



## Energy & Sustainability Statement

**Cox & Wyman Building  
Cardiff Road  
Reading  
RG1 8EX**

**17<sup>th</sup> October 2017**

Prepared for:

**Thames Properties Ltd  
6 Forge Lane  
Peterham Road  
Richmond  
TW10 7BF**

## **Contents**

- 1 Introduction
- 2 Site & Proposal
- 3 Baseline Energy results
- 4 Design for Energy Efficiency
- 5 Sourcing Clean Energy
- 6 Renewable and Energy Generating Technologies
- 7 Sustainable Design & Construction
- 8 Summary & Conclusions

## **Appendices**

- A Site Layout & House Types
- B SAP TER Outputs – Baseline Energy Use
- C SAP DER Outputs – Energy Efficiency
- D SAP DER Outputs – Renewable Technologies
- E Sample Part G Water Use calculation

## 1.0 Introduction

The proposed development at the Cox & Wyman site has been designed to achieve the highest of environmental performance standards following the principles of the energy hierarchy as set down by the local planning authority's environmental and sustainability policies.

eb7 Sustainability Ltd has been appointed to develop a strategy and to report upon just how the proposed development of the strategic 1.31 hectare site will comply with these requirements.

The fabric energy efficiency and carbon compliance requirements have been applied and the residential development achieves an overall improvement (DER/TER) in regulated emissions of circa **22%** over Part L 2013 standard, through the adoption of high standards of insulation, efficient gas fired heating/hot water systems, with electricity generation via roof mounted photovoltaic (PV) panels.

The individual new build residential properties are also designed to meet many of the aspiration of the - now withdrawn - Code for Sustainable Homes standards in terms of overall environmental performance, which aligns with the requirements of Reading's Core Strategy policies as supplemented by the Environmental Design and Construction SPD.

## 2.0 The Site & Proposal

The development site sits within the Richfield Avenue area of Reading. Currently occupied by industrial buildings and warehousing, It is bounded by residential streets of Cardiff Road and Addison Road to the south and east, with further industrial uses to the north and west on Millford Road and Meadow Road.

It is understood that the proposed redevelopment consists of a mix of apartments and houses, with a total of 96 units. The current proposals are for 48 Houses and 48 apartments and it is intended that 50% of the total units will be 3 bed or more.

### 2.1 Planning Policy Context

The project sits within the authority of Reading Borough Council (Reading).

Reading Core Strategy was adopted in January 2008, with Alteration Adopted 27th January 2015 and on matters of sustainable development, is supplemented by the Revised Sustainable Design and Construction SPD adopted in July 2011

#### 2.1.1 Core Strategy

CS Policy C1 – Sustainable Construction and Design

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, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To achieve this:-

All new developments maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand;

All developments of more than 10 dwellings or 1000m<sup>2</sup> floorspace incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development;

All developments reduce mains water use and demonstrate that water conservation measures are incorporated so that predicted per capita consumption does not exceed the appropriate levels set out in the Code for Sustainable Homes or BREEAM Standards

Developments incorporate sustainable urban drainage facilities and techniques as part of the layout of a development as appropriate and as advised by the Environment Agency, including minimising the size of impermeable areas so that peak run-off and annual water run-off is reduced where possible and in any case is no greater than the original conditions of the site. Particular care will be needed in areas of flood risk where different solutions may be required.

### 2.1.2 Revised Sustainable Design and Construction SPD

This document notes that the requirement to off-set at least 20% of building emission through energy efficiency measures has now been superseded by changes to Building Regulations (Part L).

Section 3 of the SPD outlines the requirement for Major Applications to be accompanied by an Energy Statement and a Sustainability statement in line with the guidance within the SPD

Accordingly, eb7 will prepare the required energy statement and sustainable construction assessment will comply with the policies of Reading Borough Council and to include any feedback or requirements from pre-application advice received.

### **3.0 Baseline energy results**

#### **3.1 The Energy Hierarchy**

This report will consider the scheme against the above noted policies by implementing the methodology as set out in the Energy Hierarchy.

Application of the Energy Hierarchy sets out how any development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following 3 stage analysis:

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

The scheme at the Cox & Wyman site will be designed to limit the emissions of carbon dioxide to the atmosphere from the operation of the building services as per the 'Energy Hierarchy'; the first step in which, as set out above requests that buildings be designed to use improved energy efficiency measures – Be Lean. This will reduce demand for heating, cooling, and lighting, and therefore reduce operational costs while also minimizing associated carbon dioxide emissions following the guidance within the Revised Sustainable Design and Construction SPD.

Thereafter, this report will consider the opportunities to introduce renewable and energy generating technologies to further reduce and/or off-set carbon emissions.

