessor nu	mber	101		
Client	Default	Client						Last modifie	ed	30/0	8/2018	
Address	2.9 red	ellow 42, I	ondon									
1. Overall dwelling dir	nensions											
	_				Area (m²)		,	Average store height (m)	Ŷ	v	olume (m	³)
Lowest occupied					88.30	(1a)	×	2.62	(2a) =	T	231.35	(3a)
otal floor area	(1a) + (1b) + (:	1c) + (1d)(1n) ≈ 🗌	88.30	(4)					*	12
Dwelling volume								(3a) + (3b) + (3	3c) + (3d)(3n) =	231.35	(5)
2. Ventilation rate					N TR		STRAIN W	and a star	2 11			
				÷1					_	m	n³ per hou	r
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 vent	s							0	× 10 -		0	(7b)
lumber of flueless gas f	ires							0	x 40 :		0	(7c)
										Air	changes p	er
nfiltration due to chimn	evs. flues. fan	s. PSVs		(6	a) + (6b) +	(7a) + (7b)	+ (7c) =	0	7 + (5)		0.00	(0)
f a pressurisation test h	as been carrie	d out or is i	intended. pi	oceed to	(17). othe	rwise conti	nue from (9) to (16)	(J) +	- L	0.00	(0)
, vir permeability value, g	50. expressed	in cubic m	etres per h	our ner si	nuare met	e of envelo	ne area	5) (0 (10)			3.00	(17)
based on air permeabi	lity value, the	1(18) = [(1	7) ÷ 20] + (8	a otherv	vise (18) =	(16)	spe ureu				0.15	(17)
lumber of sides on whic	h the dwelling	is shelter	ed	,, other	150 (10)	(10)					2	(10)
helter factor			-					1.	- [0 075 v (1	0)1 -	0.79	
filtration rate incorpor	ating shelter f	actor						1	(18) v (1	20) ~ [0.12	(20)
nfiltration rate modified	for monthly v	vind speed	:						(10) X (2		0.12	(21)
Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1onthly average wind sp	peed from Tab	le U2		1.00			20206		1000	1000		
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)
/ind factor (22)m ÷ 4	1							15				
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)
djusted infiltration rate	(allowing for	shelter and	wind facto	r) (21) x ((22a)m		1.50				1	
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)
Iculate effective air cha	ange rate for t	he applical	ble case:	1.1	1			_			1	()
If mechanical ventilati	ion: air change	rate throu	ugh system								0.50	(23a)
If balanced with heat	recovery: effic	iency in %	allowing fo	r in-use f	actor from	Table 4h					76.50	(23c)
a) If balanced mechan	ical ventilatio	n with heat	t recovery (MVHR) (2	22b)m + (2	3b) x [1 - (2	3c) ÷ 100]			, L	70.50	(250)
0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.23	0.23	0.24	0.25	0.25	(24-)
fective air change rate	enter (24a) o	r (24b) or (24c) or (24	d) in (25)	0.20	0.20	0.40	0.23	0.44	0.20	0.25	_ (24d)
0.27	0.26	0.26	0.25	0.24	0.32	0.22	0.22	0.22	0.24	0.25	0.05	Lach
0.27	0.20	0.20	0.25	0.24	0.23	0.23	0.23	0.23	0.24	0.25	0.25	(25)

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3. Heat losses and	l heat los	s paramete	er									
Element			а	Gross rea, m²	Openings m ²	Net A,	area m²	U-value W/m ² K	A x U W/	/Κ κ-valı kJ/m	ие, Ахк, ².К kJ/К	
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 exter	nal eleme	nts ∑A, m²				50	.77					(31)
Fabric heat loss, W	'/K = Σ(A >	< U)							(26)(30) + (32)	= 28.86	(33)
Heat capacity Cm =	= ∑(Ахк)							(28)	(30) + (32) +	(32a)(32e)	= N/A	(34)
Thermal mass para	meter (Ti	MP) in kJ/m	η²Κ		-						100.00	(35)
Thermal bridges: ∑	(L x Ψ) ca	lculated us	ing Appen	dix K							7.62	(36)
Total fabric heat lo	SS									(33) + (36)	= 36.47	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov Dec	
Ventilation heat lo	ss calcula	ted month	ly 0.33 x (2	25)m x (5)								
Ī	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 coef	icient, W	/K (37)m +	(38)m									
Г	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)112/12	= 55.15	(39)
Heat loss parameter	er (HLP), \	N/m²K (39)m ÷ (4)								4	
F	0.64	0.64	0.64	0.63	0.62	0.61	0.61	0.61	0.62	0.62	0.63 0.63	1
	0.04	0.01	0101						Average = Σ	(40)112/12	= 0.62	(40)
Number of days in	month (T	able 1a)							0 2			
Number of days in	21.00	29.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00 31.00	(40)
