

Report

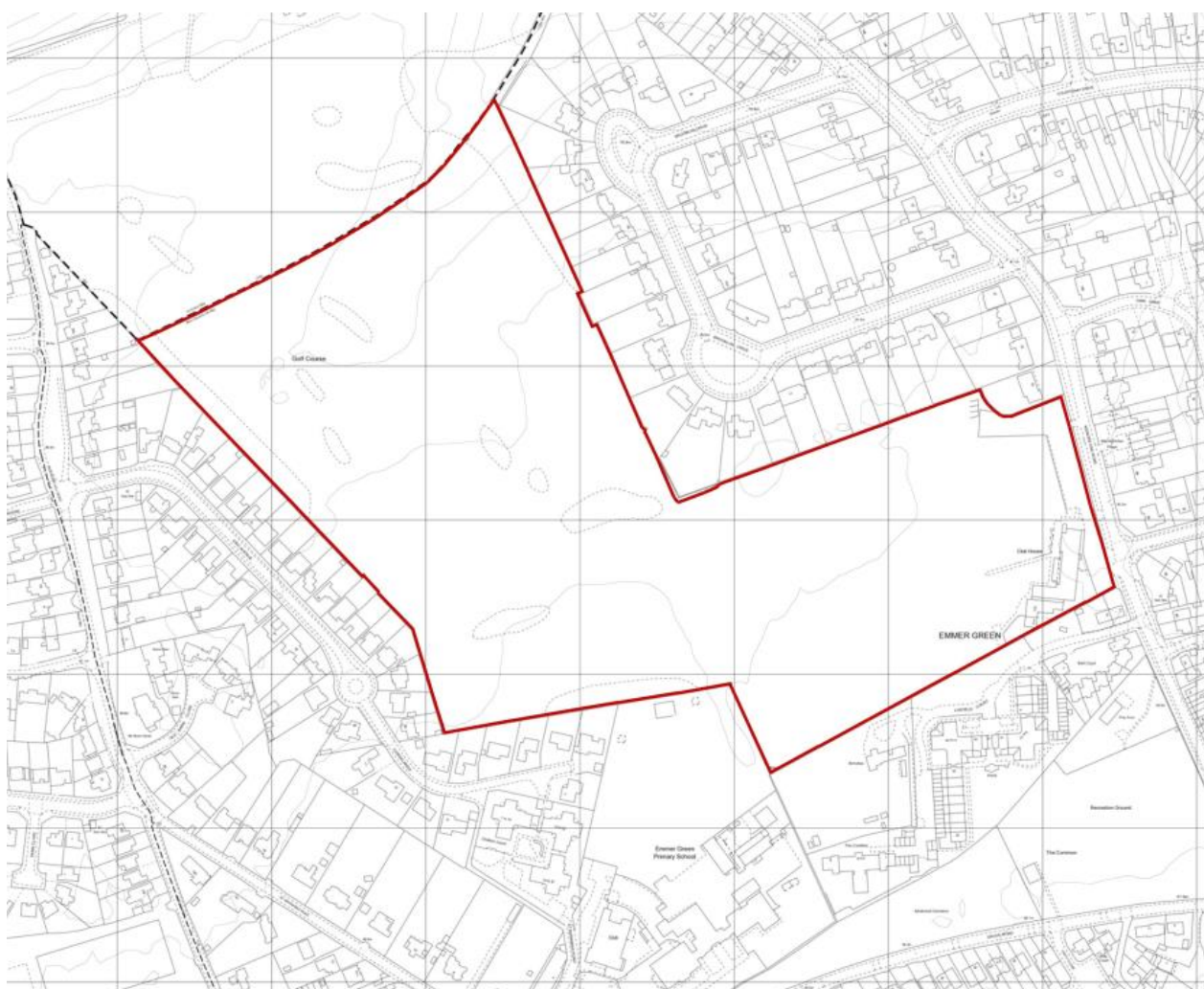
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TEMPLE

LEADERS IN ENVIRONMENT,
PLANNING & SUSTAINABILITY.

Report for – Fairfax (Reading) Ltd & Reading Golf Club Ltd
Reading Golf Course, Emmer Green
Energy and Sustainability Report



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Report for: Fairfax (Reading) Ltd & Reading Golf Club Ltd

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1.0 Executive Summary

1.1 General

- 1.1.1 Ridge & Partners LLP have been appointed to undertake an Energy and Sustainability Report for the development of the Reading Golf Club, Emmer Green, on behalf of Temple Group Ltd in support of a planning application for the scheme. The Proposed Development comprises of approximately 260 new dwellings - including a mix of private and affordable homes - and an approximately 850m² health centre.
- 1.1.2 When reviewing the energy and sustainability strategy for this development, careful consideration has been given to the context of the Site, local & regional planning policy and the 2013 Building Regulations.

1.2 Key Energy Efficient Design Measures

- 1.2.1 The approach taken in developing the energy strategy for the scheme has followed a sequential approach, assessing in turn:
- The feasibility of the integration of passive design measures and energy efficient building services strategies;
 - Determining the viability of a decentralised energy network; and
 - An assessment of the feasibility of a number of Low or Zero Carbon (LZC) Technologies for application to the Site.
- 1.2.2 The key passive energy efficient design measures proposed for inclusion in the development are as follows:
- U-values of external walls: 0.18 W/m²K;
 - U-values of ground floors: 0.13 W/m²K;
 - U-values of roofs: 0.13 W/m²K;
 - Maximum U-values for windows 1.4 W/m²K;
 - U-values of domestic external doors: 1.0 W/m²K;
 - Air leakage rate is to be 70% lower than the maximum permissible under the Building Regulations, i.e. target 3.0m³/m².h at 50Pa;
 - Centralised continuous mechanical ventilation with heat recovery (MVHR) in each of the dwellings, in accordance with SAP Appendix Q;
 - Reduction in hot water demand, in part due to higher insulation standards but also due to lower water consumption;
 - Maximise daylighting and consequently passive solar heating;
 - Specification of energy efficient external lighting;
 - Reduce energy requirements for lighting by utilising daylighting and by incorporating fixed energy efficient lamps to 100% of luminaires throughout;

- Recommendations to building users regarding energy efficient appliances and operation of systems and equipment; and
- Provision of smart meters by utility supply companies.

1.2.3 An exercise has also been undertaken to assess the feasibility of district type heating system and a series of low or zero carbon technologies for the development - in terms of the design philosophy and overall functional, technical and economic viability.

1.2.4 The major technologies considered were:

- District Heating Installation;
- Ground Source Heat Pumps (GSHP);
- Air Source Heat Pumps (ASHP);
- Photovoltaics;
- Solar Thermal; and
- Wind Energy.

1.2.5 ASHPs were identified as an appropriate form of renewable technology to aid in meeting the thermal energy loads of the houses, apartments and health centre that comprise the development proposals.

1.2.6 It was determined that a district heating installation would not be appropriate for the Site given the number of units proposed and the density of the Site proposals.

1.2.7 Of the remaining forms of LZC – a photovoltaic (PV) installation has been identified as an additional form of technology that could be installed on the roof of the health centre to contribute to the daytime electrical loads of this building. At this stage, it is proposed that a 5kWp PV array is provided.

1.2.8 Preliminary Standard Assessment Procedure (SAP) and Simplified Building Energy Model (SBEM) calculations have been undertaken for a representative sample of dwellings and the health centre respectively. These energy performance calculations have demonstrated that the proposed energy efficiency strategy would meet the requirements of Part L of the Building Regulations.

1.2.9 Further to Part L compliance, the proposed strategy for the dwellings has been demonstrated to result in a 43% reduction in CO2 emissions over a Part L compliance baseline – exceeding the mandatory 35% on site reduction required by the Reading Borough Local Plan.

1.3 Key Water Efficiency Design Measures

1.3.1 A water efficiency strategy has been developed for the Proposed Development to reduce the demand for potable water on site. The proposed strategy is envisaged to meet a water consumption target of 110 litres per person per day (including external water use) – in line with the requirements set out by the Reading Borough Local Plan.

1.3.2 The feasibility of a number of measures have been explored, including the installation of water conservation appliances, rainwater harvesting and greywater harvesting.

- 1.3.3 An analysis has been undertaken of various routes to achieve a reduction in potable water usage. A standard approach is proposed for the dwellings utilising water conservation appliances such as dual flush toilets, low flow taps and baths with a low capacity to overflow. A Water Efficiency Calculator for New Dwellings tool has been utilised to demonstrate that this approach could meet a performance level of 110 l/p/day.

1.4 Key Resource Efficiency Design Measures

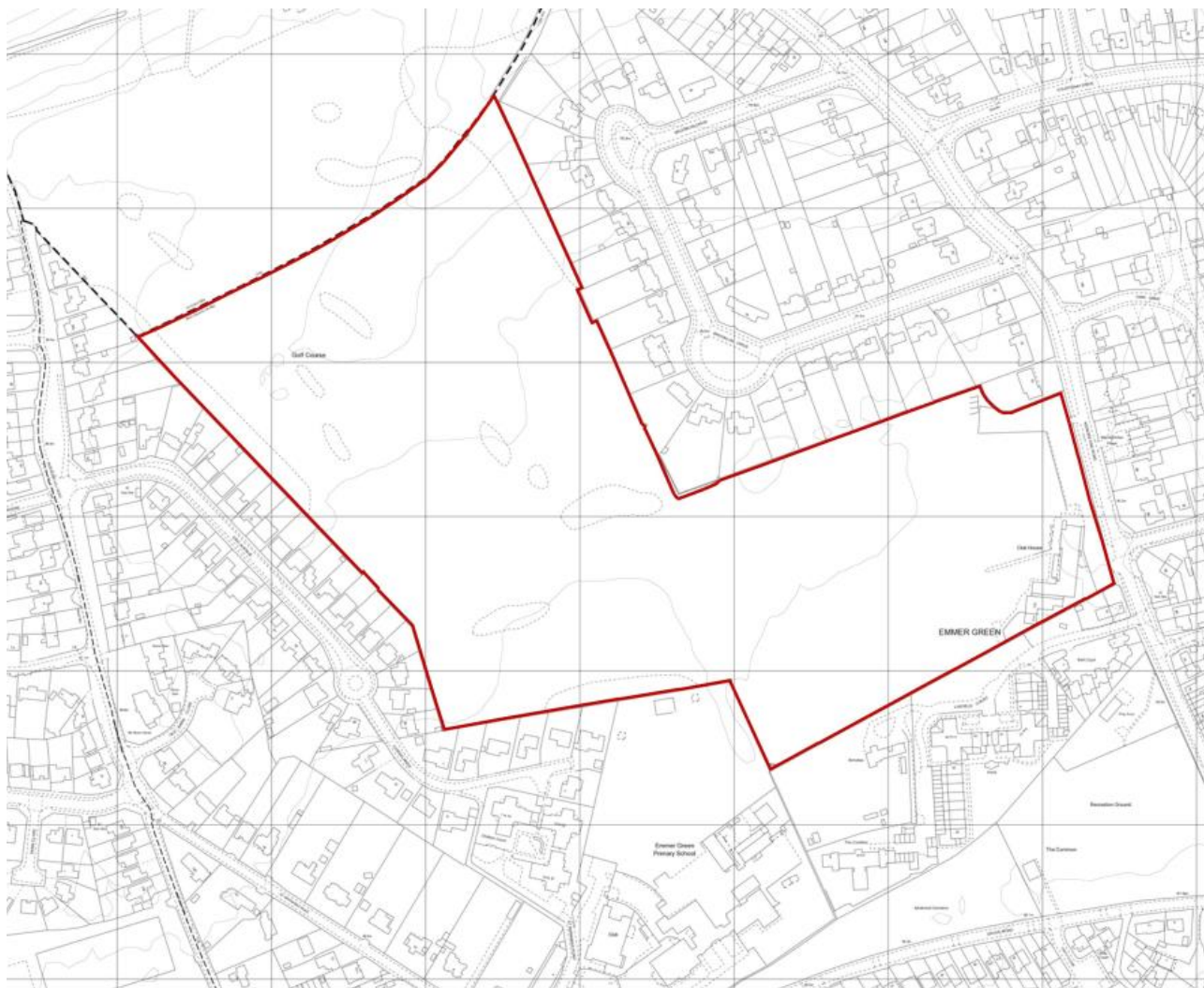
- 1.4.1 A strategy has been developed for the Proposed Development to maximise the efficient use of resources, both through the construction process and during future occupation. The waste hierarchy has been referenced throughout this assessment process to prioritise measures that would have the most significant resource saving impacts.
- 1.4.2 A summary of the key resource efficiency proposals for the Site are detailed below:
- The production of a Site Waste Management Plan (SWMP) to set good practice target waste benchmarks, set procedures for minimising, measuring, monitoring & reporting various waste streams and identifying potential for re-use to divert potential waste from landfill;
 - Reduce the resource intensity of the detailed design architectural proposals where feasible and maximise end of life potential; and
 - Encourage the use of recycling and composting facilities. Provide guidance to future occupants via Home User Guides detailing Local Authority collection schemes, information on local recycling facilities & tips, guidance on procedures to discard potentially hazardous waste (i.e. batteries, fridges / freezers etc.) and WRAP sustainable waste disposal principles.

2.0 Introduction

2.1 Site Overview

- 2.1.1 The Proposed Development will be located in Emmer Green, Reading. The Site map is shown in Figure 2.1 below.

Figure 2.1: Site Location Map (Original Source: Fairfax Boundary Plan Drawing)



- 2.1.2 The Site is located within Emmer Green – the northernmost suburb of Reading. The Site is bounded to the east and west by residential properties, and to the south by a retirement village and a primary school.
- 2.1.3 Figure 2.2, on the next page, illustrates the Site proposals for the scheme. The residential site proposals consist of 260 properties with a health centre on the eastern boundary of the Site.
- 2.1.4 The residential development is to consist of a mix of 1 bed apartments, 2 bed apartments, 2 bed houses, 3 bed houses and 4 bed houses.