In order to do this, the "Baseline" energy demand must be established, this is the energy consumption and associated emissions from the development meeting only the minimum standards required under the current Building Regulations for England and Wales;

#### **3.2 New Build Housing**

The baseline emission levels – the Target Emission Rate (TER) as required for Building regulations compliance - is obtained by applying the design to a reference 'notional' building the characteristics of which are set by regulations – SAP2012; The new Part L Building Regulations 2013 came into force on April 2014 and introduced a completely new notional dwelling as detailed below:-

**Table 4 Summary of concurrent notional dwelling specification**

| Element or System                                               | Values                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Opening areas (windows and doors)                               | Same as actual dwelling up to a maximum proportion of 25% of total floor area [1]                                                                                                                                                                                                                 |
| External Walls (including opaque elements of curtain walls) [6] | 0.18 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                           |
| Party Walls                                                     | 0.0 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                            |
| Floor                                                           | 0.13 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                           |
| Roof                                                            | 0.13 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                           |
| Windows, roof windows, glazed rooflights and glazed doors       | 1.4 W/m <sup>2</sup> K [2]<br>(Whole window U-value)<br>g-value = 0.63 [3]                                                                                                                                                                                                                        |
| Opaque doors                                                    | 1.0 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                            |
| Semi glazed doors                                               | 1.2 W/m <sup>2</sup> K                                                                                                                                                                                                                                                                            |
| Air tightness                                                   | 5.0 m <sup>3</sup> /hr/m <sup>2</sup>                                                                                                                                                                                                                                                             |
| Linear thermal transmittance                                    | Standardised psi values – See SAP Appendix R, except use of $y=0.05$ W/m <sup>2</sup> K if the default value of $y=0.15$ W/m <sup>2</sup> K is used in the actual dwelling                                                                                                                        |
| Ventilation type                                                | Natural (with extract fans) [4]                                                                                                                                                                                                                                                                   |
| Air conditioning                                                | None                                                                                                                                                                                                                                                                                              |
| Element or System                                               | Values                                                                                                                                                                                                                                                                                            |
| Heating System                                                  | Mains gas<br>If combi boiler in actual dwelling, combi boiler;<br>otherwise regular boiler<br>Radiators<br>Room sealed<br>Fan flue<br>SEDBUK 2009 89.5% efficient                                                                                                                                 |
| Controls                                                        | Time and temperature zone control [5]<br>Weather compensation<br>Modulating boiler with interlock                                                                                                                                                                                                 |
| Hot water storage system                                        | Heated by boiler (regular or combi as above)<br>If cylinder specified in actual dwelling, volume of cylinder in actual dwelling.<br>If combi boiler, no cylinder. Otherwise 150 litres.<br>Located in heated space.<br>Thermostat controlled<br>Separate time control for space and water heating |
| Primary Pipework                                                | Fully Insulated                                                                                                                                                                                                                                                                                   |
| Hot water cylinder loss factor (if specified)                   | Declared loss factor equal or better than $0.85 \times (0.2 + 0.051 V^{2/3})$ kWh/day                                                                                                                                                                                                             |
| Secondary Space Heating                                         | None                                                                                                                                                                                                                                                                                              |
| Low Energy Lighting                                             | 100% Low Energy Lighting                                                                                                                                                                                                                                                                          |
| Thermal Mass Parameter                                          | Medium (TMP=250)                                                                                                                                                                                                                                                                                  |

SAP first creates the notional reference building, based upon the same shape and form as the proposed dwelling and applies the above the characteristics as defined in SAP2012.

Once all of the baseline emission rates have been calculated in line with the above Government approved methodologies, they are considered as stage 'zero' of the energy hierarchy as described earlier and Target Emission Rate sets the benchmark for the worst performing, but legally permissible, development.

For the project at the Cox & Wyman site a sample of 10 dwelling types has been selected to offer a representative collection to enable an accurate figure for emissions per sqm of development which can then be applied to the full gross internal residential floor area.

Table 1 below, details the baseline regulated emission rates (as calculated above) for the sample house types which can then be used for the full 96 dwelling development and thereby calculate the total baseline emission rates before then applying the energy hierarchy.

Table 1 – Baseline energy consumption and CO2 emissions

| Unit           | Baseline Emission Rate<br>(regulated energy use)<br>Kg/sqm | Total baseline emissions<br>Kg |
|----------------|------------------------------------------------------------|--------------------------------|
|                |                                                            |                                |
| House Type D01 | 15.31                                                      | 1649.35                        |
| House Type D02 | 13.27                                                      | 1464.61                        |
| House Type E01 | 15.5                                                       | 1622.08                        |
| House Type E02 | 13.63                                                      | 1557.23                        |
| House Type E03 | 15.89                                                      | 1582.96                        |
| House Type E04 | 14.57                                                      | 1451.46                        |
| B-G-03         | 17.88                                                      | 1246.41                        |
| B-1-03         | 16.12                                                      | 1123.73                        |
| B-2-03         | 16.12                                                      | 1123.73                        |
| B-3-03         | 19.67                                                      | 1082.24                        |
|                |                                                            |                                |
| Total          |                                                            | 13,3476                        |

The baseline SAP TER outputs as generated by the appropriate approved software are attached at **Appendix A** for reference, confirming the above tabulated figures.

## 4.0 Design for Energy Efficiency

The Revised Sustainable Design and Construction SPD notes that; it is vital that the effects of climate change are considered over the lifetime of a development, especially with regard to its location and design. If they are not, then the long term sustainability of the development could be compromised.