Ļ	51.00	28.00	51.00	1 30.00	1 51.00	50.00	1 51.00	01.00	00.00			
4. Water heating	energy re	equiremen										
Assumed occupant	cy, N			17							2.60	(42)
Annual average ho	t water u	sage in litre	es 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 pe	r day for ea	ich month	Vd,m = fact	tor from Tab	ole 1c x (43	3)					
Г	105.59	101.75	97.91	94.07	90.23	86.39	86.39	90.23	94.07	97.91	101.75 105.59	9
										∑(44)112	= 1151.89	(44)
Energy content of	hot water	used = 4.1	.8 x Vd,m x	nm x Tm/3	3600 kWh/m	nonth (see	Tables 1b), 1c 1d)				
Γ	156.59	136.95	141.32	123.21	118.22	102.02	94.53	108.48	109.77	127.93	139.65 151.65	5
					1					Σ(45)112	= 1510.31	(45)
Distribution loss 0	.15 x (45)	m										
Г	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 (lit	tres) inclu	ding any so	olar or WM	/HRS stora	e within sar	ne vessel				h	180.00	(47)
Water storage loss												
a) If manufacturer	's declare	d loss facto	or is known	(kWh/dav							1.85	(48)
Temperature fa	o decidire	Table 2b		((())) ad /							0.60	(49)
Enorgy lost from	m water s	torage (k)	(h/day) (49	8) v (49)							1.11	(50)
Energy lost from		torage (Kw		J/ X (45)							1.11	(55)
Enter (50) or (54) I	n (55) Galculate	d for each	month (5)	$5) \times (41)m$							L	
water storage loss			24.44	22.20	24.41	33.30	2/ /1	2/ /1	33.30	34.41	33 30 34 /1	(56)
M de autore de la companya de la compa	34.41	31.08	54.41	Jodicated V	34.41	55.5U	Vel ± /47		53.30	J4.41	55.50 54.41	
IT the vessel contained	ins dedica	nea solar s	lorage or d		(סכ) כחדעע ע		vsj - (47)	24.41	22.20	24.41	33 30 24 41	(57)
	3/1/1	21 (192			2 2 4 4 4					144		1311
	J4.41	51.00	34.41	33.30	34.41	33.30	34.41	34.41	55.50	0111	55.50	
Primary circuit los	s for each	month fro	34.41 m Table 3	33.30	34.41	33.30	34.41	34.41	55.50		33.50 34.12	100

			32 1										
Combi loss for	r each mont	h from Tab	ole 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 req	uired for wa	ater heatin	g calculated	for each m	nonth 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 inp	out calculate	ed using Ap	pendix G or	Appendix	н					<i>.</i>	× .	2AV7	140
	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 v	vater heater	for each r	nonth (kWh	/month) (f	52)m + (63)	m			1		1		- 200
	214.26	189.04	198.99	179.02	175.89	157.83	152.21	166.15	165.59	185.60	195.46	209.32	1
					_1	1		1		Σ(64)1.	.12 =	2189.36	(64)
leat gains fro	m water hea	ating (kWh	/month) 0.2	25 × (0.85 ×	< (45)m + (6	51)ml + 0.8	× [(46)m + (57)m + (59)ml	2(0.)2			(0.1/
	98.20	87.21	93.13	85.62	85.45	78 57	77 57	82.21	81 15	88.67	91.08	96.56	1(65)
	Loona			1 00.02	05.45	10.57		02.21	01.15	00.07	. 91.08	50.50	_ (03)
5. Internal ga	ins									10.000	a. E en		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Aetabolic gair	ns (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)
ghting gains	calculated i	n Appendi	x L, equatior	n L9 or L9a)), also see T	able 5		1				1	
	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)
ppliance gain	s (calculated	in Appen	dix L. equati	on L13 or L	13a), also s	see Table 5			1	1 41107		- caller	11011
	235.92	238.36	232.19	219.06	202.48	186.90	176.49	174.04	180.21	193 35	209.92	225 51	7 (68)
ooking gains (calculated i	n Appendi	x L. equation	n 15 or 1	5a) also se	e Table 5	170.45	_ 1/4.04	100.21	155.55	205.52	225.51	(00)
0.0	36.01	36.01	36.01	76.01	36.01	26.01	36.01	36.01	26.01	25.01	36.01	25.01	100
imn and fan i	ains (Table	5a)	50.01	50.01	30.01	30.01	39.01	50.01	30.01	50.01	30.01	30.01	(09)
			0.00	0.00	0.00	0.00	0.00	0.00		0.00			1
	0.00	1 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
isses e.g. eva		Die 5)	1		F	1			,				1
	-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)
ater neating	gains (Table	5)								1.1			
	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)
otal internal g	ains (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)
. Solar gains	THE REAL PROPERTY IN				The amo	1	1005	10		1000			
