

6-8 MARKET PLACE READING

Energy Statement

June 2020

THE DESIGN COLLECTIVE

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1.0 Issue Register

Revision	Reason for Issue	Date of Issue	Issued By
1.0	For Information	12.06.2020	MJS

2.0 Executive Summary

The proposed refurbishment and extension works at 6-8 Market Place, Reading have been designed to achieve the highest of environmental performance standards following the guidance within Reading's Sustainable Design and Construction Supplementary Planning Document (December 2019) in order to meet the requirements of Reading's newly adopted Local Plan policies.

The proposals are for the refurbishment and extension of the existing building to create an office lead development, with design options including roof top and side extensions as well as a refurbished ground floor space creating a club/café area and receptions space.

A 'Lean, Clean, Green' approach to assessing energy and thermal comfort needs and appropriate solutions has been adopted following the guidance with the energy hierarchy and the development achieves an overall improvement (BER/TER) in regulated emissions of **>60.94%** when taking into account unregulated energy use, through the adoption of high standards of insulation, efficient heat pump driven heating, cooling and hot water systems, mixed mode ventilation and roof a mounted PV array.

The reduction in regulated emissions achieved through the use of renewable and energy generating technologies is over **35.36%**.

It is notable that the MEP strategy involves the use of 100% electrically driven systems which will generate zero local emissions; and if the project was assessed against the new emissions standards for SAP 10, the reduction in regulated emissions would ammiunt to over **73%** from the Part L compliant baseline.

3.0 The Site & Proposal

The project is based on an existing office development site in central Reading overlooking Market Place square. The site is occupied by a single building of multiple heights, straddling a storey height level change between Market Place and Abbey Square.

The building was originally contrasted in the 1960's to 1970's over ground plus 3-storeys, with a setback floor and roof terrace.

The proposals are for the refurbishment and extension of the existing building to create an office lead development, with roof top and side extensions as well as a refurbished ground floor space creating a club/café area and receptions space.

3.1 Planning Policy

The project is within the Reading Borough Council; Reading's new local plan was adopted in November 2019 and key policies relevant to this Energy Statement are: -

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 involving 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 to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and.....
- All development shall minimise the impact of surface water runoff from the development in the design of the 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 1,000 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 1,000 sq. m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

Reading also adopted their Sustainable Design and Construction Supplementary Planning Document in December 2019. This document confirms the requirement for Sustainability Statements and Energy Statements for Major Schemes.

Energy Statements demonstrate how the energy related aspects of the proposed development actually meets the requirements of local planning policy and BREEAM energy and emissions standards. An energy statement would typically include the following information:

- Energy efficiency of the building.
- Baseline annual predicted energy demand of the development (regulated and unregulated).
- Baseline annual predicted carbon emissions of the development (regulated and unregulated), the Target Emission Rate (TER).
- The contribution of each proposed renewable energy technology.
- Cost information of technically feasible low or zero carbon renewable technologies, including additional insulation, low carbon decentralised energy, heat pumps etc.
- Feasibility of district or community heating.
- Summary of the benefits of various energy technologies.
- The total estimated reduction in the development's baseline carbon and/or energy emissions.

The SPD also summarises the planning submission requirements for

- A pre-assessment estimator incorporating a 5% buffer and provision of other appropriate information to provide confidence to the LPA that policy requirements can be achieved.
- Sustainability Statement for all major development.
- Energy Statement for all major development.