Long term development sustainability is delivered via the fabric first approach. The fabric energy efficiency of a home is determined by the annual space heating and cooling demand in KWh per m<sup>2</sup>, assessed using SAP.

This section sets out the measures included within the design of the dwellings, to reduce the demand for energy, both gas and electricity (not including energy from renewable sources). The table at the end of this section details the amount of energy used and CO<sub>2</sub> produced by the proposed dwelling after the energy efficiency measures have been included.

To achieve reductions in energy demand the following measures have been included within the design and specification of the dwellings:

### 4.1 Orientation & Passive Design

To consider the issues of orientation and passive design for the proposed development, the design team have followed the methodology of the Cooling Hierarchy:-

- **minimise internal heat generation through energy efficient design**

The project will be designed to best practice thermal insulation levels as noted, full details of which are noted under 4.3 below.

Not only does good insulation assist in reducing heat losses in the winter, it has a significant impact on preventing heat travelling through the build fabric during the summer.

- **reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and wall**

This large development clearly has a requirement to be designed with dwellings of various designs and orientations.

In general, the dwellings have a design that incorporates large areas of glazing to the living areas to ensure good levels of natural daylight and sunlight. This in turn offers improved levels of solar gain, thereby reducing heating loads during winter periods.

The overheating risk has been considered as part of the scheme design and bedroom, kitchen and bathroom areas have reduced areas glazing to avoid any significant overheating risks as these areas do not require to be maintained to the same temperature as the principal living areas.

All glazing will be specified with a g-value of 0.45 or better in order to further ensure there is no overheating risk during the peak summer months.

Key to the landscaping proposals is the use of deciduous trees; the Revised Sustainable Design and Construction SPD notes that trees can provide a significant contribution to helping adapt to and minimise the impacts of climate change, through helping to reduce flood risk, improving air quality through absorption of vehicle emissions and providing wildlife corridors. They can help to dissipate the impact of heavy rainfall, reducing urban temperatures, and provide shade and protection against the detrimental effects of sunlight.

Deciduous large canopy trees are a particularly useful tool in passive design methodology, offering shade during the summer, but allowing low level winter sun to penetrate the canopy introducing radiant heat gain into dwelling and thereby reducing heat loads

- **manage the heat within the building through exposed internal thermal mass and high ceilings**

All apartments have been designed with floor to ceiling heights at 2.5m.

- **passive ventilation**

All glazing is designed to have large opening areas to introduce high levels of natural ventilation to further assist in the reduction of overheating risks.

The levels of natural ventilation are enhanced by the ability to cross ventilate, as well as the site layout allowing adequate air flow between dwellings – further improving the levels wind driven ventilation.

With the above strategy in place, there is no expectation of the need, nor the design intention, to introduce mechanical cooling.

## **4.2 Heating system**

For the energy efficient model, the primary heating system for the dwellings will consist of a high efficiency condensing combination gas boilers providing instant hot water to kitchen/utility taps, while the 2 and 3 bed units will incorporate a highly insulated unvented DHW cylinder on a heating circuit to provide domestic hot water to the high consumption areas; bathrooms and en-suites.

A typical installation would be:-

- Vaillant Home gas combination boiler – (89.3% SEDBUK efficiency)
- Incorporating flue gas heat recovery

To increase the efficiency in the use of the heating system, the following controls will be used in a 'boiler interlock' system to eliminate needless firing of the boiler.

- Time and temperature zone control
- Boiler fitted with a delayed start thermostat

### 4.3 Fabric heat loss

#### *Fabric*

Insulation measures will be utilised to ensure the calculated u values exceed the Building Regulations minima, with specific guidance taken from the design team: -

New wall constructions are yet to be specified, but the design team is targeting achieving a u-value of 0.18 via a highly insulated brick and block construction with a full-fill PIR board such as the Kingspan K106 product.

The roof structures and terraces will meet a u-value of 0.12; again using phenolic foam insulation, while insulated ceilings meeting a u-value of 0.10 – insulated with 400mm of rockwool.

Ground and exposed floors will target a u value at 0.14 or better, with a minimum of 100mm of insulation in the floor structure.

#### *Glazing*

New glazing for windows will be double glazed with the glazing units achieving an area weighted average u-value of 1.2w/m<sup>2</sup> K or better.

#### *Air Tightness*

The project will be tested for air tightness with a target value of 3.5m<sup>3</sup>/hr/m<sup>2</sup> for the new build residential units in line with the use of a mechanical ventilation strategy (as noted below).

#### *Construction Details*

Heat loss via non-repeating thermal bridging will be minimised by the use of Accredited Construction Details for these new build units to ensure compliance with the minimum standards for dwelling fabric energy efficiency under SAP2012.

### 4.4 Ventilation

There are specific external influences on the ventilation strategy, notably local air quality and noise issues (see reports under separate cover).

Accordingly, the HVAC solution will include the use of a mechanical ventilation system with heat recovery, selected for the low fan powers, which when combined with the low air tightness rating; will much improvement the energy efficiency of the dwellings.