Figure 2.2: Indicative Site Layout Drawing (Original Source: Paul J Hewett)



2.2 Planning Context

- 2.2.1 There is increasing awareness and legislation regarding low carbon design in the built environment. This Energy and Sustainability Report supplements the planning application for the Proposed Development and seeks to address strategic issues raised by local, regional and national planning policies relating to climate change and sustainability.
- 2.2.2 The Site is located within the Reading Borough. The Reading Borough Local Plan was adopted in November 2019, and contains planning policies to manage development in Reading up to 2036. The plan has 'development plan' status which means that, legally, it is the main consideration in determining planning applications in Reading.
- 2.2.3 There are a number of key cross-cutting policies within the Reading Borough Local Plan relating to sustainable development. These policies are included below:

CC1: Presumption in Favour of Sustainable Development

A positive approach to considering development proposals will be taken that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework (NPPF). Where appropriate, the Council will work proactively with applicants jointly to find solutions which mean that the proposals can be approved wherever possible.

Planning law required that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise. Planning applications that accord with the policies in the development plan (including, where relevant, with policies in neighbourhood plans) will be approved without delay, unless material considerations indicate otherwise. Proposed development that conflicts with the development plan will be refused, unless other material considerations indicate otherwise.

Where there are no policies relevant to the application or the policies which are most important to determining the application are out of date at the time of making the decision then permission will be granted unless material considerations indicate otherwise – taking into account whether:

- The Application of policies in the NPPF that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or*
- Any adverse impacts of doing so would significant and demonstrably outweigh the benefits, when assessed against the policies in the NPPF taken as a whole.*

CC2: Sustainable Design and Construction

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To meet these requirements:

- All major non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Excellent' standards, where possible;*
- All minor non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Very Good' standards as a minimum;*
- All non-residential development or conversions to residential should incorporate water conservation measures so that predicted per capita consumption does not exceed the*

appropriate levels set out in the applicable BREEAM standard. Both residential and non-residential development should include recycling greywater and rainwater harvesting where systems are energy and cost effective.

CC3: Adaptation to Climate Change

All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development:

- Wherever possible, new buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;*
- Proposals including both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc;*
- Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changes in climatic conditions; and*
- All development shall minimise the impact of surface water runoff from the development in the design and drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change.*

CC4: Decentralised Energy

In meeting the sustainability requirements of this plan, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source.

Any development of more than 20 dwellings and / or non-residential development of over 1000 sq m shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Where there is existing decentralised energy provision present within the vicinity of an application site, further developments of 10 dwellings or more or non-residential development of over 1000 sq m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

CC5: Waste Minimisation and Storage

Development should demonstrate measures to minimise the generation of waste in the construction, use and life of buildings and promote more sustainable approaches to waste management, including the reuse and recycling of construction waste and the promotion of layouts and designs that provide adequate, well-designed space to facilitate waste storage, reuse, recycling and composting.

2.2.4 In addition to these cross-cutting policies, one housing policy pertinent to sustainable development is policy H5. This policy is included on the next page.

H5: Standards for New Housing

New build housing should be built to the following standards, unless it can be clearly demonstrated that this would render the development unviable.

- a. All new build housing outside the Central Area as defined on the Proposals Map will comply with the nationally-described space standard.*
- b. All new build housing will be built to the higher water efficient standard under Regulation 36(3) of the Building Regulations.*
- c. All major new-build residential development should be designed to achieve zero carbon homes.*
- d. All other new build housing will achieve at a minimum a 19% improvements in the dwelling emission rate of the target emission rate, as defined in the 2013 Building Regulations.*
- e. All new build housing will be accessible and adaptable in line with M4(2) of the Building Regulations, unless it is built in line with M4(3) (see below).*
- f. On developments of 20 or more new build dwellings, at least 5% of dwellings will be wheelchair user dwellings in line with M4(3) of the Building Regulations. Any market homes provided to meet this requirement will be 'wheelchair adaptable' as defined in part M, whilst homes where the Council is responsible for allocating or nominating an individual may be 'wheelchair accessible'.*

2.2.5 Additionally, the Sustainable Design and Construction Supplementary Planning Document was adopted by Reading Borough Council in December 2019. This supplementary planning document (SPD) further explains planning requirements with regards to energy efficiency, climate change adaptation, water management, waste reduction and decentralised energy & district heating.

2.2.6 For major new build residential developments (i.e. schemes comprising of 10 dwellings or more) the required energy performance standard is defined as below:

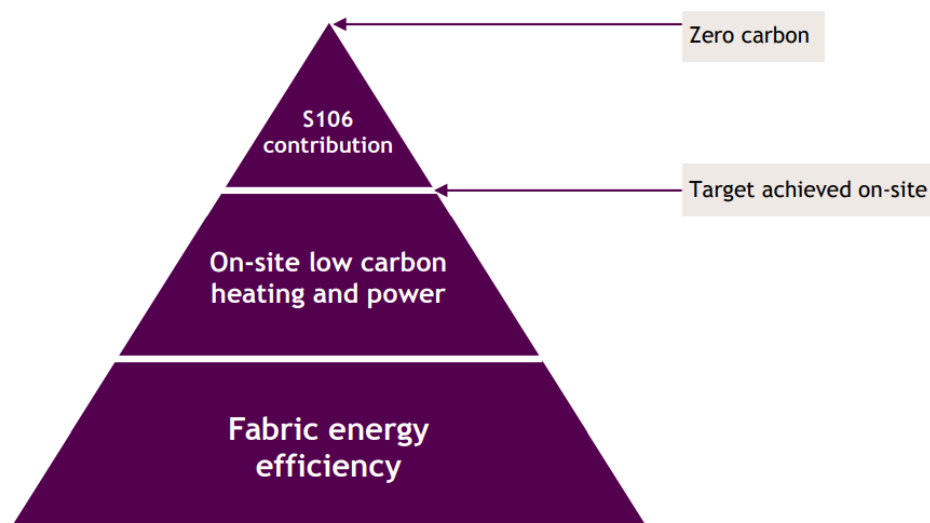
2.2.7 'Zero Carbon (or if unachievable, a minimum 35% improvement in the dwelling emission rate over the target emission rate, as defined in the 2013 Building Regulations and planning contribution to offset remaining carbon emissions to zero).'

2.2.8 The SPD sets out that in achieving zero carbon homes the preference is for the dwellings to achieve true carbon neutral development on-site. If this is found not to be achievable, it must be demonstrated that a minimum of 35% improvement in emissions over the Target Emissions Rate is achieved on site, with the remaining emissions offset via a Section 106 contribution of £1,800 per tonne of remaining carbon. The SPD confirms that this price equates to £60/ tonne over a 30-year period.

2.2.9 The S106 contributions will be ring fenced for projects to deliver a carbon saving within Reading – including energy efficiency improvements and renewable energy projects.

2.2.10 The principle of how zero carbon is envisioned to be met by the borough is set out in Figure 2.3, on the next page.

Figure 2.3: Energy Hierarchy (Original Source: Reading Borough Council Sustainable Design and Construction SPD)



2.2.11 Notably, the SPD provides the following guidance on the carbon emission factors that are to be used when completing the projected carbon dioxide emission calculations:

'Where a SAP assessment is required to demonstrate compliance with policy H5 for new build residential, applicants are expected to use SAP 2012 emission factors, as well as updated (SAP 10) carbon emission factors, to assess the expected carbon performance of a new development. Applicants should undertake this approach until such a time as central government adopts the new Building Regulations, at which point only SAP 10 emission factors shall be used. Applicants should continue to use the current Building Regulations methodology for estimating energy performance against Part L 2013 requirements as set out in Policy H5 but with the outputs manually converted for the SAP 10 emission factors. This is for demonstrating performance against planning policy targets and is separate to Building Regulations compliance.'

2.3 Objectives

2.3.1 The objectives of this report are:

- To demonstrate to the Planning Authority, the Reading Borough, that the Proposed Development will comply with the relevant policies in the Reading Borough Local Plan;
- To provide an initial assessment of the measures required to comply with the Building Regulations Approved Document L; and
- To contribute to the development of a sustainable design strategy for the Site which will be carried through to detailed design, construction, operation and ultimate demolition.

3.0 Energy Efficient Design

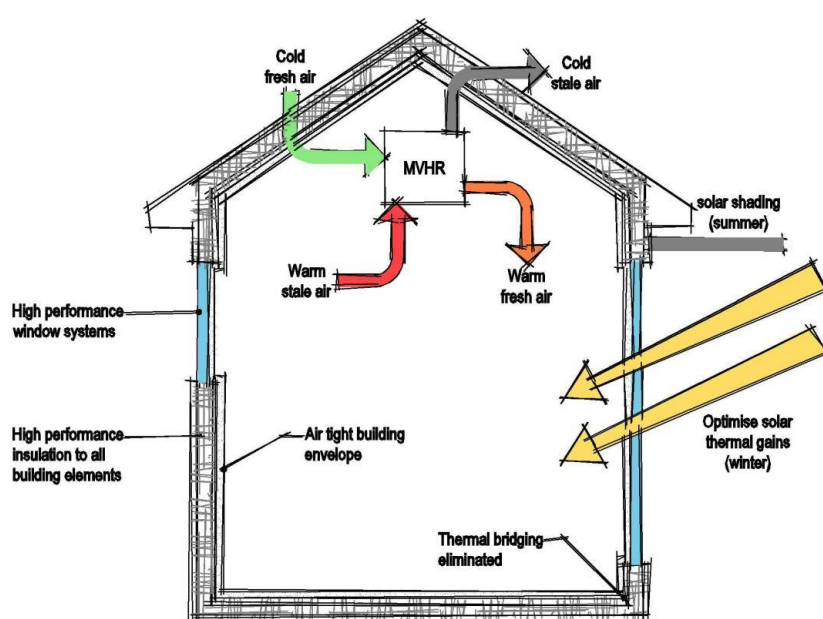
3.1 Introduction

- 3.1.1 This section of the report looks at areas where the energy demand of the development can be reduced in order to create an energy efficient design solution.
- 3.1.2 The implications of the Building Regulations and the local policy are explored, with reference to the technical, functional and economic feasibility of various energy efficiency measures.
- 3.1.3 Some of the factors that can affect the energy requirements of a building include:
- Location;
 - Orientation;
 - Construction methods;
 - Thermal properties of the building envelope; and
 - Building services equipment and controls.

3.2 Application of Passive Design Principles

- 3.2.1 Passive design uses local climatic conditions to reduce the amount of applied energy required to heat, cool or light a building. For example, passive solar gain via south facing windows can reduce the heating requirements of a space, although this must be balanced against the risk of excessive solar gains in summer. Passive design centres around the building envelope and its relationship with its surroundings. The integration of passive design measures can be critical in enhancing a building's resilience to the impacts of climate change.

Figure 3.1: Key Passive Design Measures Illustration



3.2.2 An overview of the key issues considered in the development of the passive design study for the scheme are addressed in Table 3.1, below.

Table 3.1: Key Passive Design Considerations

Passive Design Measure	Considerations
 Site Location, Weather and Microclimate	The Site is located in Reading, UK. The UK has a temperate oceanic climate – with a relatively narrow annual temperature range and precipitation fairly evenly dispersed throughout the year. As Reading is a large town (albeit the Site is located in an outer suburb) the Site may be subject to a mild Urban Heat Island (UHI) effect i.e. temperatures are likely to typically be higher than surrounding rural areas.
 Building Orientation, Layout and Form	The primary axis of the health centre runs from west to east. The large south facing facade will afford the opportunity for significant passive solar gains. Additionally, a pitched south facing roof will be well suited to a potential solar PV array. Flats are proposed above the health centre, which will reduce the building fabric heat losses for these spaces. The orientation of the dwellings varies across the Site – but it is proposed that, where feasible, living areas will be provided with southerly facing windows. Infrequently occupied spaces such as bathrooms, WCs and stores will be located on north facing facades where feasible. The proposed terraced houses and flats will have reduced building fabric heat losses due to shared party walls/ ceilings.
 Building Fabric	Enhanced building fabric performance parameters are proposed to exceed the minimum standards set out in Part L1A and Part L2A of the Building Regulations. The proposed properties are detailed in Table 3.2 and 3.3. The low U values and infiltration rate will aid in reducing winter heat losses. Further to this, the inclusion of solar control glazing will aid in mitigating excessive solar gains and overheating risk in the summer period.
 Thermal Mass	One form of managing heat within a building can be the incorporation of high thermal mass. Materials with a high thermal mass have the ability to absorb and store thermal energy during the day – facilitating a resistance to sharp temperature changes and associated space conditioning equipment loads. The construction type of the proposed dwellings and health centre have not yet been established, but at this stage it is recommended that concrete floor slabs are considered – as these alone can afford a degree of thermal mass to the proposals.
 Building Occupancy Type	The occupancy of the dwellings will vary – with working occupants envisaged to predominantly be present on weekdays during the morning, evening and overnight. Demand for heating and artificial lighting will be pertinent during these periods. It is envisioned that the health centre will primarily be occupied during working hours – this will include the hours of peak solar gain, so overheating risk will need to be given key consideration.

Passive Design Measure	Considerations
 Daylighting Strategy	It is proposed that all primary occupied spaces will be located on the perimeter of the proposed buildings with windows to allow natural daylighting into these spaces. Where feasible within the health centre (i.e. in admin offices), it is proposed to integrate photocell controls to reduce the amount of electric lighting required as a result of this natural daylighting provision.
 Ventilation Strategy	Where supply and extract mechanical ventilation systems are being provided, mechanical ventilation with heat recovery (MVHR) is proposed to mitigate the heat losses in the winter condition. It is proposed for window openings to be provided in the dwellings and the health centre - with dual aspect provision where feasible - to facilitate natural ventilation in the summer condition to aid in mitigating overheating risk.
 Adaptation to Climate Change	Climate change is the long-term shift in the earth's weather pattern and average temperatures. It is envisaged that temperatures are likely to increase over the coming years due to this phenomenon. One way of aiding in reducing future risk of overheating would be to not specify excessive glazing as part of the architectural proposals and the specification of solar control glazing (to be addressed further in Section 3.3).

3.3 Building Envelope Thermal Performance

- 3.3.1 In the first instance, the performance of the proposed building fabric is to be optimised. At this early stage, it is anticipated that these will be based on the building envelope properties outlined in Table 3.2 for the dwellings and Table 3.3 for the health centre.