a borar gamo			Access (factor	Area	Sol	ar fluv			50		Cains	
			Table	e 6d	m ²	W	V/m ²	spec	ific data	specific d	lata	W	
								or T	able 6b	or Table	6c		
st			. 0.7	7 x [17.21	X 1	9.64 x	0.9 x 📃	0.45 x	0.80	=	84.33	(76)
lar gains in w	atts ∑(74)m	ı(82)m						2					
	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)
tal gains - int	ernal and so	lar (73)m ·	+ (83)m	1 10000									
	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)
			· · · · · ·		,								1
. Mean interr	nal tempera	ture (heat	ing season)				عدر وخطيت		2 bro				
mperature di	uring heating	g periods in	n the living a	area from T	able 9, Th1	.(°C)						21.00	(85)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
ilisation facto	or for gains fo	or living ar	ea n1,m (se	e 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)
ean internal t	emp of livin	g area T1 (.	steps 3 to 7	in Table 9c	:)								
ean internal t	emp of living	g area T1 (20.15	steps 3 to 7	in Table 9c 20.78	20.93	20.99	21.00	21.00	20.96	20.73	20.28	19.88	(87)

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)
or for gains f	or rest of d	welling 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)
temperature	in the rest	ofdwelling	T2 (follow	steps 3 to	7 in Table 9	e)						
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)
tion								Līv	ving area ÷	(4) =	0.45	(91)
temperature	for the wh	iole dwellin	g fLA x T1 +	-(1 - fLA) x	Т2		_	_				
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)
ent to the me	ean interna	l temperatu	ure from Ta	ble 4e whe	ere appropr	iate				2		
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)
ing requirem	nent											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
or for gains.	nm		201402	5427.40			6470	20/64				
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)
mGm. W (94	l)m x (84)m	1										
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)
e external t	emperature	e from Tabl	e U1	1.100.01			1					1
	1 90	6 50	8 90	11 70	14.60	16.60	16.40	14 10	10.60	7.10	4.20	(96)
or mean inte	4.50	arature Im	W/ [(39)m	x [(93)m -	(96)ml	10.00	10.40	1.110	10.00		1	1 (2 2)
			626 42	490 70	227 11	210.01	220 73	355 35	537 53	705.82	845 70	(97)
855.79	034.37	th 0.024 v	(107)m (0	$5ml \times (41)$	m	219.91	223.75		337.33	1.705.02	1 045.70] (37)
equirement,		1 122.00	[(37)][-(3	3)iii] X (41)	0.00	0.00	0.00	0.00	66.92	160.93	272.20	1
265.31	190.69	133.86	54.50	17.01	0.00	0.00	0.00	5/00	P)1 E 10	12 -	1171 20] (08)
								2(90	op)15, 10	. (4)	12.27	
requirement	kWh/m²/yo	ear							(98)	÷ (4)	13.27] (99)
quirements -	communit	ty heating s	cheme									
ce heat from	secondary	/suppleme	ntary syste	m (table 11	L)				'0' if i	none	0.00	(301)
ce heat from	communit	y system				1			1 - (3	01) =	1.00	(302)
nmunity heat	t from heat	pump									1.00	(303a)
l space heat	from comr	nunity heat	pump						(302) x (30	3a) =	1.00	(304a)
rol and charg	ging metho	d (Table 4c(3)) for com	nmunity spa	ace heating						1.00	(305)
ging method	(Table 4c(3	3)) for comr	nunity wat	er heating							1.00	(305a)
s factor (Tab	le 12c) for	community	heating sy	stem							1.05	(306)
			0,									-
												1
eating requi	rement							171.30	1			(98)
n heat pumr							(98	3) x (304a) ;	x (305) x (3	06) = 🗌	1229.87	(307a)
n heat pump)						(98	3) x (304a) x	x (305) x (3	06) = 🗌	1229.87) (307a)
n heat pump	3						(98	3) x (304a) x	x (305) x (3	06) =	1229.87] (307a)
n heat pump eating requi	rement						(98	3) x (304a) : 189.36	x (305) x (3	06) = 🤶	1229.87] (307a) (64)
n heat pump leating requi m heat pump	rement o						(98 2 (64)	3) x (304a) x 189.36 x (303a) x	x (305) x (3] (305a) x (3	06) =	2298.83) (307a) (64)] (310a)
n heat pump leating requi m heat pump for heat disi	rement p tribution					0.01	(98 	3) x (304a) ; 1 89.36 x (303a) x .(307e) + (3	x (305) x (3] (305a) x (3 310a)(310	06) = 2 06) = 2 be)] = 2	1229.87 2298.83 35.29) (307a) (64)] (310a)] (313)