These mechanical ventilation systems will also incorporate a summer by-pass and boost mode to ensure free cooling is maximised outside of the heating season.

### 4.5 Lighting

A 100% of internal light fittings throughout the development will be dedicated low-energy/compact fluorescent fittings, with extensive use of LED lighting.

PIR/presence controls will be used in the common areas and stairwells in the apartment blocks to ensure lights do not operate when not required.

To further reduce energy consumption, the developers will adopt Code for Sustainable Homes principles; providing A+ rated white goods, ensuring all external lighting systems are fitted with high efficacy luminaries with appropriate daylight controls and providing smart metering to all dwellings to enable occupants to accurately measure and manage their energy consumption.

#### 4.6 Fabric Energy Efficiency Results

The following table shows a comparison between the baseline scheme assessed under the SAP methodology Part L1A minima and the scheme following the introduction of energy efficiency measures

Table 2 – Energy consumption and CO2 reductions

| Unit           | Building Emission Rate<br>(regulated energy use)<br>Kg/sqm | Total emissions<br>Kg |
|----------------|------------------------------------------------------------|-----------------------|
|                |                                                            |                       |
| House Type D01 | 14.94                                                      | 1609.49               |
| House Type D02 | 12.64                                                      | 1395.08               |
| House Type E01 | 15.42                                                      | 1613.70               |
| House Type E02 | 13.33                                                      | 1522.95               |
| House Type E03 | 15.79                                                      | 1573.00               |
| House Type E04 | 14.6                                                       | 1454.45               |
| B-G-03         | 17.15                                                      | 1195.53               |
| B-1-03         | 14.98                                                      | 1044.26               |
| B-2-03         | 14.98                                                      | 1044.26               |
| B-3-03         | 19.15                                                      | 1053.63               |
|                |                                                            |                       |
| Total          |                                                            | <b>129,661</b>        |

The results show that, for the new development with the energy efficiency measures, the reduction in CO<sub>2</sub> emissions is **2.86%**.

The proposed development therefore, goes beyond the requirements of the now stringent 2013 Building Regulations AD Part L1A using passive energy efficiency measures.

The SAP Building Emission Rates outputs are attached at **Appendix B**.

## 5.0 Sourcing Clean Energy

The Revised Sustainable Design and Construction SPD requires the consideration of a decentralised energy supply – an energy supply from local low-carbon sources (i.e. on-site and near-site) usually on a relatively small scale – and CHP (Combined Heat and Power) - the simultaneous generation of usable heat and power (usually electricity) in a single process, thereby reducing wasted heat and putting to use heat that would normally be wasted.

Accordingly, this report considers the use of CHP and/or district heating systems.

### 5.1 District Heating(DH)/Combined Heat and Power (CHP)

A district heating network comprises a series of insulated pipes used to deliver heat, in the form of hot water or steam, to a number of different locations or dwellings. They range from small, providing heat to a house and a couple of holiday cottages for example, to large scale systems such as the EoN operated Citigen network in The City of London.

Most commonly powered by biomass in this country, DH networks currently provide less than two per cent of the UK's heat demand. The Department of Energy and Climate Change (DECC) is keen to increase this figure. It offers support to local authorities to develop heat networks and is exploring how such schemes could benefit more from renewable heat incentives in 2014.

So firstly, this report must consider a local DH network for the Cox & Wyman project.

The heat production facility for a DH scheme is generally considered to include heat only boilers (HOB) and/or the production of both electricity and heat i.e. CHP.

CHP systems are essentially biomass or fossil fuel fired electricity generators that use the heat by-product to provide space and water heating. The electricity generated can be used directly within the host buildings or sold to electricity suppliers on the national grid.

CHP is, as a rule of thumb, is only operated as a base load as, depending on the technology, it may be difficult and/or inefficient to operate according to daily variations in demand. In a well-designed district heating network heat from CHP will provide between 60% and 80% of the annual baseline heat (heating and hot water) requirement with heat-only boiler plants providing the peak load and back-up. To maximise efficiency of the engine it needs to run for at least 17 hours a day; therefore, the heat load needs to be present for this period.

In more recent time, the difference between the actual and assumed efficiency of DH networks has come under the spotlight from a number of different sources.

Indeed, in a recent studies collated by Innovate UK in the Building Data Exchange, inappropriately installed community heating systems were suffering heat losses of 50% or more.

However, when it comes to small scale networks at least, it is becoming very apparent that there is a difference between theoretical and real-world system efficiencies.

In the CBSE Technical symposium "CHP and District Heating - how efficient are these technologies?" (2011), further commentary is made on this issue.

This paper defines an ‘equivalent heat efficiency’ parameter and a CO<sub>2</sub> content of heat supply to enable Combined Heat and Power (CHP) to be compared to boilers and heat pumps

The comparison also considers CHP supplying District Heating (DH) and the impact of heat mains losses and the use of peak boilers. These theoretical calculations have been backed up by actual experience and data is provided based on monitoring results from CHP/DH schemes operated by Cofely GdF Suez and from statistics published by the Danish District Heating Association.