Table 3.2: Proposed Residential Building Fabric Properties

Element	Limiting Fabric Parameters Set out by Part L1A 2013 W/m ² K	Proposed Properties	% Improvement
Walls	0.30 W/m ² K	0.18 W/m ² K	40%
Party Walls	0.20 W/m ² K	0.00 W/m ² K	100%
Ground Floor	0.25 W/m ² K	0.13 W/m ² K	48%
Roof	0.20 W/m ² K	0.13 W/m ² K	35%
Windows	2.0 W/m ² K	1.4 W/m ² K	30%
Doors	2.0 W/m ² K	1.0 W/m ² K	50%
Air Permeability	10 m ³ /h/m ²	3.0 m ³ /h/m ²	70%
Thermal Bridging	(SAP Default is $\psi=0.15$)	Accredited details assumed	46.6%

- 3.3.2 One of the major design considerations at this stage for the dwellings was to ensure that Part L compliance was possible. Part L1A sets out elemental minimum performance standards for each residential building fabric element, in addition to requiring the overall

energy performance of a dwelling to meet the performance of a comparable notional building when assessed as a whole.

- 3.3.3 It is a statutory requirement for the Dwelling Emission Rate (DER) and the Dwelling Fabric Energy Efficiency (DFEE) to be equal to or less than the Target Emission Rate (TER) and the Target Fabric Energy Efficiency (TFEE) respectively. However, the proposals for the building envelope need to be technically feasible as well as economic.
- 3.3.4 It can be seen that the proposed building fabric properties are more stringent than those required in Part L1A, generally meeting or exceeding current “good practice” standards.
- 3.3.5 Further to the above properties, it is proposed for the residential glazing to have a G value of 0.55, to facilitate a degree of solar control.

Table 3.3: Proposed Health Centre Building Fabric Properties

Element	Limiting Fabric Parameters Set out by Part L1A 2013 W/m ² K	Proposed Properties	% Improvement
Walls	0.35 W/m ² K	0.18 W/m ² K	48%
Ground Floor	0.25 W/m ² K	0.13 W/m ² K	48%
Roof	0.25 W/m ² K	0.13 W/m ² K	48%
Windows	2.2 W/m ² K	1.4 W/m ² K	36%
Doors	2.2 W/m ² K	2 W/m ² K	9%
Air Permeability	10 m ³ /h/m ²	3.0 m ³ /h/m ²	70%

- 3.3.6 It is proposed for the building fabric parameters for the health centre to be in line with the dwellings, given the health centre is proposed to be below a block of flats.
- 3.3.7 Further to the above properties, it is proposed for the glazing in the health centre to be solar control glazing, with a G value of 0.4.

3.4 Reduction of Mechanical Cooling and Ventilation Loads

- 3.4.1 Appropriate analysis will be undertaken at design stage to ensure that the dwellings and health centre are adequately provided for by natural ventilation in summer, so that the introduction of comfort cooling at a future date and associated cooling system electricity usage is avoided.

3.5 Mechanical Ventilation Systems

- 3.5.1 For an airtight dwelling with an air permeability equal to or less than 3.0m³/m².hr it would be more appropriate for a whole house mechanical ventilation system with heat recovery (MVHR) to be installed.
- 3.5.2 SAP Appendix Q listed mechanical ventilation systems have been tested and certified as being more energy efficient and the best performing units will be considered in the calculations, i.e. those with the lowest specific fan power (electrical energy consumption).
- 3.5.3 Ventilation systems in the dwellings will operate on a trickle and boost arrangement, with the air flow rate increasing in response to a signal from a local switch (for kitchen ventilation) and humidistats/ light switches (for bathroom or WCs).

- 3.5.4 At this stage, it is also envisioned that mechanical ventilation systems are proposed for the occupied spaces within the health centre. It is proposed that these systems are equipped with heat recovery systems with an efficiency $\geq 73\%$, and a specific fan power (SFP) $\leq 1.2 \text{ W/l/s}$.

3.6

Reduction of Domestic Hot Water Loads

3.6.1

The dwellings will be designed to meet a maximum domestic water consumption of 110 l/p/d. This is significantly lower than the UK average of 150 l/p/d. Therefore, the hot water (DHWS) for dwellings will be reduced and a saving in DHWS energy requirements will likely be achieved.

3.6.2

Heat losses will be minimised via factory applied thermal insulation to cylinders or thermal stores. All DHWS pipework will also be fully insulated to reduce heat losses associated with this distribution pipework.

3.7

Energy Consumption Monitoring

3.7.1

It is anticipated that each dwelling will be provided with smart meters and a display device by the energy supplier. The device will provide both a simple means for real time observation of energy consumed and cost consumption together with the facility to view/print out historic records for energy consumption for the associated dwelling.

3.7.2

It is proposed that the health centre will have energy metering systems installed to enable at least 90% of the estimated annual energy consumption to be assigned to the various end use categories of energy consuming systems. The energy consuming end uses are to be identifiable to the building users via labelling or data outputs.

3.8

Artificial Lighting

Internal Lighting Strategy

3.8.1

Preliminary analysis assumes that all main internal lighting systems will incorporate energy efficient lamps, including:

- High frequency control gear; and
- 100% energy efficient lighting throughout, generally fitted with LED lamps.

3.8.2

It is assumed that presence detection lighting control systems will be provided in the communal circulation areas in the proposed apartment blocks.

3.8.3

In the health centre, presence detection lighting control systems are proposed for the WC facilities and stores, and absence detection lighting control systems are proposed for admin offices and tea rooms.

External Lighting Strategy

3.8.4

The external lighting for the dwellings will be designed in accordance with the requirements of Part L1a of the Building Regulations. The following criteria will be met:

3.8.5

Either a)

- Lamp capacity not greater than 100 lamp-watts per light fitting; and

- All lamps automatically controlled so as to switch off after the area lit by the fitting becomes unoccupied; and
- All lamps automatically controlled so as to switch off when daylight is sufficient.

3.8.6 Or b)

- Lamp efficacy greater than 45 lumens per circuit-watt; and
- All lamps automatically controlled so as to switch off when daylight is sufficient; and
- Light fittings controllable manually by occupants.

3.9 Home User Guides

- 3.9.1 It is anticipated that a Home User Guide will be supplied by the Developer to each dwelling. The guide will include recommendations on energy efficient operation of the dwelling, including buying A-rated appliances (if not fitted) and instructions on operation of systems.

3.10 Building Log Book

- 3.10.1 A Building Log Book for the health centre will be provided to the Client as required by the Building Regulations. This document will contain information on the operation and predicted energy use of the various services and building types and will assist the Client in operating the building as energy efficiently as possible.

4.0 Building Services Engineering Strategy

4.1 Introduction

- 4.1.1 In developing the energy strategy for the Site, passive design elements have been addressed in the first instance to minimise energy loads – including principle measures of a thermally efficient building envelope and low levels of air leakage.
- 4.1.2 The consideration of a general building services strategy hinges largely on the proposed heating strategy of an individual heating plant proposal or a centralised heating plant proposal. These options will be addressed in this section of the report and the respective suitability of these options to the Site will be assessed.
- 4.1.3 The nominated heating strategy will then aid in informing the selection of appropriate forms of LZC technologies in Section 5.

4.2 Energy Sources

- 4.2.1 Ridge & Partners LLP are in the process of applying for mapping records from the major statutory services providers indicating the routes of services on – and local to – the Site.
- 4.2.2 Major routes of existing gas, water, electricity, telecoms and sewerage will be identified. It is a possibility that some offsite infrastructure upgrades will be required to facilitate the development although the full extent remains to be confirmed.

4.3 Decentralised Energy Networks

- 4.3.1 In the first instance, the feasibility of connecting the scheme into an existing district heating network is being explored.
- 4.3.2 The Associated for Decentralised Energy (ADE) have produced a map showing university, hospital and residential/ commercial district heating installations in the UK. An extract from this map - showing Reading and the surrounding area - is included below in Figure 4.1.

Figure 4.1: Extract from the ADE Heat Map (www.theade.co.uk)



- 4.3.3 The map shows that there are no existing networks in the vicinity of the Site in Reading. The closest network is shown to be to the south east of the Site in Farnborough – The Frimley Park Hospital Network. This network is a significant distance away from the Site, and therefore not considered to be a feasible connection opportunity.

4.4 Dwelling Servicing Option 1: Individual Heating Plant

General

- 4.4.1 Providing heating plant to the houses and the health centre on an individual basis would appear to be appropriate for this scheme due to the number of units proposed and the density of the proposals.

Gas Boilers

- 4.4.2 Individual gas fired boilers could be installed within each of the proposed dwellings. Combination boilers would be appropriate for the apartments /smaller houses and system boilers with domestic hot water cylinders would be appropriate for the larger houses which have more than one bathroom.
- 4.4.3 SEDBUK 'A' rated condensing boilers would be required, with an annual efficiency in excess of 89%. Optimum start and/or weather compensated controls would also be incorporated.
- 4.4.4 Notably, however, the National Grid electricity supply has rapidly decarbonised since the last update to Part L of the Building Regulations. In recognition of this, Reading Borough planning policy requires compliance with the CO₂ emission reduction targets to be demonstrated on the basis of the emerging SAP 10 carbon emission factors. This drastically reduces the feasibility of this form of heating installation.

Direct Electric Heating

- 4.4.5 It may be possible to achieve Part L1A compliance with direct electric heating, but the fabric and ventilation systems must be enhanced to reduce loads.
- 4.4.6 Heat emitters may be standard convectors or storage heaters.
- 4.4.7 However, to meet planning requirements significant renewable energy sources may be required to meet the minimum 35% reduction in CO₂ emissions on site.
- 4.4.8 Therefore, this type of solution should be avoided if a sustainable solution is sought.

Heat Pump Systems

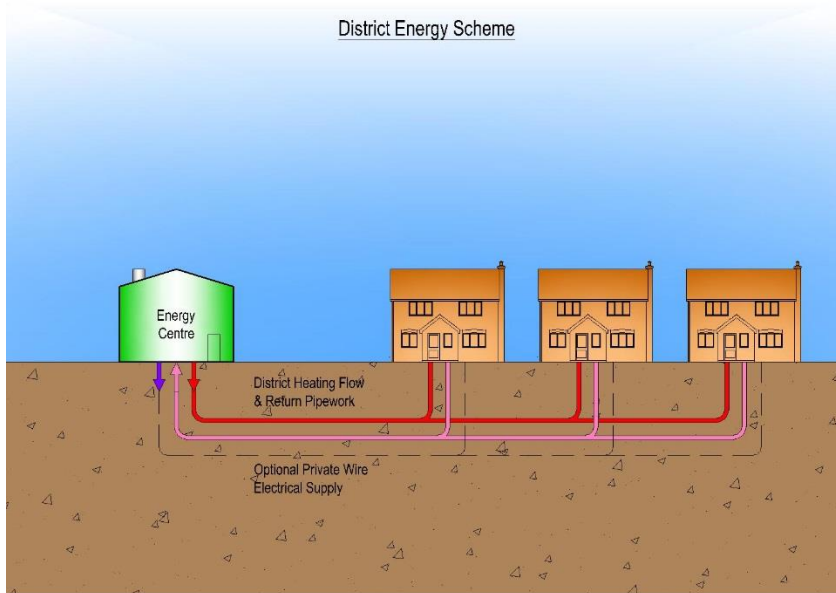
- 4.4.9 Ground or air source heat pumps may be feasible substitutes for individual gas fired condensing boilers. The operation of these technologies is described in Section 5.
- 4.4.10 These systems utilise grid supplied electricity, and will therefore aid in demonstrating compliance with Reading Borough's on site carbon emission targets when assessed utilising the emerging SAP 10 emission factors.

4.5 Dwelling Servicing Option 2: Centralised Heating Plant

General

- 4.5.1 A community or district energy scheme may be appropriate for large scale residential developments, particularly if high density apartments blocks are proposed as part of a scheme.

Figure 4.2: Indicative District Energy Scheme Configuration

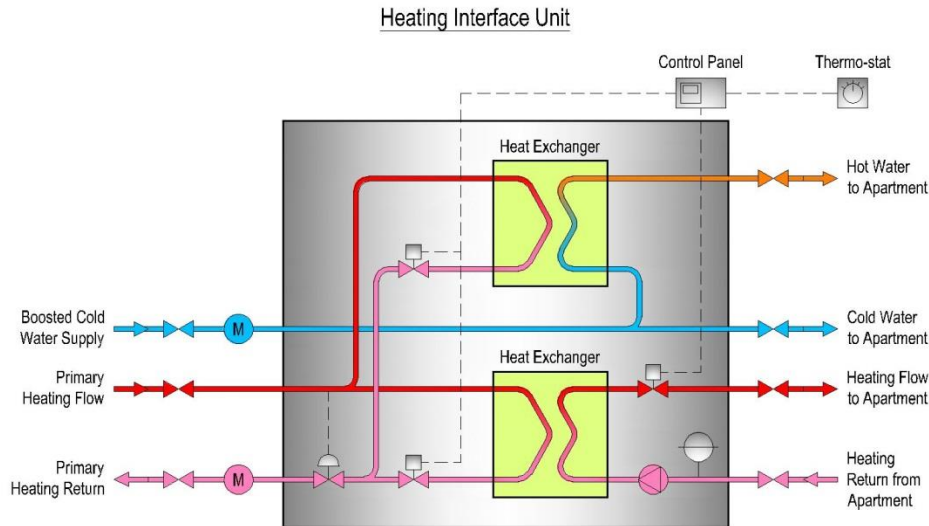


- 4.5.2 The centralised heat generation plant for a base scheme would be accommodated in an energy centre which would need to be easily accessible. Distribution pipework above and below ground would be selected to exceed minimum standards required by Building Regulations and design temperatures optimised to minimise distribution losses.
- 4.5.3 A Building Energy Management System (BEMS) would control the centralised plant, commissioned to maximize efficiency to best utilise the energy sources available and to closely match the building load. The BEMS would also collect the data from the various sub-meters installed throughout the buildings, allowing billing (see sections below), and targeting and monitoring.
- 4.5.4 The BEMS would also alert the appointed management company of any system faults and generate reminders that maintenance is due.

Heating of Dwellings

- 4.5.5 Individual properties would be served by the following:
1. Heating Interface Unit (HIU).
 2. An HIU will replace a conventional boiler, comprising a heat exchanger and valve arrangement, plus a heat meter. Heat will be drawn from the central distribution system to satisfy the requirements of the dwelling.
 3. Distribution Pipework.
 4. Hot water for heating and domestic water purposes will be pumped to the heat emitters and hot water draw-offs.
 5. Heat Emitters – radiators and/or underfloor heating.
 6. Automatic and Thermostatic Controls - including a 24-hour / 7-day programmer for the heating.