n heat pump leating requi m heat pump for heat disi	rement p tribution					0.01	(98 (68) (64) × [(307a)	3) x (304a) ; 1 89.36 x (303a) x .(307e) + (3	x (305) x (3] (305a) x (3 310a)(310	06) = 06) = 0e)] =	1229.87 2298.83 35.29	(307a) (64) (310a) (313)
n heat pump heating requi m heat pump for heat dist umps, fans a	rement p tribution and electric	keep-hot ('	Table 4f)			0.01	(98 (64) L × [(307a)	3) x (304a) x 1 89.36 x (303a) x .(307e) + (3	x (305) x (3)] (305a) x (3) 310a)(310	06) = 06) = 9e)] =	2298.83 35.29	(64) (310a) (310a) (313)
n heat pump leating requi m heat pump for heat disi umps, fans a ventilation f	rement p tribution and electric ans - balanc	keep-hot (ced, extract	Table 4f)	e input fror	n outside	0.01	(98 (64) (307a)	3) x (304a) ; 189.36 x (303a) x .(307e) + (3 194.04	x (305) x (3) (305a) x (3 310a)(310	06) = 06) = 0e)] =	2298.83 35.29	(64) (310a) (313) (330a)
n heat pump neating requi m heat pump for heat dist umps, fans a ventilation f	rement p tribution and electric ans - balanc ve, kWh/ye	keep-hot (ced, extract	Table 4f) : or positive	e input fror	n outside	0.01	(98 (64) L × [(307a)	3) x (304a) x 189.36 x (303a) x .(307e) + (3 194.04	x (305) x (3) (305a) x (3) 310a)(310	06) = 06) = be)] =	1229.87 2298.83 35.29 194.04	(64) (310a) (313) (330a) (331)
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(9) 265.31 190.69 133.86 54.50 equirement kWh/m²/yearuninity heat from secondary/supplementary systemimunity heat from community systemimunity heat from community heat pump(space heat from commu	20.39 20.39 20.40 20.41 20.41 or for gains for rest of dwelling n2,m 0.94 0.91 0.83 0.69 0.52 remperature in the rest of dwelling T2 (follow steps 3 to 18.92 19.25 19.70 20.13 20.33 iton 18.92 19.25 19.70 20.13 20.33 iton 19.38 19.66 20.05 20.43 20.61 int to the mean internal temperature from Table 4e whole 19.38 19.66 20.05 20.43 20.61 ing requirement Jan Feb Mar Apr May or for gains, nm 0.93 0.90 0.83 0.69 0.53 indfm, W (94)m x (84)m 499.19 550.61 583.11 560.73 466.84 ge external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 or mean internal temperature, Lm, W [(39)m x [(93)m x [(93)m - [(95)m] x (41) 265.31 190.69 133.86 54.50 17.01 equirement, kWh/month 0.024 x [(97)m - (95)m] x (41) 265.31 190.69 133.86 54.50 17.01	20.39 20.39 20.40 20.41 20.41 20.42 or for gains for rest of dwelling n2,m 0.94 0.91 0.83 0.69 0.52 0.36 emperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 5 18.92 19.25 19.70 20.13 20.33 20.41 tion emperature for the whole dwelling fLA x T1 + (1 - 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(96)m] 855.79 834.37 76	20.39 20.40 20.41 20.41 20.42 20.42 20.42 pr for gains for rest of dwelling n2,m 0.94 0.91 0.83 0.69 0.52 0.36 0.25 0.28 emperature 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 tion emperature in the rest of dwelling fLA x T1 +(1 - fLA) x T2 19.38 19.66 20.05 20.43 20.61 20.67 20.68 20.68 int 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 ng requirement Jan Feb Mar Apr May Jun Jul Aug 0.93 0.90 0.83 0.69 0.53 0.37 0.27 0.30 nGm, W (94)m x (84)m 499.19 550.61 58.31 560.73 466.84 323.02 219.13 228.48 re external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 1.660 16.6	20.39 20.49 20.41 20.41 20.42 20.42 20.42 20.42 or 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 emperature 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 tion U 19.36 19.66 20.05 20.43 20.61 20.67 20.68 20.68 20.64 in 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 int 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 ing requirement Jan Feb Mar Apr May Jun Aug Sep ot rog ains, nm 0.30	20.39 20.39 20.40 20.41 20.41 20.42 20.42 20.42 20.42 20.42 20.42 20.42 20.41 or 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 emperature 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 20.64 20.38 tom living area + emperature for the whole dwelling fLA x T1 +(1 - 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