This report identifies and acknowledge that the heat losses within a well-designed DH network will be at minimum of 15%, so immediately it can be seen that, a large scale modular boiler system offering gross efficiencies at circa 96%, will be less efficient than a local condensing boiler with a gross efficiency of 92%-93% at point of delivery.

It should be noted, that the efficiency of the latest condensing boilers with built-in flue-gas heat recovery systems and modern controls, such as the Vaillant Home boilers noted under 4.2 above, can achieve gross efficiencies close to 96%. A further significant benefit of the use of local gas boilers, is the lower NO<sub>x</sub> emission associated, commonly less than 40mg/KWh of heat delivered.

Clearly, a DH network driven by HOB would not be viable, and a CHP led system has to be considered.

When considering a CHP led District Heating (DH) there are other factors that need to be considered: the pumping energy required and the use of boilers to meet peak demands.

The peak demands in a predominantly residential development scheme are considerable albeit relatively predictable – the usual assumptions being DHW demands at early morning and early evening, and a 5-6 month heating season, with a similar demand pattern.

The use of large scale thermal store and local calorifiers to provide the “heat dump” during low demand periods has the effect of:-

- a/ Increasing heat losses within the overall DH network and delivery mechanisms.
- b/ Increasing the hot water return temperatures to the boilers during the majority of the 24hour period, reducing condensing efficiency and overall gross efficiency.

We must also consider the net carbon benefits from such a system as the de-carbonisation of national grid dilutes the benefits obtained from the higher efficiency of larger-scale CHP led system.

Reference is made to the latest CIBSE Symposium on the topic; “An operational lifetime assessment of the carbon performance of gas fired CHP led district heating” (2016).

This paper sets out a calculation methodology to determine the greenhouse gas emissions associated with district heat networks which use gas fired CHP as a heat source.

Currently, Part L calculations and CHP emissions savings are based on the grid based emission rate taken from the SAP 2012 3-year average - 519g/KwhCO<sub>2</sub>; SAP 2012 introduced a 15-year average at 381g/KwhCO<sub>2</sub> to assist designers considering the longer term impacts.

Such a difference will markedly affect the relative calculated performance of a gas CHP engine versus a gas boiler, particularly if any DH network losses are removed from the equation through the use of localised boilers.

The CIBSE paper further advises that “Using a typical good practice assumption of 40% thermal efficiency of the CHP, the threshold for net benefit is a grid carbon factor of around 338 gCO<sub>2</sub>/kWh. Below that threshold, CHP is found to be worse than a gas boiler and grid electricity.”

DECC provides data for treating energy and emissions in their guidance; this provides projections of grid emissions factors over the next 85 years. With the rapid and recent introduction of renewable technologies to the grid – wind power and PV - DECC’s “Green Book” guidance projects that grid carbon intensity will reach 338 gCO<sub>2</sub>/kWh by 2017/18 and will reach 300 gCO<sub>2</sub>/kWh by 2018/19.

So it can be surmised, that by the time any CHP led DH network at the Cox & Wyman project has reached maturity in the latter part of this decade, the carbon benefits will already have been lost

Mention has been made above, of the Danish District Heating Association. According to some research, the “Danish Model” for district heating with combined heat and power (CHPDH) is the cheapest method of cutting carbon emissions, and has one of the lowest carbon footprints of all fossil generation plants.

CHPDH is being developed in Denmark as a store for renewable energy, particularly wind energy, that exceeds instantaneous grid demand via the use of heat pumps and thermal stores.

Only with this large scale development, combining other low and zero carbon technologies to offer a holistic approach, can the long term use of CHP led DH networks be seen as a long term solution.

Accordingly, without the required economy of scale to enable such a development, the use of local gas boilers with flue gas heat recovery systems offer a more efficient and lower emission solution, so it is proposed that the use of a community based DH heating system will not be included within the HVAC strategy for the proposed development.

## 6.0 Renewable and Energy Generating Technologies

Renewable energy can be defined as energy taken from naturally occurring or renewable sources, such as sunlight, wind, waves/tides, geothermal etc. Harnessing these energy sources can involve a direct use of natural energy, such as solar water heating panels, or it can be a more indirect process, such as the use of Biofuels produced from plants, which have harnessed and embodied the sun's energy through photosynthesis.

Reading Core Strategy policies stipulate a requirement for developments to reduce CO<sub>2</sub> emissions over Part L 2013 through energy efficiency and the use of renewable technologies.

The Fabric Energy Efficiency measures outlined under 4 above have the most significant impact on the heating and hot water energy requirements for the dwellings, and the associated reduction in gas consumption.

It should be noted that each Kwh of gas energy saved reduces emissions by 0.216kgCO<sub>2</sub>/kwh, whereas, grid based electrical energy has a emissions factor of 0.519kgCO<sub>2</sub>/kwh and accordingly, emphasis will be placed upon “off-setting” grid based electricity in order to achieve the optimum use of renewable technologies.

This section then sets out the feasibility of implementing different energy technologies in consideration of: -

- Potential for Carbon savings
- Capital costs
- Running costs
- Payback period as a result of energy saved/Government incentives
- Maturity/availability of technology
- Reliability of the technology and need for back up or alternative systems.