Figure 4.3: HIU Configuration



- 4.5.6 Thermostatic Radiator Valves (TRVs) would be included on each heat emitter to provide local room control and to avoid overheating when casual and solar gains are significant.

Billing of Dwellings

- 4.5.7 The data from the sub-metered water and energy supplies would be automatically collected via a data retrieval device in each dwelling and processed remotely using a dedicated piece of software except where there will be direct billing from statutory authorities. This software would automatically generate bills.
- 4.5.8 In a similar manner to ordinary utilities accounts, all relevant information would be contained on the bill and would include latest and previous readings, the number of pulses (method of measurement), conversion to volume or units of energy, plant efficiency factors and unit costs.

Additional Considerations

- 4.5.9 Location of an energy centre and distribution routes for a district heating system are a particular concern, as typically local highways departments resist the routing of non-statutory services in the adopted road, pavement or any service margin. To route pipework through gardens there would need to be 24-hour access rights and legal agreements put in place to define access arrangements and the responsibility of reinstatement works.
- 4.5.10 Developments of this size would not be of interest for adoption by a statutory supplier or Energy Service Company (ESCo). The relatively low density of the Site proposals also makes district or community heating marginal in terms of economic viability. Standing charges – incorporating management charges, cost of maintenance and funding of plant replacement – can be considerable, especially on smaller schemes.

4.6 Health Centre Services Strategy

- 4.6.1 It is proposed for the health centre to also have a standalone individual heating installation. A baseline assumption would be that this heating installation would be served

by a gas fired boiler installation. As outlined for the dwellings, however, the decarbonisation of the grid is resulting in a significant drop in the carbon intensity of grid supplied electricity. Although this decarbonisation is not currently reflected in Part L of the Building Regulations – this should be considered when planning the energy strategy proposals for new buildings. The appropriateness of renewable heat pump technologies – such as ground source and air source heat pumps – are likely to be more feasible with the dropping carbon emission factor. The operation of these technologies is described in Section 5.0.

4.7 Services Strategy: Summary

- 4.7.1 Electricity supplies to each unit within the development will be individually metered by the statutory service provider.
- 4.7.2 As outlined earlier in this section there are two major servicing options for heating provision; individual unit heating systems or district / community wide.
- 4.7.3 However, in part due to the number of proposed units and the relative low density of the Site proposals, the adopted approach is for heating and renewables systems to be applied on an individual unit basis.

5.0 Assessment of Low & Zero Carbon Technologies

5.1 Introduction

5.1.1 There are a number of renewable and low carbon energy technologies which may be suitable for the Proposed Development proposals. The Low or Zero Carbon (LZC) technologies listed below have been assessed for their applicability to this development:

- Ground source heat pumps (GSHP);
- Air source heat pumps (ASHP);
- Photovoltaic arrays (PV);
- Solar Thermal for hot water; and
- Wind Energy.

5.1.2 Technologies such as biomass and CHP have not been considered further in this section, as it has been determined that a district heating strategy (which would form the most appropriate application of these technologies) would not be a suitable strategy for this site.

5.2 Ground Source Heat Pump

5.2.1 Ground source heat pumps (GSHPs) extract heat from the ground and upgrade it to a more useful temperature. The heat pump consists of a closed loop ground heat exchanger, a heat pump and a distribution system. The ground heat exchanger is a sealed loop of pipe buried either vertically or horizontally in the ground.

5.2.2 Horizontal arrays tend not to be feasible on restricted sites, as the length of the loops can include multiples of pipework up to 50m in length.

5.2.3 Vertical arrays require a series of boreholes which accommodate the pipework and are infilled with a heat conducting grout. Environment Agency licences are not required – because it is a sealed, closed loop system – but a ground investigation would be required as part of a detailed feasibility study.

5.2.4 Heat pumps use electrical energy - usually grid supplied - to upgrade the energy collected by the ground loop; typically 1 unit of electricity will be produce 3 to 4 units of useful heat. However, the output temperature is normally limited to between 40 and 45°C, or the unit efficiency will drop considerably. Performance monitoring of GSHP has indicated that the claimed efficiency of GSHP installations are not being achieved in practice, resulting in higher energy consumption and running costs.

5.2.5 A GSHP installation could be eligible for the Domestic Renewable Heat Incentive (RHI). This scheme is a government financial incentive to encourage the uptake of renewable forms of heat. Members of the scheme who abide by the relevant rules receive quarterly payments for 7 years for the amount of renewable heat it is estimated that their systems will produce. A similar scheme is available for commercial buildings – the Non-Domestic RHI – albeit with different tariffs, and installations being eligible for 20 years.

5.2.6 GSHP is best suited to applications where the building heat load is small, and the heat delivery system is either underfloor heating or air heating with coils sized to suit.

5.2.7 It is generally accepted that to be viable the minimum heat contribution from GSHP needs to be greater than 50% of the annual load. Under Part L, the principal heating fuel is

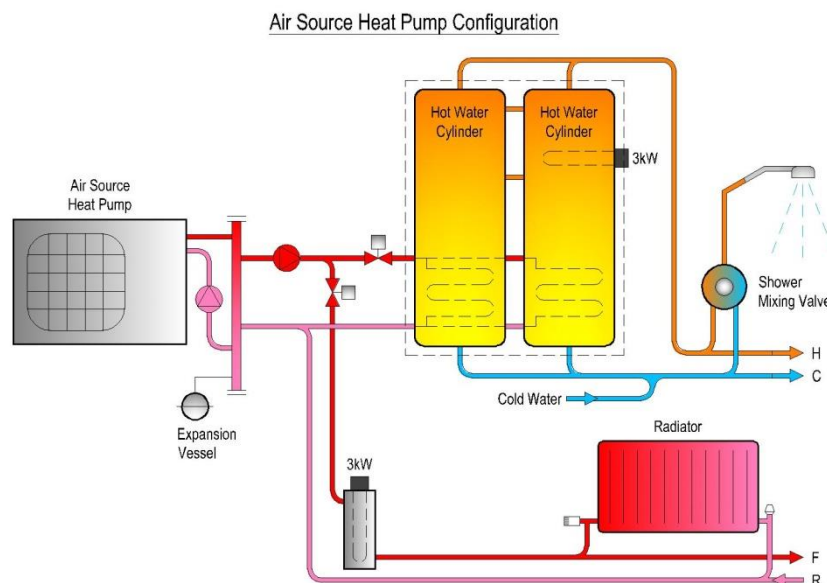
taken to calculate the target emission, and this is advantageous with GSHP, as the TER for electricity based systems will be higher and easier to achieve.

- 5.2.8 Factors to be considered on this project would be coordination with other buried services (drainage, tanks etc), the geology in the area (borehole drilling), the impact on thermal insulation and the heating distribution systems - GSHP mainly suits lightly loaded buildings with underfloor heating.
- 5.2.9 Domestic Hot Water (DHW) generation is a major issue with GSHP. As outlined above, the heat pump output temperature must be limited to maximise the co-efficient of performance (CoP); this is incompatible with domestic hot water storage and distribution systems, which need to achieve 60°C to minimise the risk from Legionella. With individual dwellings, the DHW issue is overcome by a stepped immersion heater.
- 5.2.10 Overall, we believe that GSHP is not the most appropriate solution for this type of development, due to the number of boreholes that would be required to meet the thermal loads of the Site proposals.

5.3 Air Source Heat Pumps

- 5.3.1 Heat pump boilers or air source heat pumps (ASHP) have, in general, been developed using existing air conditioning technology. However, instead of cooling, the refrigerant cycle is reversed so that heating is supplied to the dwelling.
- 5.3.2 The equipment is supplied as a package, with two major components:
- External unit; and
 - Thermal store.

Figure 5.1: Typical ASHP System Configuration



- 5.3.3 The external unit is a fully integrated package including the complete refrigerant circuit. A typical split cooling system would have an in room evaporator unit. The advantage of the

integrated approach is that the unit is supplied and pre-charged with refrigerant and skilled labour is not required; only a water pipework circuit needs to be connected.

- 5.3.4 The seasonal coefficient of performance (SCoP) of an ASHP may achieve around 3.2 if serving a domestic hot water cylinder, noting that the storage temperature needs to be raised either by elevating the heat pump output or via an immersion heater.
- 5.3.5 As is the case with GSHP installations, ASHP installations may be eligible for government RHI payments.
- 5.3.6 Many heat pump boiler / ASHP installations feature de-frost functions on the coils and electric immersion heaters on the space heating circuits to overcome low ambient conditions. However, with appropriate control systems these direct electric functions should seldom be called upon.
- 5.3.7 Practical considerations for ASHPs include the location of the outdoor unit. On the Site, the outdoor units for the houses could be located at ground floor level to the rear of the properties. As the development for the apartment blocks develop, flat roof areas would be appropriate for the location of ASHPs serving the apartments. Alternatively, a well-ventilated roof void (with louvre provision) may provide an appropriate location for these units.
- 5.3.8 Noise generation may also be an issue with this form of equipment; however, 'quiet' ranges of units are now available on the market and alternatively acoustic screening could be provided.
- 5.3.9 It is therefore considered that ASHP technology would be an appropriate form of renewable technology to serve both the dwellings and the health centre.

5.4 Photovoltaic Arrays

- 5.4.1 Photovoltaics are semiconductor devices that convert sunlight into direct current (DC) electricity. Groups of panels can be electrically configured into arrays which can be used to power a building's electrical load. A photovoltaic (PV) installation generally consists of panels, inverters, controls and wiring for integration into a building's main electrical distribution system.
- 5.4.2 A number of photovoltaic systems including monocrystalline, polycrystalline and thin film are available, generally made up into arrays using multiple panels or roof slate "substitutes", photovoltaic panels can also replace vertical cladding systems. The PV system considered for this study is based on comparatively efficient monocrystalline panels currently available. They could be installed as roof mounted arrays on the proposed dwellings.
- 5.4.3 One of the obvious benefits of a PV installation is that it is purely an electrical system, without the need for pipework distribution systems and storage vessels. The array can be sized to suit sustainability and renewables targets and could conceivably be increased in size at a later date. Additionally, PV systems are very low maintenance and are supplied with guarantees of between 20-25 years, although they should normally produce a high proportion of their original rating for some time afterwards.
- 5.4.4 Notably, the UK government scrapped the Feed-in Tariff scheme in April 2019. The scrapping applied to both export and generation tariffs. Prior to the scrapping of this scheme, solar photovoltaic arrays were eligible to receive payments per unit of electricity generated and excess electricity could also be exported back to the grid and in return for an additional export tariff payment. In January 2020 the UK government brought in the

Smart Export Guarantee (SEG). The SEG dictates that there will be a legal requirement for qualifying suppliers with more than 150,000 customers to offer payment for the surplus power that new solar arrays export back into the grid. Although the rate received for this exported electricity will not be fixed as it was in the previous government scheme, this will still offer a means of some financial return for exported electricity.

- 5.4.5 Overshadowing may significantly reduce the output of a solar photovoltaic system. In this instance, overshadowing is not deemed to pose a significant issue given the locality of the development and the low-rise nature of the proposed buildings.
- 5.4.6 **It is proposed for a 5kWp PV array to be installed on the south facing pitched roof of the health centre to aid in contributing the daytime electrical loads of this building.**

5.5 Solar Thermal

- 5.5.1 The application of solar thermal to individual dwellings/ the health centre would be relatively straightforward. The hot water cylinder in a standard heating system configuration could be replaced by a twin coil cylinder connected to a roof array – via a pumped circuit – and supplemented by the main heat generation plant.
- 5.5.2 Flat panel collectors can be integrated into the roof and are complementary to photovoltaic systems. The more efficient evacuated tube system has more versatility and orientation is less of an issue, although these arrays are more expensive than flat panel.
- 5.5.3 In the case of dwellings, the available roof area, pitch and orientation are critical. Also, the proper integration of large sections of solar thermal panels into the roof can be difficult.
- 5.5.4 Increasing the area of solar thermal panels so that they contribute to the space heating loads incurs considerable cost with little energy benefit as the panels operate far below maximum efficiency during winter when they would be most required.
- 5.5.5 Additionally, there are significant issues in summer if an installation is over capacity; this may result in system stagnation – where there is insufficient demand for the energy produced – with separation of the glycol anti-freeze from the circulation medium, with major maintenance implications. A series of small arrays serving each dwelling would be most appropriate application of this form of technology.
- 5.5.6 It should be noted that solar thermal's contribution to Building Regulations compliance and reduction of CO₂ emissions is typically quite small, especially when accounting for all energy requirements in modern, well insulated buildings, which comprise less of thermal loads and more of appliance and other electrical demands. Notably, the thermal loads are also already proposed to be met by a renewable technology - an ASHP - and therefore this form of technology is not going to be considered further at this stage for application to the Site.

5.6 Wind

- 5.6.1 Wind turbines have the capability of harnessing the power of the wind in order to produce electricity through the circular motion of the turbine's blades. The electricity produced has zero associated carbon dioxide emissions.
- 5.6.2 Should the generation of electricity from the turbines exceed the requirement of the building at any point, it can be exported to the grid. The UK government scrapped the Feed-in Tariff scheme in April 2019 - the scrappage applied to both export and generation

tariffs. As outlined in Section 5.4, however, the Site may be eligible for SEG payments from the electricity supplier.

- 5.6.3 Wind turbines are normally mounted on columns remote from the main structures on site. However, they could also be building mounted and spaced at intervals to avoid interference with each other. However, the method of support and mounting height would need to be carefully considered to avoid vibration transmission and to maximise output, respectively. Small turbines usually need to be mounted at least twice as high as any local obstructions to work effectively.
- 5.6.4 Wind turbines may be considered to be an eye sore. This could potentially cause a planning issue as the inclusion of wind turbines in the development may be viewed to be changing the landscape character. There would also be the risk that the future inhabitants of the Proposed Development, and the owners of the neighbouring properties to the west, south and east of the Site may complain about the visual impact the inclusion of wind turbines on the development would make.
- 5.6.5 Wind turbines, whether roof or pole mounted, can also be noisy. Their inclusion may cause disturbance to the future residents of the Site, in addition to potential vibration issues if the turbines are to be roof mounted.
- 5.6.6 There is also a high capital cost associated with the installation of wind turbines, whether column or roof mounted, so this is unlikely to be the most financially viable solution.
- 5.6.7 The viability of wind turbines is largely determined by the Site location, including average wind speed and the presence of obstructions (which produce undesired turbulence). The NOABL Wind Map has been accessed to obtain data for average wind speed in the area.
- 5.6.8 The following wind speeds were reported:
- At 10 metres: 4.9m/s
 - At 25 metres: 5.6m/s
 - At 45 metres: 6.1m/s
- 5.6.9 A turbine on this site would fall in the 10m bracket; a rule of thumb is that the rotor is located at twice the height of the nearest building.
- 5.6.10 Normally, a wind speed threshold of 5.0m/s is used to determine whether a site may be suitable for wind turbines. At a height of 10 metres on this site, this criterion would not be met.
- 5.6.11 Due to the potential environmental impact of wind turbines on this site, the average wind speed at a height of 10m and the financial viability of this technology, wind turbines have not been considered in any greater detail.