## 6.1 Government incentives

### 6.1.1 Feed in Tariff

Feed in Tariffs (FiTs) replaced ROCs for renewable energy generators rated at less than 5MW in April 2010. FiTs are payments made for every kilowatt-hour kWh of renewable electricity generated and the level of the payment is laid down by the government, and varies for different renewable energy sources and at different scales. Unlike the flat rates paid for ROCs, FiTs are designed to compensate for less efficient/more expensive sources of renewable energy – and for the first time – make the investment in low and zero carbon technologies viable for both domestic generators and larger companies alike.

Recent reviews of Feed in Tariff rates will lead to lower returns on such technologies in 2016 and beyond, but the expectation is that system capital costs and enhanced efficiencies will compensate for this over the medium term.

### **6.1.2 Renewable Heat Incentive**

The Renewable Heat Incentive (RHI) was formally launched by the UK Government on 10th March 2011. The RHI will pay a tariff payment to renewable technologies that provide heat energy from a renewable source such as biomass boilers, air source heat pumps, with the payment relating to the KWh of heat energy provided e.g. if a property has a heat load of 20,000 KWh per annum, and it is 100% provided from a renewable source, then the tariff is paid against the 20,000KWh.

The Government decided on a two stage delivery - the first stage being for non-domestic schemes, which commenced in July 2011, with domestic scheme having come on stream in April 2014.

### **6.2 Wind turbines**

Wind turbines come in two main types' - horizontal axis and vertical axis. The more traditional horizontally axis systems rotate around the central pivot to face into the wind, whilst vertical axis systems work with wind from all directions.

The potential application of wind energy technologies at a particular site is dependent upon a variety of factors. But mainly these are: -

- Wind speed
- Wind turbulence
- Visual impact
- Noise impact
- Impact upon ecology

The availability and consistency of wind in urban environments is largely dependent upon the proximity, scale and orientation of surrounding obstructions. The site has other properties in the locale, 2 to 3 storeys in height in all directions, as well as being surrounded by significant amounts of mature trees.

To overcome these obstructions and to receive practical amounts of non-turbulent wind, the blades of any wind turbines would need to be placed significantly above the roof level of the surrounding buildings and the new development itself.

It is clear that wind turbines of this size would be considered unacceptable in this town centre location and is therefore dismissed as an option.

### **6.3 Solar Energy**

#### **6.3.1 Solar water heating**

Solar water heating panels come in two main types; flat plate collectors and evacuated tubes. Flat plate collectors feed water, or other types of fluid used specifically to carry heat, through a roof mounted collector and into a hot water storage tank. Evacuated tube collectors are slightly more advanced as they employ sealed vacuum tubes, which capture and harness the heat more effectively.

The proposed new dwellings all have access to areas of roof space appropriate for the installation of solar panels.

The solar thermal panels would be off-setting the use of mains gas, and the low associated carbon emissions.

However, given the limited roof space available and the strategy to off-set the electrical use, solar PV may be a stronger candidate (see below) and offer a greater return in terms of carbon savings.

### **6.3.2 Photovoltaics (PV)**

Solar panel electricity systems, also known as solar photovoltaics (PV), capture the sun's energy using photovoltaic cells. These cells will be accumulated on a PV panel, usually about 2.0m x 1.0m. These panels are then wall, roof or floor mounted and are connected directly to the electricity grid via the host properties meter. In this way, the electrical generation can be fully exported and is not related to the consumption of the houses and apartments, although the host property does get the benefit from generation, when generation and domestic consumption coincide.

PV panels also offer a much more attractive return from the Feed in Tariff often achieving 7-8% returns or better.

As noted above, the roof spaces would be appropriate for solar PV panels.

The roofs of the apartment block would be suitable for the installation of 171 x 330w PV panels, totalling 56.43kwp assigned evenly across the entire site of 96 dwellings

### **6.4 Biomass heating**

Biomass is a term given to fuel derived directly from biological sources for example rapeseed oil, wood chip/pellets or gas from anaerobic digestion. It can only be considered as a renewable energy source if the carbon dioxide emitted from burning the fuel is later recaptured in reproducing the fuel source (i.e. trees that are grown to become wood fuel, capture carbon as they grow).

Biomass heating systems require space to site a boiler and fuel hopper along with a supply of fuel. There also needs to be a local source of biomass fuel that can be delivered on a regular basis.

A boiler of this type would replace the need for a conventional gas boiler and therefore offset all the gas energy typically used for space and water heating, however, biomass releases high levels of NO<sub>x</sub> emissions and would therefore have to be considered carefully against the high standard of air quality requirements in this relatively dense suburban development proposal.

Given the practical limitations as outlined above, the use of biomass fuel for the development is not considered appropriate.

### **6.5 Ground source heat pump (GSHP)**

All heat pump technologies utilise electricity as the primary fuel source – in this case displacing gas, as such, the overall reduction in emissions when using this technology can be less effective when opposed to a technology that is actually displacing electricity.

Ground source heating or cooling requires a source of consistent ground temperature, which could be a vertical borehole or a spread of pipework loops and a 'heat pump'. The system uses a loop of fluid to collect the more constant temperature in the ground and transport it to a heat pump. In a cooling system this principle works in reverse and the heat is distributed into the ground.

The heat pump then generates increased temperatures by ‘condensing’ the heat taken from the ground, producing hot water temperatures in the region of 45°C. This water can then be used as pre-heated water for a conventional boiler or to provide space heating with an under floor heating system.

The use of a ground source heating/cooling system will therefore require:

- Vertical borehole or ground loop
- Use of under floor heating
- Space for heat pump unit

As a rule of thumb, the collector loop area for a GSHP equates to 2.5 x the internal floor area of the host dwelling. The development proposal does have significant areas of open space, much of which is shared/common/open space that would not be available for the installation of GSHP collector loops.

With this limitation, it is not considered possible to consider a ground source heat pump.

## 6.6 Air source heat pump (ASHP)

Air source heating or cooling also employs the principle of a heat pump. This time either, upgrading the ambient external air temperature to provide higher temperatures for water and space heating, or taking warmth from within the building and dissipating it to the outdoor air.

It must be remembered that heat pumps utilise grid based electricity and the associated emissions, so that actual the reduction in emissions can be limited. Assuming a seasonal system efficiency of 320% (Coefficient of Performance of 3.2) and that the air source heat pump will replace 100% of the space heating/hot water demand, then the system would reduce the overall CO<sub>2</sub> emissions by approximately 17%. Table 3, below demonstrates, on the assumption of a demand of 1000Kwh/year for heating and hot water.

Table 3 – Air Source Heat Pumps – emission calculations

| Type of Array                      | Energy Consumption (Kwh/yr.) | Emission factor (kgCO <sub>2</sub> /Kwh) | Total CO <sub>2</sub> emissions (kg/annum) |
|------------------------------------|------------------------------|------------------------------------------|--------------------------------------------|
| 90% efficient gas boiler           | 11111                        | 0.216                                    | 2400                                       |
| 320% efficient ASHP                | 2813                         | 0.519                                    | 1460                                       |
| 100% efficient immersion (back-up) | 1000                         | 0.519                                    | 519                                        |

A theoretical carbon saving of 17.5%

With the above data in mind, clearly an ASHP could be an option, however, it must be born in mind that air source heat pumps can often require immersion back up for peak load times (very cold weather) and for hot water production – this can often affect overall efficiency quite dramatically.

The heat pump would also require external installation – which would in turn create a visual impact as well as a potential noise nuisance to neighbours in the location.

Given such impacts, it is considered that air source heat pumps would not be appropriate at this location, and those alternative technologies, as identified above, would be more appropriate.

## 6.7 Final Emissions Calculation

The results of the assessment of suitable technologies relative to the nature, locations and type of development suggest that the only potential solution would be the installation of the afore mentioned Photovoltaic (PV) arrays to the available and suitable roof areas to each dwelling and apartments blocks.

Potentially, this could equate to a total of 56.43Kwp across the whole development proposal, which would generate some 48,916Kwh per annum off-setting approximately 25.39 tonnes of carbon per annum.

Accordingly, the PV array has been incorporated into the design and the final SAP DER outputs are attached at **Appendix C:-**

Table 4 – Final energy consumption and CO2 reductions

| Unit           | Building Emission Rate<br>(regulated energy use)<br>Kg/sqm | Total baseline emissions<br>Kg |
|----------------|------------------------------------------------------------|--------------------------------|
|                |                                                            |                                |
| House Type D01 | 12.48                                                      | 1344.47                        |
| House Type D02 | 10.24                                                      | 1130.19                        |
| House Type E01 | 12.89                                                      | 1348.94                        |
| House Type E02 | 11.01                                                      | 1257.89                        |
| House Type E03 | 13.13                                                      | 1308.01                        |
| House Type E04 | 11.94                                                      | 1189.46                        |
| B-G-03         | 13.35                                                      | 930.63                         |
| B-1-03         | 11.18                                                      | 779.36                         |
| B-2-03         | 11.18                                                      | 779.36                         |
| B-3-03         | 14.34                                                      | 788.99                         |
|                |                                                            |                                |
| <b>Total</b>   |                                                            | <b>104,230</b>                 |

The data at Table 4 confirms that overall emissions have been reduced by **21.91%** over and above the baseline model and an **19.61%** reduction in emissions has been achieved directly from the use of energy generating and renewable technologies, i.e. over and above the energy efficient model.

## 7.0 Sustainable Design & Construction

### *The Code for Sustainable Homes (the Code)*

The Code was the national standard for the sustainable design and construction of new homes.