5.7 Summary of LZC Technologies

- 5.7.1 As a result of this appraisal of LZC technologies, the following is proposed for the Site:
- 5.7.2 **Dwellings:** It is proposed that the dwellings are provided with individual ASHP installations.

- 5.7.3 **Health Centre:** It is proposed the health centre is provided with an ASHP installation to meet the thermal loads and a 5kWp PV array to contribute to the daytime electrical loads of the practice.

6.0 Site Wide Energy Assessment

6.1 General

6.1.1 This section details a methodology in setting out the energy and emissions compliance strategy for the Proposed Development.

- A number of sources have been used in producing this statement, including:
- Standard Assessment Method for Dwellings (SAP 2012)
- Simplified Building Energy Model for Non- Dwellings (SBEM)
- Building Regulations Approved Document Part L1A “Conservation of fuel and power in new dwellings” 2016
- Building Regulations Approved Document Part L2A “Conservation of fuel and power in new buildings other than dwellings” 2016
- Building Regulations Approved Document Part L “Domestic Building Services Compliance Guide” 2013
- Building Regulations Approved Document Part L “Non-Domestic Building Services Compliance Guide” 2013

6.2 Part L Compliance

- 6.2.1 To demonstrate Building Regulations (Part L) compliance SAP 2012 and SBEM software has been used to undertake preliminary calculations for a large sample of dwellings and the proposed Health Centre respectively. The sample of dwellings have been selected based on type, size and orientation.
- 6.2.2 For the dwellings - this assessment has been undertaken to assess compliance of the properties with both the overall energy efficiency and the building fabric energy efficiency targets (TER and TFEE) dictated by Part L1A. A sample SAP compliance calculation is included in Appendix A.
- 6.2.3 For the health centre – this assessment has been undertaken to assess compliance of the centre with the overall energy efficiency target (TER) dictated by Part L2A. The preliminary BRUKL output is included in Appendix B.
- 6.2.4 Table 6.1, on the next page, shows the preliminary Part L results for the Site – demonstrating that the proposed strategy will meet the requirements of the current version of Part L1a and Part L2a of the Building Regulations. It is demonstrated that the integration of the proposed passive measures & energy efficiency measures outlined in Section 3, the servicing strategy outlined in Section 4 and the integration of LZC technologies as set out in Section 5 would result in the proposed dwellings meeting the TER and TFEE targets and the proposed medical centre meeting the TER target.
- 6.2.5 More detailed calculations will be submitted to Building Control at detailed design and following construction.

Table 6.1: Site Wide Part L Compliance Energy Assessment

Dwelling Type	Typical Area (m²)	Part L TER (kg CO ₂ /m²)	Part L DER (kg CO ₂ /m²)	Part L TFEE (kWh/m²/yr)	Part L DFEE (kWh/m²/yr)	CO ₂ Emissions per Dwelling			Building Fabric Efficiency			Dwelling Type Multiplier	CO ₂ Emissions per Dwelling Type (kgCO ₂)	
						Part L TER (kg CO ₂)	Part L DER (kg CO ₂)	% below Part L Target	Part L TFEE (kWh)	Part L DFEE (kWh)	% below Part L Target			
2B Hse End/SD N/S	112.0	24.36	18.76	52.99	49.69	2,728.32	2,101.12	22.99%	5,934.88	5,565.28	6.23%	11	23,112.32	
2B Hse End/SD E/W	112.0	24.63	18.99	54.22	50.53	2,758.56	2,126.88	22.90%	6,072.64	5,659.36	6.81%	3	6,380.64	
2B Hse Det N/S	112.0	25.66	20.03	57.37	53.35	2,873.92	2,243.36	21.94%	6,425.44	5,975.20	7.01%	14	31,407.04	
2B Hse Det E/W	112.0	25.92	20.25	58.55	54.16	2,903.04	2,268.00	21.88%	6,557.60	6,065.92	7.50%	14	31,752.00	
3B Hse M Terr N/S	120.0	22.53	17.05	48.26	45.49	2,703.60	2,046.00	24.32%	5,791.20	5,458.80	5.74%	2	4,092.00	
3B Hse End/SD N/S	120.0	24.12	18.61	53.60	50.01	2,894.40	2,233.20	22.84%	6,432.00	6,001.20	6.70%	26	58,063.20	
3B Hse End/SD E/W	120.0	24.37	18.81	54.71	50.77	2,924.40	2,257.20	22.81%	6,565.20	6,092.40	7.20%	23	51,915.60	
3B Hse Det N/S	120.0	25.70	20.15	58.95	54.51	3,084.00	2,418.00	21.60%	7,074.00	6,541.20	7.53%	15	36,270.00	
3B Hse Det E/W	120.0	25.94	20.35	59.99	55.23	3,112.80	2,442.00	21.55%	7,198.80	6,627.60	7.93%	15	36,630.00	
4B Hse End/SD N/S	141.2	22.78	17.69	51.93	48.12	3,216.54	2,497.83	22.34%	7,332.52	6,794.54	7.34%	12	29,973.94	
4B Hse Det N/S	141.2	23.98	18.89	55.98	51.48	3,385.98	2,667.27	21.23%	7,904.38	7,268.98	8.04%	37	98,688.92	
4B Hse Det E/W	141.2	24.18	19.05	56.82	52.06	3,414.22	2,689.86	21.22%	8,022.98	7,350.87	8.38%	32	86,075.52	
1 Bed Flat LF	48.0	29.88	22.18	52.14	48.39	1,434.24	1,064.64	25.77%	2,502.72	2,322.72	7.19%	16	17,034.24	
1 Bed Flat UF	48.0	32.34	24.67	60.40	56.29	1,552.32	1,184.16	23.72%	2,899.20	2,701.92	6.80%	16	18,946.56	
2 Bed Flat LF	66.0	26.15	18.98	46.58	42.18	1,725.90	1,252.68	27.42%	3,074.28	2,783.88	9.45%	12	15,032.16	
2 Bed Flat UF	66.0	28.27	21.01	53.65	48.68	1,865.82	1,386.66	25.68%	3,540.90	3,212.88	9.26%	12	16,639.92	
												Residential Total	260	562,014.05

Building Type	Area (m²)	Part L TER (kg CO ₂ /m²)	Part L BER (kg CO ₂ /m²)	CO ₂ Emissions for Commercial Building			CO ₂ Emissions per Commercial Unit (kgCO ₂)	
				Part L TER (kg CO ₂)	Part L BER (kg CO ₂)	% below Part L Target		
Health Centre	850.0	17.10	15.50	14,535.00	13,175.00	9.36%	13,175.00	
							Sitewide Total (kgCO ₂)	575,189.05

6.3 Energy Compliance of Dwellings with Policy H5

- 6.3.1 Policy H5 of the *Reading Borough Local Plan* dictates that all major new build development should be designed to achieve zero carbon homes. The emissions should be calculated on the basis of emerging SAP 10 emission factors. If unachievable, a minimum 35% improvement in the dwelling emission rate over the target emission rate should be achieved, with the remaining emissions to be offset via S106 payments.
- 6.3.2 As per guidance in the *Reading Sustainable Design and Construction Supplementary Planning Document*, the GLA Carbon Emission Reporting Spreadsheet has been utilised to convert the projected emissions from the SAP 2012 compliance calculations to reflect the emerging SAP 10 emission factors:

Table 6.2: SAP Carbon Factors

	Fuel Carbon Factor (kgCO ₂ /kWh)	
Fuel Type	SAP 2012	SAP 10
Natural Gas	0.216	0.210
Grid Electricity	0.519	0.233

- 6.3.3 Notably, the SAP 10 emission factors have been utilised, rather than the SAP10.1 emission factors, as per the GLA reporting spreadsheet and guidance that has previously been received from GLA energy officers.
- 6.3.4 The key outputs from this spreadsheet are shown in Table 6.3, below. The baseline emissions have been calculated on a baseline scenario of a boiler heating installation.

Table 6.3: CO₂ Emissions After Each Stage of the Energy Hierarchy for Domestic Buildings

	Regulated CO ₂ Emissions for Domestic Buildings (Tonnes CO ₂ per Annum)	% Regulated Domestic CO ₂ Saving (Cumulative)
Baseline: Part L 2013 of the Building Regulations Compliant Development	441	
After Energy Demand Reduction	398	10%
After Heat Network/ CHP	398	10%
After Renewable Energy	252	43%

- 6.3.5 A 43% reduction in regulated CO₂ emissions is demonstrated to be achievable on site via the proposed energy strategy.
- 6.3.6 More extensive outputs from the GLA reporting spreadsheet for the dwellings is included in Appendix C.

-
- 6.3.7 The Sustainable Design and Construction SPD confirms that the remaining emissions should be offset via a Section 106 contribution of £1,800 per tonne of remaining carbon. On the basis of the remaining 252 tonnes of CO₂, this equates to an offset payment of £453,600 to achieve net zero emissions.

7.0 Water Efficiency

7.1 Overview

- 7.1.1 The World Economic Forum's Global Risks 2020 report listed water security as one of the top five global risks in terms of impact, with water supplies in Southern England coming under increasing pressure due to population growth and urbanisation. Therefore, the importance of reducing water consumption is becoming an increasingly critical priority.
- 7.1.2 Policy H5 of the Reading Borough Local Plan sets an aspiration for new build housing to achieve a water efficiency standard of 110l/p/day (with an allowance of 5l/p/day for outdoor use).
- 7.1.3 Methods and technologies that may be utilised include:
- Rainwater harvesting;
 - Grey water re-use;
 - Composting toilets;
 - Waste water treatment via reed beds;
 - Sustainable drainage systems (SuDS); and
 - Water conservation appliances.
- 7.1.4 Composting toilets and reed beds are not considered suitable for most multi-residential developments, given site space constraints and the general availability of mains sewerage, so will not be considered further.

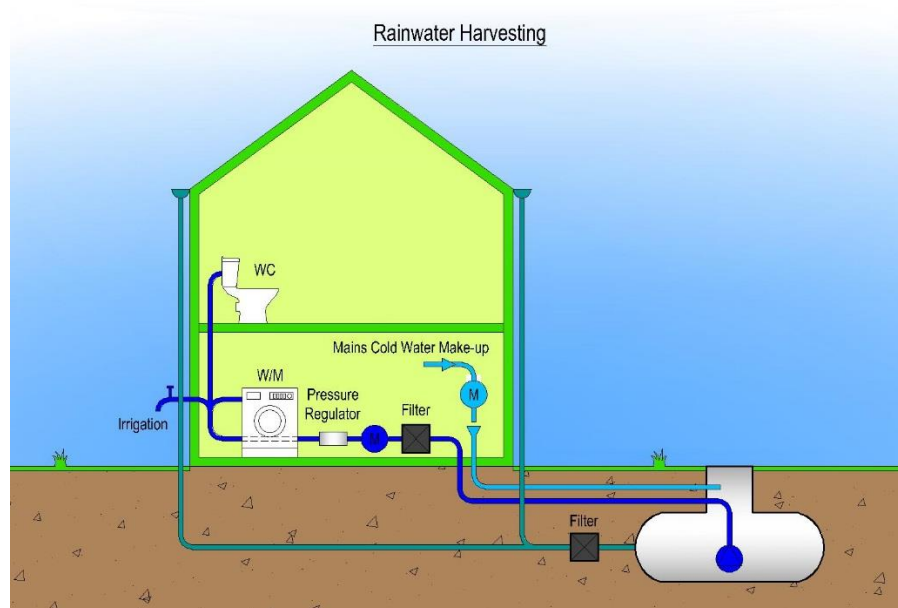
7.2 Rainwater Harvesting

- 7.2.1 Rainwater harvesting is a simple and effective method of reducing the consumption of mains water on a site. It is usually put to use where water of drinking water quality is unnecessary. For instance, rainwater can be utilised to provide supplies for the following:
- Irrigation systems;
 - WC flushing;
 - Laundry facilities, i.e. washing machines; and
 - Vehicle washing.
- 7.2.2 A rainwater harvesting system would normally consist of the following:
- Pre-filters located in the downpipes or integrated into the below ground pipework;
 - Underground storage tank with calmed, filtered inlet and overflow;
 - Submersible pump with integral filter;

- Control panel with pump pressure regulator;
- Mains water make-up (into main or header tank);
- Fine Filter(s) in main distribution pipework (optional); and
- Ultra-violet disinfection unit (optional).

7.2.3 It is recommended that sanitary appliances are selected to be as efficient as possible, so that the use of rainwater can be maximised.

Figure 7.1: Typical Rainwater Harvesting System Illustration



7.2.4 Rainwater can be filtered and disinfected to provide water of drinking quality, but this is rare in the United Kingdom given the availability and quality of mains water.