This has now been formally withdrawn by DCLG, and planning authorities are no longer able to require developments to meet the technical guidance within the Code for Sustainable Homes

However, the applicants do acknowledge the requirements of Reading Core Strategy Policy CS1, and further details provided within the Revised Sustainable Design & Construction, specifically within Appendix 5, and will actively introduce the following elements to the development:-

#### Materials

- Construction techniques will be considered against the BRE Green Guide to ensure that, where practical, the most environmentally friendly construction techniques are deployed.
- Construction materials will be sourced from suppliers capable of demonstrating a culture of responsible sourcing via environmental management certification, such as BES6001
- Insulation materials will be selected that demonstrate the use of blowing agents with a low global warming potential, specifically, a rating of 5 or less. Additionally, all insulants used will demonstrate responsible sourcing of material and key processes.
- The principle contractor will be required to produce a site waste management plan and sustainable procure plan, in line with BREEAM requirements – this will include a pre-demolition audit to identify demolition materials to reuse on-site or salvage appropriate materials to enable their reuse or recycling off-site. The procurement plan will follow the waste hierarchy Reduce; Reuse & Recycle.
- A Site Waste Management Plan (SWMP) will be developed prior to commencement of development stage to inform the adoption of good practice waste minimisation in design. This will set targets to minimise the generation of non-hazardous construction waste using the sustainable procurement plan to avoid over-ordering and to use just-in-time delivery policies.
- The developer will also maximise the use of recycled and secondary aggregates.
- Waste and recycling – appropriate internal and external storage space will be provided to ensure that residents can sort, store and dispose of waste and recyclable materials in line with Reading's collection policies.

#### Pollution

- The contractor will also monitor the use of energy and water use during the construction phase and incorporate best site practices to reduce the potential for air (dust) and ground water pollution.
- The completed dwellings will use low NOx emission gas boilers, with a minimum NOx rating of 5 and emissions at less than 40mg/Kwh
- The main contractor will be required to register the site with the Considerate Constructors Scheme and achieve a best practice score of 25 or more.

- To void the issue of noise pollution, the development will comply with Building Regulations Part E, providing a good level of sound insulation between the proposed development and surrounding buildings. All new windows will be triple glazed to minimise the transmission of noise between the building and adjacent properties.

## Energy

- All new dwelling will incorporate renewables technologies as noted in the main report above.
- Each home will also be supplied with a Home User Guide offering practical advice on how to use the home economically and efficiently.
- This will be further enhanced by the installation of smart energy metering, enabling occupants to accurately assess their energy usage and thereby, manage it.
- Xx Cycle storage spaces are to be provided to reduce reliance of journeys via private cars, forming part of an overriding sustainable transport plan (see report under separate cover)

## Water

- The development minimise water use as far as practicable by incorporating appropriate water efficiency and water recycling measures. In new homes, the applicants will ensure that all dwellings meet the required level of 105 litres maximum daily allowable usage per person in accordance with Level 4 of the Code for Sustainable Homes. A sample Part G internal water use calculation is attached at **Appendix D**
- Individual dwelling will have rainwater harvesting – water butts connected to rainwater pipes to enable the recycling of rainwater for the upkeep of gardens.
- SuDs – a flood risk assessment will be produced to consider and ensure that the proposed development is resilient to risk of flooding from ALL sources, and to ensure that surface water run-off is no greater than was associated with the site pre-development - using SuDs techniques; permeable surfaces, infiltration and attenuation. (See report under separate cover)

## 9.0 Summary & Conclusions

This report has detailed the baseline energy requirements for the proposed residential development, the reduction in energy demand as a result of energy efficiency measures and the potential to achieve further CO<sub>2</sub> reductions using renewable energy technologies.

The baseline results have shown that if the development was built to a standard to meet only the minimum requirements of current building regulations, the total amount of CO<sub>2</sub> emissions for the sampled units would be **133,476Kg/year**.

Following the introduction of the fabric energy efficiency measures into the development, as detailed in section 4, the total amount of CO<sub>2</sub> emissions for the residential development would be reduced to **129,661Kg/year**, a reduction of **2.86%**.

There is also a requirement to reduce CO<sub>2</sub> emissions across the development using Carbon Compliance, where practical and feasible. Therefore, the report has considered the feasibility of the following technologies:

- Wind turbines
- Solar hot water
- Photovoltaic (PV) systems
- Biomass heating
- CHP (Combined heat and power)
- Ground & Air source heating

The results of the assessment of suitable technologies relative to the nature, locations and type of development suggest that the preferred solution to be the installation of a 0.59KwP panel Photovoltaic (PV) array to each dwelling, each producing some **0.51Kwh/annum**.

The SAP models (reproduced at **Appendix C**) for the development which have also been detailed above in Table 4, show a final gross emission level for the development of **104,230Kg/year** representing a total **21.91%** reduction in emissions over the baseline model.

**The applicant is satisfied that all reasonable endeavours have been undertaken in terms of passive design, efficient build fabric, HVAC solutions and the introduction of renewable technologies to maximise the emission reductions for the proposed development at the Cox & Wyman development.**



# Appendix A

**Baseline Energy Use:-**

**SAP 2012 – Dwelling TER outputs**

# Appendix B

**SAP 2012 Dwelling Emission Rate Outputs**

**“Design for Energy Efficiency”**

# Appendix C

**SAP 2012 Dwelling Emission Rate Outputs**

**“Renewable and Energy Generating Technologies”**

# Appendix D

## Part G – Internal Water Use Calculation