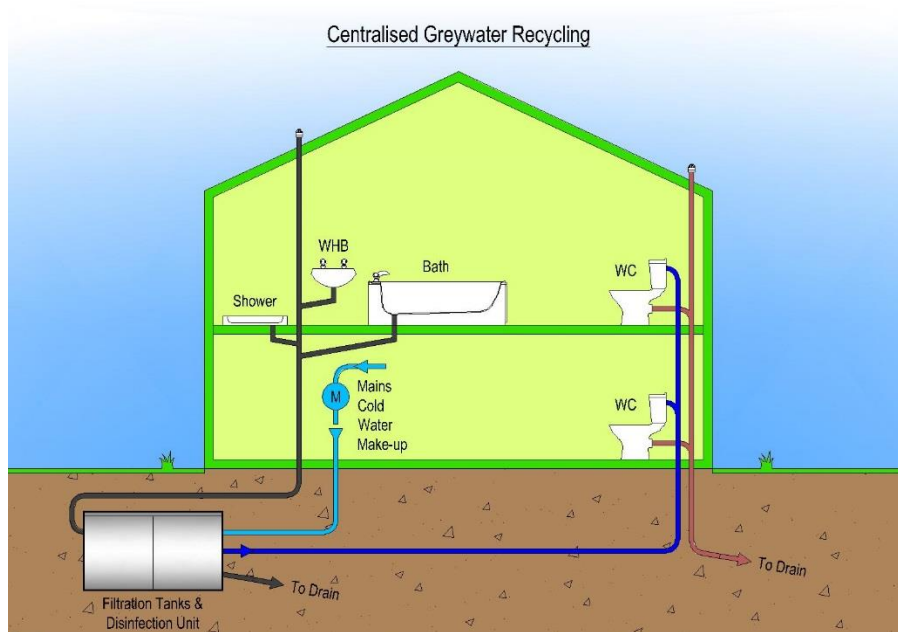
7.2.5 Particular factors that need to be addressed when considering a rainwater harvesting system include:

- The supply of rainwater may not meet the demand and therefore large volumes of storage may be necessary to compensate;
- Compliance with the Water Regulations, including avoidance of backflow and cross connection into the mains water supply;
- The additional expense of a centralised system and also of maintenance, although the works necessary are relatively straightforward; and
- The relatively low impact of WC use on overall dwelling regulated water usage.

7.3 Greywater Recycling

- 7.3.1 Grey water is defined as wastewater collected from sources with relatively low levels of contaminants, i.e. basins, baths, sinks, showers and, in some cases, washing machines. When filtered and disinfected it is primarily used in WC flushing. Grey water is collected via a dedicated waste water pipework system and stored in tanks. Screen filtering and settlement takes place in the tank, after which the water is filtered and disinfected.
- 7.3.2 Packaged systems are now available, but filtration and disinfection methods vary between manufacturers. Reverse osmosis, sand and cartridge filters may be utilised; ultra-violet lamps, bromine and chlorination may be used for disinfection purposes.
- 7.3.3 Storage of 'raw' grey water for long periods is not recommended and a grey water installation should address all the possible health and safety issues, i.e. labelling of outlets and pipework, avoidance of cross contamination with mains water, regular maintenance.

Figure 7.2: Typical Greywater Harvesting System Illustration



7.3.4

- 7.3.5 Factors that need to be addressed when considering a grey water system include:
- Compliance with the Water Regulations, including avoidance of backflow and cross connection into the mains water supply;
 - The additional capital expense of a centralised system;
 - Ongoing maintenance, which is invariably expensive;
 - The relatively low impact of WC use on overall dwelling regulated water usage; and
 - Possibility of more concentrated effluent returned to the sewerage system.

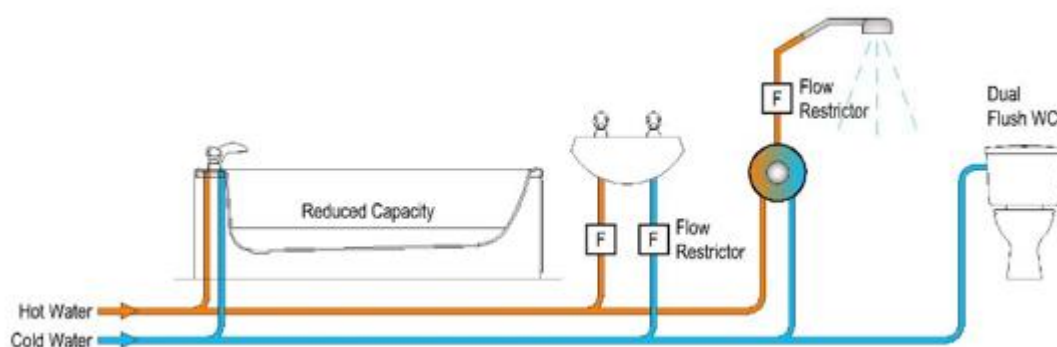
7.4 Sustainable Urban Drainage Systems (SuDS)

- 7.4.1 Sustainable drainage systems (SuDS) include a variety of methods of controlling surface water run-off and therefore assist in prevention of overloading of drainage systems and water courses during periods of heavy rainfall.
- 7.4.2 Solutions may include porous road surfaces to allow water to filter through the subsoil; or, attenuation tanks which hold large volumes of water to prevent sudden discharges into the surface water drainage system.
- 7.4.3 Other associated innovations include 'green roofs' which are able to absorb rainwater and therefore delay run-off from buildings, providing a valuable buffer against prolonged downfall.
- 7.4.4 Rainwater harvesting systems may be part of a SuDS strategy, although the tanks are usually designed to overflow on a regular basis to prevent stagnation and therefore their use alone may not be particularly effective.
- 7.4.5 The surface water drainage strategy is detailed elsewhere- within the outline drainage strategy for the scheme.

7.5 Water Conservation Appliances

- 7.5.1 One of the most straightforward approaches to reducing water consumption would be to specify water conservation appliances such as dual flush toilets, low flow taps and baths with a low capacity to overflow.

Figure 7.3: Water Conservation Appliance Approach to Reducing Water Consumption



- 7.5.2 Factors that need to be addressed when considering a low flow appliance focused strategy include:
- May potentially conflict with user preferences; and
 - There is a risk that residents may remove flow restrictors on occupation.

7.6 Proposed Water Conservation Strategy

7.6.1 It is important to note that in isolation the use of rainwater or greywater recycling is unlikely to reduce water consumption sufficiently to achieve water consumption less than 105l/p/day, however, in combination with low flow appliances these levels should be achievable. Sample regulated water usage calculations have been completed based on the following 3 scenarios:

- Appliance only strategy;
- Rainwater and appliance strategy; and
- Greywater and appliance strategy.

7.6.2 The calculated impact of these 3no. water conservation strategies is included in Table 7.1, below.

Table 7.1: Summary of Routes to 105 l/p/day Water Consumption (Internal Usage Only)

	Water Conservation Strategy		
	Appliance Only	Rainwater and Appliance	Greywater and Appliance
Toilet	Dual flush – 4.5 litres capacity full flush, 3 litres capacity half flush	Dual flush – 4.5 litres capacity full flush, 3 litres capacity half flush	Dual flush – 6 litres capacity full flush, 4 litres capacity half flush
Wash Hand Basin Taps	2.4l /min	2.4l /min	2.4l /min
Shower	8l/min	9 l/min	10 l/min
Bath	Capacity to overflow - 130 litres	Capacity to overflow - 130 litres	Capacity to overflow - 150 litres
Kitchen Taps	Flow – 4 l/min	Flow – 4 l/min	Flow – 6 l/min
Washing Machine	49 litres / cycle	49 litres / cycle	49 litres / cycle
Dishwasher	13 litres / cycle	13 litres / cycle	13 litres / cycle
Water Consumption	104.37 l/p/day	102.46 l/p/day	104.20 l/p/day

7.6.3 Table 7.1 is based on a two-bedroom dwelling. It should be noted that this example makes several assumptions that may affect the overall water consumption such as the amount of rainwater that is i) collected and ii) reused in the dwelling.

7.6.4 This example is based on 9.9m² collection area per dwelling which receives 0.64 m/yr of rainfall and collects 33% of the rainwater that falls; the table above gives an indication of the likely impact on the types of appliances that can be specified to be used in conjunction with this technology to achieve an indoor water usage target of 105 l/p/day. An estimated 5 l/p/day external water usage estimate takes the usage to the total of 110 l/p/day overall usage.

7.6.5 In terms of costing, it is very difficult to establish how much achieving a notional water usage target of 110 l/p/day will cost in total as this will depend on the approach that is employed and the type of dwellings that it is used in. Table 7.2, below, gives an indication of how much the various routes may cost a developer, but should be used for preliminary guidance purposes only.

Table 7.2: Indicative Cost Comparison of Routes to 105 l/p/day Water Consumption (Internal Usage Only)

Water Consumption	Potential Routes	Potential Additional Cost per Unit
≤120 l/p/day	Appliance only	£0
≤105 l/p/day	Appliance only	£140
	Appliance & Greywater	£2,700
	Appliance & Rainwater	£2,500

- 7.6.6 The cost of rainwater harvesting when applied to individual dwellings is relatively high, although connecting a terrace or block of houses to a single tank and pump system may reduce the cost per dwelling. Drawbacks with this type of solution include rights of access for maintenance, metering and management of the installation.
- 7.6.7 It can be seen from Table 7.2 that an appliance only route to meeting a 105 l/p/day internal water usage target is likely to be a substantially more cost-effective route than integrating a rainwater or greywater harvesting system.

7.7 Summary

- 7.7.1 Although not particularly desirable in terms of user satisfaction, the limiting of water flow rates and appliance capacity is the most practical and cost-effective solution for application to the Proposed Development to achieve a significant impact on the regulated water usage of the proposed dwellings.
- 7.7.2 A form of rainwater collection could additionally be provided in the form of above ground water butts for external irrigation to further improve the unregulated water usage efficiency of the scheme.

Figure 7.4: Water Butt for Unregulated Water Usage



8.0 Resource Efficiency

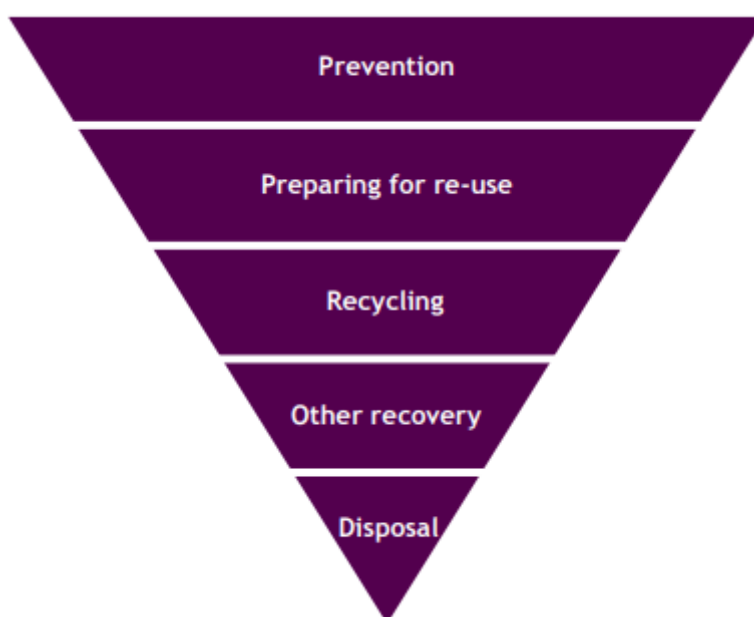
8.1 Overview

- 8.1.1 Resource efficiency means utilising the earth's limited natural resources in a sustainable manner and in turn mitigating negative environmental impacts. The management of waste is increasingly recognised by local authorities as an area that should be addressed in the development of design proposals. This section of the report will outline a strategy for a resource efficient development at the Proposed Development.

8.2 Waste Hierarchy

- 8.2.1 The Waste Hierarchy aids in identifying actions that can improve resource efficiency by prioritising waste management options in line with their relative impact.

Figure 8.1: The Waste Hierarchy¹



- 8.2.2 The Building Research Establishment (BRE) outline the following steps in identifying a route to resource efficiency:
- Where is waste being produced?
 - What is the cause of this and is it avoidable?
 - If not avoidable, what opportunities are there for this material to be used internally, or by another business through recycling or refurbishing?
 - Can improvements be made to the way waste is currently handled?

¹ (Original Source: Reading Borough Council Sustainable Design and Construction SPD)

8.3 Construction Waste

- 8.3.1 Construction waste can be minimised during the construction process via the effective and appropriate management of construction site waste.
- 8.3.2 It is proposed that this is implemented on the Site through the production of a Site Waste Management Plan (SWMP) outlining procedures and good practice measures that can be adopted on Site.
- 8.3.3 It is proposed that a SWMP will be developed for the Site in accordance with guidance from:
- DEFRA (Department for Environment, Food and Rural Affairs);
 - BRE (Building Research Establishment);
 - Envirowise;
 - WRAP (Waste & Resources Action Programme); and
 - Environmental performance indicators and / or key performance indicators (KPI) from Envirowise or Constructing Excellence.
- 8.3.4 The SWMP will outline the following:
- Target benchmarks for resource efficiency, i.e. m³ of waste per 100m² or tonnes of waste per 100m² set in accordance with best practice;
 - Procedures and commitments to minimize non-hazardous construction waste at design stage. Specify waste minimisation actions relating to at least 3 waste groups and support them by appropriate monitoring of waste;
 - Procedures for minimising hazardous waste;
 - Monitoring, measuring and reporting of hazardous and non-hazardous site waste production according to the defined waste groups; and
 - Procedures to divert waste from landfill through re-use on site, re-use on other sites, reclaim for re-use, return to the supplier via a 'take-back' scheme, recovery and recycling using an approved waste management contractor or composting according to the defined waste groups.
- 8.3.5 It is proposed that the defined waste groups referenced in the SWMP will include the following materials as defined in the European Waste Catalogue: bricks, concrete, insulation, packaging, timber, electrical and electronic equipment, canteen / office / ad hoc, asphalt & tar, tiles and ceramics, inert materials, metals, gypsum, plastics, floor coverings, soils, hazardous materials, architectural features and other / mixed materials.
- 8.3.6 It is proposed that target benchmarks for resource efficiency will be set using best practice guidance and will be reviewed throughout the construction process.

8.4 Built Fabric Resource Intensity

- 8.4.1 The resource intensity of the building fabric of the proposed dwellings and health centre can be addressed through the specification of 'resource light' construction and consideration of the end of life of the building.
- 8.4.2 Resource-light construction refers to the appropriate use of construction materials and building techniques to provide the most efficient response to the particular building requirements. 'Eco' materials will be considered for their applicability to the scheme as the architectural design progresses. Eco-materials are less resource intensive than alternative materials, and have a lower level of embodied carbon as a result of their sourcing, production process, delivery requirements etc. Examples of these materials are locally sourced eco-cement, wood, straw, clay etc. The application of these materials in the Proposed Development will be within the Site, economic and thermal performance constraints of the scheme.
- 8.4.3 The design of the scheme will also consider the end of life of the future dwellings. The following options will be explored as the scheme develops to maximise the end of life potential for the dwellings:
- The use of prefabricated components may make them easier to dismantle on demolition and therefore more appropriate for re-use;
 - Utilising simple connections and avoiding non-standard connection details will allow for efficient deconstruction and will reduce the need for multiple tools;
 - Designing with reusable and adaptable materials. Materials such as bricks, steel beams / columns and wood can be easily re-used / repurposed to avoid them going to landfill on demolition; and
 - Resilience to climate change may extend the economic life of the proposed buildings.

8.5 Recycling and Composting In-use

- 8.5.1 Encouraging the occupants of the development to recycle and compost biodegradable waste will aid in reducing the amount of waste being sent to landfill through the lifetime of the Proposed Development.
- 8.5.2 It is proposed that the Home User Guides will include a section on Recycling and Waste to provide guidance on good practices to the future occupants of the dwellings.
- 8.5.3 It is proposed that this section of the Home User Guide will include the following:
- Information about the Local Authority collection scheme;
 - Information on the Waste and Resource Action Programme (WRAP) which can offer guidance on recycling and sustainable waste disposal;
 - Information on the procedure to follow with items of waste not covered by the standard weekly Local Authority collection scheme – for example fridges / freezers, computer equipment, batteries and other potentially hazardous equipment; and

-
- Information and location of local recycling facilities and waste tips.

8.5.4 It is proposed for dedicated storage facilities for the health centre's operational related recyclable waste streams to be provided. This will aid in diverting this waste from landfill/ incineration.

9.0 Conclusions

- 9.1.1 A Sustainability Strategy for the Site has been developed to optimise the use of resources during the design, construction and end use.
- 9.1.2 A sequential approach has been taken for the scheme energy strategy to minimise the potential carbon dioxide (CO₂) emissions from the Site - firstly by passive measures and secondly by more active means. We believe that this has been achieved without unduly compromising the external appeal of the buildings and comfort of the occupants.
- 9.1.3 The occupants will receive direct benefits in the provision of energy efficient dwellings. Demand for heating and mechanical cooling will be significantly reduced, with a consequential decrease in carbon emissions. In terms of running costs, the residents and users will see the benefit through financial savings.
- 9.1.4 Detailed calculations regarding the predicted energy demand and carbon dioxide emissions will be undertaken at detailed design development stage. However, based on the preliminary calculation exercises carried out for this report, the Building Regulations energy targets will be met through a combination of passive measures, energy efficient fixed services and LZC technologies.
- 9.1.5 Energy savings and subsequent reduction in CO₂ emissions have been targeted through implementation of the following:
- Exceeding good or best practice standards for thermal insulation of opaque and glazed elements;
 - Achieving air permeability of 3.0m³/h.m² at 50Pa;
 - LED lighting throughout with enhanced controls where relevant;
 - High efficiency heat recovery ventilation systems;
 - ASHP installations; and
 - A solar photovoltaic installation.
- 9.1.6 The proposed energy strategy for the Site has been demonstrated to comply with the local authority requirement for major residential proposals to reduce regulated carbon emissions on site by at least 35% - the proposals are shown to achieve a 43% reduction.
- 9.1.7 Other areas which will contribute to the water and resource efficiency of the Site have been targeted through the implementation of the following:
- integration of water conservation appliances in dwellings such as low flow fittings to reach water consumption targets set by the local authority;
 - consideration of local rainwater collection for external irrigation;
 - production of a SWMP to set good practice target waste benchmarks, set procedures for minimising, measuring, monitoring and reporting various waste streams and identifying potential for re-use to divert potential waste from landfill;

-
- at detailed design stage opportunities to reduce the resource intensity and maximise end of life potential of the architectural proposals will be explored; and
 - recommendations/ guidance to users and residents/ occupants on waste disposal.

9.1.8 This report has set out a route map for the future design development of the Site to meet the sustainability guidelines set out in the *Reading Borough Local Plan*.

Appendix A – Sample Dwelling SAP Calculation



BASIC COMPLIANCE REPORT

Calculation Type: New Build (As Designed)



Property Reference	551009	Issued on Date	18/03/2020
Assessment Reference	001	Prop Type Ref	12 - 3 Bed House End E/W
Property			

SAP Rating	82 B	DER	18.81	TER	24.37
Environmental	84 B	% DER<TER	22.81		
CO ₂ Emissions (t/year)	1.78	DFEE	50.77	TFEE	54.71
General Requirements Compliance	Pass	% DFEE<TFEE	7.20		

Assessor Details	Ms. Jessica Finnigan, Jessica Finnigan, Tel: 07575654509, jfinnigan@ridge.co.uk	Assessor ID	R478-0001
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Client	
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SUMMARY FOR INPUT DATA FOR New Build (As Designed)

Criterion 1 – Achieving the TER and TFEE rate

1a TER and DER

Fuel for main heating	Electricity		
Fuel factor	1.55 (electricity)		
Target Carbon Dioxide Emission Rate (TER)	24.37	kgCO ₂ /m ²	
Dwelling Carbon Dioxide Emission Rate (DER)	18.81	kgCO ₂ /m ²	Pass
	-5.56 (-22.8%)	kgCO ₂ /m ²	

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	54.71	kWh/m ² /yr	
Dwelling Fabric Energy Efficiency (DFEE)	50.77	kWh/m ² /yr	
	-3.9 (-7.1%)	kWh/m ² /yr	Pass

Criterion 2 – Limits on design flexibility

Limiting Fabric Standards

2 Fabric U-values

Element	Average	Highest	
External wall	0.18 (max. 0.30)	0.18 (max. 0.70)	Pass
Party wall	0.00 (max. 0.20)	-	Pass
Floor	0.13 (max. 0.25)	0.13 (max. 0.70)	Pass
Roof	0.13 (max. 0.20)	0.13 (max. 0.35)	Pass
Openings	1.35 (max. 2.00)	1.40 (max. 3.30)	Pass

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	3.00 (design value)	
Maximum	10.0	Pass

Limiting System Efficiencies

4 Heating efficiency

Main heating system	Heat pump with radiators or underfloor - Electric Air-to-water heat pump	
Secondary heating system	None	





BASIC COMPLIANCE REPORT

Calculation Type: New Build (As Designed)



5 Cylinder insulation

Hot water storage	Nominal cylinder loss: 1.06 kWh/day Permitted by DBSCG 1.32	Pass
Primary pipework insulated	Yes	Pass

6 Controls

Space heating controls	Programmer and at least two room thermostats	Pass
Hot water controls	Cylinderstat	Pass
	Independent timer for DHW	Pass

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100	%	
Minimum	75	%	Pass

8 Mechanical ventilation

Continuous supply and extract system			
Specific fan power	0.56		
Maximum	1.5		Pass
MVHR efficiency	88	%	
Minimum	70	%	Pass

Criterion 3 – Limiting the effects of heat gains in summer

9 Summertime temperature

Overheating risk (Thames Valley)	Not significant	Pass
Based on:		
Overshading	Average	
Windows facing East	8.00 m ² , No overhang	
Windows facing West	8.00 m ² , No overhang	
Air change rate	8.00 ach	
Blinds/curtains	None	

Criterion 4 – Building performance consistent with DER and DFEE rate

Party Walls

Type	U-value		
Filled Cavity with Edge Sealing	0.00	W/m ² K	Pass

Air permeability and pressure testing

3 Air permeability

Air permeability at 50 pascals	3.00 (design value)	
Maximum	10.0	Pass

10 Key features

Party wall U-value	0.00	W/m ² K
Door U-value	1.00	W/m ² K
Air permeability	3.0	m ³ /m ² h

This report has not been submitted through the Elmhurst Energy members' portal, therefore results are subject to change when the dwelling is completed.



Appendix B – Preliminary BRUKL Output for Health Centre

BRUKL Output Document



Compliance with England Building Regulations Part L 2013

Project name

Reading Golf Course - Medical Centre

As designed

Date: Thu Mar 19 15:43:02 2020

Administrative information

Building Details

Address: Reading,

Owner Details

Name: TBC

Telephone number: TBC

Address: TBC, TBC, TBC

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.6.a.2

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.12

BRUKL compliance check version: v5.6.a.1

Certifier details

Name: Ridge & Partners LLP

Telephone number: 01962 834400

Address: Partnership House, Moorside Road, Winchester, SO23 7RX

Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	17.1
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	17.1
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	15.5
Are emissions from the building less than or equal to the target?	BER ≤ TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	U _{o-Limit}	U _{a-Calc}	U _{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	GF000004_W1
Floor	0.25	0.13	0.13	GF000004_F
Roof	0.25	-	-	"No heat loss roofs"
Windows***, roof windows, and rooflights	2.2	1.4	1.4	GF000004_W1_O0
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"
U _{o-Limit} = Limiting area-weighted average U-values [W/(m ² K)] U _{a-Calc} = Calculated area-weighted average U-values [W/(m ² K)] U _{i-Calc} = Calculated maximum individual element U-values [W/(m ² K)]				
* There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	3

Appendix C – GLA Emissions Spreadsheet Outputs

1. Baseline

The applicant should complete all the light blue cells including information on the modelled units, the area per unit, the number of units, the baseline energy consumption figures, the TER and the TFEF.												SAP 2012 CO2 PERFORMANCE						SAP10 CO2 PERFORMANCE										
DOMESTIC ENERGY CONSUMPTION AND CO2 ANALYSIS																						DEMAND						
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	Number of units	Total area represented by model (m²)	VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - TER WORKSHEET						REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.)						REGULATED CO2 EMISSIONS PER UNIT						Fabric Energy Efficiency (FEE)				
				Calculated TER 2012 (kgCO2 / m2)	TER Worksheet TER 2012 (kgCO2 / m2)	Space Heating	Fuel type Space Heating	Domestic Hot Water	Fuel type Domestic Hot Water	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	2012 CO2 emissions (kgCO2 p.a.)	Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated TER SAP10 (kgCO2 / m2)	Target Fabric Energy Efficiency (TFEE) (kWh/m²)		
TER Worksheet (Row 4)				TER Worksheet (Row 273)		TER Worksheet (Row 211)		TER Worksheet (Row 219)		TER Worksheet (Row 232)		TER Worksheet (Row 231)		N / A														
2B Hse End/SD N/S	112	11	1232	16.6	16.6	4893.5	Natural Gas	2422.67	Natural Gas	461.46	75	1,057	523	239	39	1,859	1,028	509	108	17	1,661	14.8	52.99					
2B Hse End/SD E/M	112	3	336	16.8	16.8	4984.66	Natural Gas	2423.1918	Natural Gas	461.46	75	1,077	523	239	39	1,879	1,047	509	108	17	1,681	15.0	54.22					
2B Hse Det N/S	112	14	1568	17.4	17.4	5332.4432	Natural Gas	2418.6846	Natural Gas	461.46	75	1,152	522	239	39	1,953	1,120	508	108	17	1,753	15.6	57.37					
2B Hse Det E/W	112	14	1568	17.6	17.6	5420.4696	Natural Gas	2419.1524	Natural Gas	461.46	75	1,171	523	239	39	1,972	1,138	508	108	17	1,771	15.8	58.55					
3B Hse M Terr N/S	120	2	240	15.4	15.4	4763.3532	Natural Gas	2440.6607	Natural Gas	486.9266	75	1,029	527	253	39	1,848	1,000	513	113	17	1,644	13.7	48.26					
3B Hse End/SD N/S	120	26	3120	16.4	16.4	5338.2142	Natural Gas	2435.2344	Natural Gas	486.9266	75	1,153	526	253	39	1,971	1,121	511	113	17	1,763	14.7	53.6					
3B Hse End/SD E/M	120	23	2760	16.6	16.6	5426.8598	Natural Gas	2435.7473	Natural Gas	486.9266	75	1,172	526	253	39	1,990	1,140	512	113	17	1,782	14.9	54.71					
3B Hse Det N/S	120	15	1800	17.4	17.4	5909.1203	Natural Gas	2430.723	Natural Gas	486.9266	75	1,276	525	253	39	2,093	1,241	510	113	17	1,882	15.7	58.95					
3B Hse Det E/W	120	15	1800	17.6	17.6	5994.2283	Natural Gas	2431.1553	Natural Gas	486.9266	75	1,295	525	253	39	2,112	1,259	511	113	17	1,900	15.8	59.99					
4B Hse End/SD N/S	141.2	12	1694.4	15.5	15.5	6157.0356	Natural Gas	2454.094	Natural Gas	550	75	1,330	530	285	39	2,184	1,293	515	128	17	1,954	13.8	51.93					
4B Hse Det N/S	141.2	37	5224.4	16.2	16.2	6665.4413	Natural Gas	2450.797	Natural Gas	550	75	1,440	529	285	39	2,293	1,400	515	128	17	2,060	14.6	55.98					
4B Hse Det E/W	141.2	32	4518.4	16.4	16.4	6747.8472	Natural Gas	2451.2236	Natural Gas	550	75	1,458	529	285	39	2,311	1,417	515	128	17	2,077	14.7	56.82					
5B Hse Det N/S	180	0	0	15.2	15.2	8462.3599	Natural Gas	2467.0307	Natural Gas	654.8365	75	1,828	533	340	39	2,740	1,777	518	153	17	2,465	13.7	55.03					
5B Hse Det E/W	180	0	0	15.3	15.3	8538.7195	Natural Gas	2467.3486	Natural Gas	654.8365	75	1,844	533	340	39	2,756	1,793	518	153	17	2,481	13.8	55.61					
1 Bed Flat LF	48	16	768	20.5	20.5	1882.3755	Natural Gas	1925.9828	Natural Gas	231.4898	75	407	416	120	39	982	395	404	54	17	871	18.1	52.14					
1 Bed Flat UF	48	16	768	22.0	22.0	2243.3662	Natural Gas	1918.0955	Natural Gas	231.4898	75	485	414	120	39	1,058	471	403	54	17	945	19.7	60.4					
2 Bed Flat LF	66	12	792	18.0	18.0	2381.344	Natural Gas	2148.8721	Natural Gas	327.4404	75	514	464	170	39	1,187	500	451	76	17	1,045	15.8	46.58					
2 Bed Flat UF	66	12	792	19.4	19.4	2809.1046	Natural Gas	2140.7115	Natural Gas	327.4404	75	607	462	170	39	1,278	590	450	76	17	1,133	17.2	53.65					
Sum	28,981	260	28,981	17.0	-	1,335,746	N/A	610,344	N/A	118,639	19,500	0	288,521	131,834	61,573	10,121	0	492,049	280,507	128,172	27,643	4,544	0	440,865	15.2	55.63		

2. Be Lean

The applicant should complete all the light blue cells including information on the 'be lean' energy consumption figures, the 'be lean' DER, the DFEE and the regulated energy demand of the 'be lean' scenario.										SAP 2012 CO2 PERFORMANCE						SAP10 CO2 PERFORMANCE										
DOMESTIC ENERGY CONSUMPTION AND CO ₂ ANALYSIS																										
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	Number of units	Total area represented by model (m²)	VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET						REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.)						REGULATED CO2 EMISSIONS PER UNIT						Fabric Energy Efficiency (FEE)		
				Calculated DER 2012 (kgCO2 / m2)	DER Worksheet DER 2012 (kgCO2 / m2)	Space Heating	Fuel type Space Heating	Domestic Hot Water	Fuel type Domestic Hot Water	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	2012 CO2 emissions (kgCO2 p.a.)	Space Heating CO2 emissions (kgCO2 p.a.)	Domestic Hot Water CO2 emissions (kgCO2 p.a.)	Lighting CO2 emissions (kgCO2 p.a.)	Auxiliary CO2 emissions (kgCO2 p.a.)	Cooling CO2 emissions (kgCO2 p.a.)	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated DER SAP10 (kgCO2 / m2)	Dwelling Fabric Energy Efficiency (DFEE) (kWh/m²)
				DER Sheet (Row 384)		DER Sheet [[Row 307a) ÷ (Row 367a x 0.01)]	Select fuel type	DER Sheet [[Row 310a) ÷ (Row 367a x 0.01)]	Select fuel type	DER Sheet Row 332	DER Sheet (Row 313 + 331)	DER Sheet Row 315														
2B Hse End/SD N/!	112	11	1232	15.7	15.7	3777.201	Natural Gas	2471.9618	Natural Gas	461.46	319.24		816	534	239	166	1,755	793	519	108	74	1,494	13.3	49.69		
2B Hse End/SD E/!	112	3	336	15.8	15.9	3868.1872	Natural Gas	2472.4618	Natural Gas	461.46	319.24		836	534	239	166	1,775	812	519	108	74	1,513	13.5	50.53		
2B Hse Det N/S	112	14	1568	16.6	16.6	4260.7375	Natural Gas	2465.361	Natural Gas	461.46	319.24		920	533	239	166	1,858	895	518	108	74	1,594	14.2	53.35		
2B Hse Det E/W	112	14	1568	16.8	16.8	4347.1689	Natural Gas	2465.8858	Natural Gas	461.46	319.24		939	533	239	166	1,877	913	518	108	74	1,613	14.4	54.16		
3B Hse M Terr N/S	120	2	240	14.4	14.4	3494.8439	Natural Gas	2493.5065	Natural Gas	486.93	339.9		755	539	253	176	1,723	734	524	113	79	1,450	12.1	45.49		
3B Hse End/SD N/!	120	26	3120	15.5	15.5	4135.852	Natural Gas	2483.9219	Natural Gas	486.93	339.9		893	537	253	176	1,859	869	522	113	79	1,583	13.2	50.01		
3B Hse End/SD E/!	120	23	2760	15.7	15.7	4224.2689	Natural Gas	2484.4978	Natural Gas	486.93	339.9		912	537	253	176	1,878	887	522	113	79	1,601	13.3	50.77		
3B Hse Det N/S	120	15	1800	16.6	16.6	4767.272	Natural Gas	2476.3814	Natural Gas	486.93	339.9		1,030	535	253	176	1,994	1,001	520	113	79	1,714	14.3	54.51		
3B Hse Det E/W	120	15	1800	16.8	16.8	4850.3996	Natural Gas	2476.9224	Natural Gas	486.93	339.9		1,048	535	253	176	2,012	1,019	520	113	79	1,731	14.4	55.23		
4B Hse End/SD N/!	141.2	12	1694.4	14.7	14.7	4681.3707	Natural Gas	2503.0754	Natural Gas	550	466.28		1,011	541	285	242	2,079	983	526	128	109	1,746	12.4	48.12		
4B Hse Det N/S	141.2	37	5224.4	15.6	15.6	5260.9972	Natural Gas	2497.0688	Natural Gas	550	466.28		1,136	539	285	242	2,203	1,105	524	128	109	1,866	13.2	51.48		
4B Hse Det E/W	141.2	32	4518.4	15.7	15.7	5342.1005	Natural Gas	2497.6779	Natural Gas	550	466.28		1,154	539	285	242	2,221	1,122	525	128	109	1,883	13.3	52.06		
5B Hse Det N/S	180	0	0	14.5	14.5	6612.5339	Natural Gas	2512.1588	Natural Gas	654.84	586.16		1,428	543	340	304	2,615	1,389	528	153	137	2,205	12.3	50.05		
5B Hse Det E/W	180	0	0	14.6	14.6	6687.0001	Natural Gas	2512.7073	Natural Gas	654.84	586.16		1,444	543	340	304	2,631	1,404	528	153	137	2,221	12.3	50.45		
1 Bed Flat LF	48	16	768	19.0	19.1	1354.1339	Natural Gas	1974.1458	Natural Gas	231.49	145.11		292	426	120	75	914	284	415	54	34	787	16.4	48.39		
1 Bed Flat UF	48	16	768	20.8	20.8	1765.0065	Natural Gas	1961.8636	Natural Gas	231.49	145.11		381	424	120	75	1,000	371	412	54	34	870	18.1	56.29		
2 Bed Flat LF	66	12	792	16.4	16.4	1548.1117	Natural Gas	2205.7134	Natural Gas	327.44	200.45		334	476	170	104	1,085	325	463	76	47	911	13.8	42.18		
2 Bed Flat UF	66	12	792	17.9	17.9	2014.346	Natural Gas	2191.9719	Natural Gas	327.44	200.45		435	473	170	104	1,183	423	460	76	47	1,006	15.2	48.68		
Sum	28,981	260	28,981	16.1	-	1,044,046	N/A	622,761	N/A	118,639	88,163	0	225,514	134,516	61,574	45,757	0	467,360	219,250	130,780	27,643	20,542	0	398,214	13.7	51.39

3. Be Clean

The applicant should complete all the light blue cells including information on the 'be clean' energy consumption figures and the 'be clean' DER.														SAP 2012 CO2 PERFORMANCE							SAP10 CO2 PERFORMANCE												
DOMESTIC ENERGY CONSUMPTION AND CO2 ANALYSIS																																	
Unit Identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	Number of units	Total area represented by model (m²)	VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE CLEAN' SAP DER WORKSHEET										REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.)							REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.)										
				Calculated DER 2012 (kgCO2 / m2)	DER Worksheet DER 2012 (kgCO2 / m2)	Space Heating (Heat Source 1)	Fuel type Space Heating	Domestic Hot Water (Heat Source 1)	Fuel type Domestic Hot Water	Space and Domestic Hot Water from CHP	Fuel type CHP	Total Electricity generated by CHP (-)	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Space Heating and DHW from CHP	Electricity generated by CHP	Lighting	Auxiliary	Cooling	2012 CO2 emissions (kgCO2 p.a.)	Space Heating	Domestic Hot Water	Space Heating and DHW from CHP	Electricity generated by CHP	Lighting	Auxiliary	Cooling	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated DER SAP10 (kgCO2 / m2)	
								DER Sheet (Row 384)	DER Sheet (Row 307b + (Row 367b x 0.01))	Select fuel type	DER Sheet (Row 310b + (Row 367b x 0.01))	Select fuel type	if applicable [(Row 307a + 310a) + (Row 362 x 0.01)]	if applicable Select fuel type	if applicable DER Sheet [(Row 307a + 310a) x (Row 361 + 362)]	DER Sheet Row 332	DER Sheet (Row 313 + 331)	DER Sheet Row 315				if applicable	if applicable						if applicable	if applicable			
2B Hse End/SD N/A	112	11	1232	15.7	15.7	3777.2019	Natural Gas	2471.9618	Natural Gas			461.46	319.24		816	534			239	166		1,755	793	519			108	74	1,494	13.3			
2B Hse End/SD E/A	112	3	336	15.8	15.9	3868.1872	Natural Gas	2472.4618	Natural Gas			461.46	319.24		836	534			239	166		1,775	812	519			108	74	1,513	13.5			
2B Hse Det N/S	112	14	1568	16.6	16.6	4260.7375	Natural Gas	2465.361	Natural Gas			461.46	319.24		920	533			239	166		1,858	895	518			108	74	1,594	14.2			
2B Hse Det E/W	112	14	1568	16.8	16.8	4347.1689	Natural Gas	2465.8858	Natural Gas			461.46	319.24		939	533			239	166		1,877	913	518			108	74	1,613	14.4			
3B Hse M Terr N/S	120	2	240	14.4	14.4	3494.8439	Natural Gas	2493.5065	Natural Gas			486.93	339.9		755	539			253	176		1,723	734	524			113	79	1,450	12.1			
3B Hse End/SD N/A	120	26	3120	15.5	15.5	4135.852	Natural Gas	2483.9219	Natural Gas			486.93	339.9		893	537			253	176		1,859	869	522			113	79	1,583	13.2			
3B Hse End/SD E/A	120	23	2760	15.7	15.7	4224.2689	Natural Gas	2484.4978	Natural Gas			486.93	339.9		912	537			253	176		1,878	887	522			113	79	1,601	13.3			
3B Hse Det N/S	120	15	1800	16.6	16.6	4767.272	Natural Gas	2476.3814	Natural Gas			486.93	339.9		1,030	535			253	176		1,994	1,001	520			113	79	1,714	14.3			
3B Hse Det E/W	120	15	1800	16.8	16.8	4850.3996	Natural Gas	2476.9224	Natural Gas			486.93	339.9		1,048	535			253	176		2,012	1,019	520			113	79	1,731	14.4			
4B Hse End/SD N/A	141.2	12	1694.4	14.7	14.7	4681.3707	Natural Gas	2503.0754	Natural Gas			550	466.28		1,011	541			285	242		2,079	983	526			128	109	1,746	12.4			
4B Hse Det N/S	141.2	37	5224.4	15.6	15.6	5260.9972	Natural Gas	2497.0688	Natural Gas			550	466.28		1,136	539			285	242		2,203	1,105	524			128	109	1,866	13.2			
4B Hse Det E/W	141.2	32	4518.4	15.7	15.7	5342.1005	Natural Gas	2497.6779	Natural Gas			550	466.28		1,154	539			285	242		2,221	1,122	525			128	109	1,883	13.3			
5B Hse Det N/S	180	0	0	14.5	14.5	6612.5339	Natural Gas	2512.1588	Natural Gas			654.84	586.16		1,428	543			340	304		2,615	1,389	528			153	137	2,205	12.3			
5B Hse Det E/W	180	0	0	14.6	14.6	6687.0001	Natural Gas	2512.7073	Natural Gas			654.84	586.16		1,444	543			340	304		2,631	1,404	528			153	137	2,221	12.3			
1 Bed Flat LF	48	16	768	19.0	19.1	1354.1339	Natural Gas	1974.1458	Natural Gas			231.49	145.11		292	426			120	75		914	284	415			54	34	787	16.4			
1 Bed Flat UF	48	16	768	20.8	20.8	1765.0065	Natural Gas	1961.8636	Natural Gas			231.49	145.11		381	424			120	75		1,000	371	412			54	34	870	18.1			
2 Bed Flat LF	66	12	792	16.4	16.4	1548.1117	Natural Gas	2205.7134	Natural Gas			327.44	200.45		334	476			170	104		1,085	325	463			76	47	911	13.8			
2 Bed Flat UF	66	12	792	17.9	17.9	2014.346	Natural Gas	2191.9719	Natural Gas			327.44	200.45		435	473			170	104		1,183	423	460			76	47	1,006	15.2			
Sum	28,981	260	28,981	16.1	-	1,044,046	N/A	622,761	N/A	0	N/A	0	118,639	88,163	0	225,514	134,516	0	0	61,574	45,757	0	467,360	219,250	130,780	0	0	27,643	20,542	0	398,214	13.7	

4. Be Green

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

DOMESTIC ENERGY CONSUMPTION AND CO ₂ ANALYSIS															SAP 2012 CO ₂ PERFORMANCE							SAP10 CO ₂ PERFORMANCE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
Unit identifier (e.g. plot number, dwelling type etc.)				VALIDATION CHECK		REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE GREEN' SAP DER WORKSHEET															REGULATED CO ₂ EMISSIONS PER UNIT (kgCO ₂ p.a.)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
				Calculated DER 2012 (kgCO ₂ / m ²)	DER Worksheet DER 2012 (kgCO ₂ / m ²)	Space Heating (Heat Source 1)	Fuel type Space Heating	Domestic Hot Water (Heat Source 1)	Fuel type Domestic Hot Water	Space Heating (Heat source 2)	Fuel type Space Heating	Domestic Hot Water (Heat source 2)	Fuel type Domestic Hot Water	Space and Domestic Hot Water from CHP	Fuel type CHP	Total Electricity generated by CHP (-)	Electricity generated by renewable (-)	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Space Heating and DHW from CHP	Electricity generated by CHP	Electricity generated by renewable	Lighting	Auxiliary	Cooling	2012 CO ₂ emissions (kgCO ₂ p.a.)	Space Heating	Domestic Hot Water	Space Heating and DHW from CHP	Electricity generated by CHP	Electricity generated by renewable	Lighting	Auxiliary	Cooling	SAP10 CO ₂ emissions (kgCO ₂ p.a.)	Calculated DER SAP10 (kgCO ₂ / m ²)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
DER Sheet (Row 384)	DER Sheet (Row 307b + (Row 307b x 0.01))	Select fuel type	DER Sheet (Row 310b + (Row 310b x 0.01))	Select fuel type	DER Sheet (Row 307c + (Row 307c x 0.01))	Select fuel type	DER Sheet (Row 310c + (Row 310c x 0.01))	Select fuel type	DER Sheet (Row 307a + 310a) + (Row 361 x 0.01))	Select fuel type	DER Sheet (Row 307a + 310a) + (Row 361 + 362))	DER Sheet Row 380	DER Sheet Row 332	DER Sheet (Row 313 + 331)	DER Sheet Row 315																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	