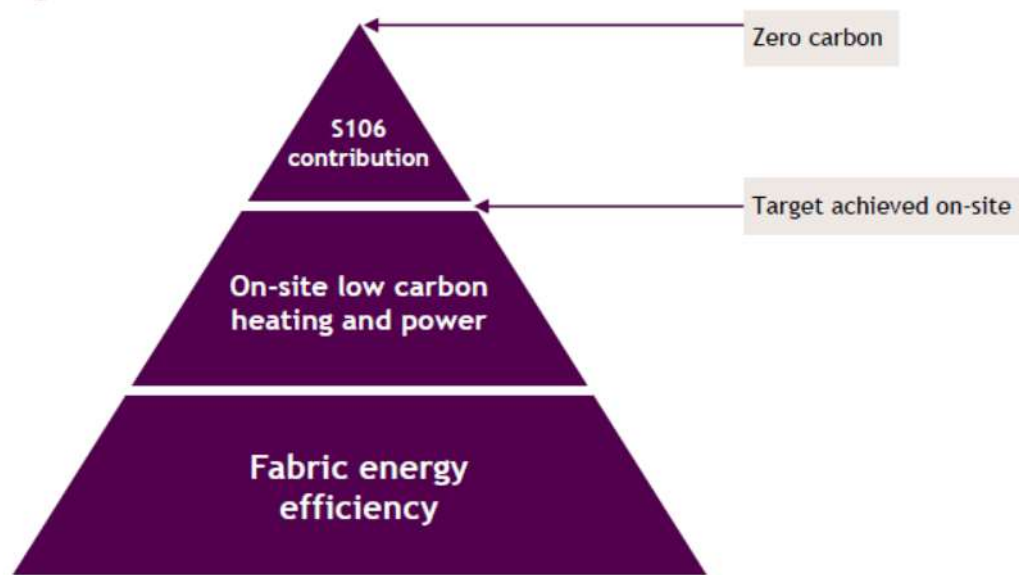
3.2 The Energy Hierarchy

As noted above, this report will consider the project against the principles of the energy hierarchy commonly in use across London Boroughs; this means reducing carbon dioxide emissions from construction and operation, and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

- 1) **Be lean:** use less energy and manage demand during construction and operation.
- 2) **Be clean:** exploit local energy resources (such as secondary heat or district energy networks) and supply energy efficiently and cleanly.
- 3) **Be green:** generate, store, and use renewable energy on-site.

See Figure 4.1 taken from Reading's Sustainable Design and Construction Supplementary Planning Document: -

Figure 4.1



4.0 Baseline Energy Results

The first stage of the Energy Hierarchy is to consider the baseline energy model. The following section details the baseline energy requirements for the development – the starting point when considering the energy hierarchy.

4.1 New Build Commercial Space

The refurbishment and extension of 6-8 Market Place involves the addition of new floor space to the rear and street front commercial blocks and roof top extensions.

The energy requirements for space heating, water heating and ventilation within the new build retail space have been calculated using the National Calculation Method (NCM) in line with AD L2A of the Building Regulations 2013 and the Non-Domestic Heating Compliance Guide.

The Government approved assessment methodology is the Simplified Building Energy Model (SBEM), eb7 Sustainability Ltd use an advanced modelling software - Design Builder - which enables accurate SBEM models to be created, as well as heat loss and cooling load calculations and full M&E design to be undertaken.

To consider the subject building performance against The Building Regulations (Approved Document L2A) SBEM first creates the notional reference building, the characteristics of which are defined within NCM and the minimum fabric values and fixed services efficiencies set down by AD L2A and the Non-domestic Compliance Guide.

In order to establish the baseline, the HVAC solution has been assumed as a low temperature hot water serving fan coil units, via centralised gas fired boilers and natural

ventilation. Domestic Hot Water (DHW) will be supplied from the same boilers via appropriately sized calorifiers and a secondary circulation loop. This creates the Target Emission Rate (TER) and should be considered as stage 'zero' of the energy hierarchy as described earlier and sets the benchmark for the worst performing, but legally permissible, development against which, SBEM assesses the "actual" design, fabric values, heating lighting and ventilation systems and creates the Building Emissions Rate (BER).

4.2 Refurbishment of Commercial Space

The lower floors of the project at 6-8 Market Place are to be refurbished and re-configured. It should be noted that under Regulation 5 of the Building Regulations, there is no material change of use, so there are no obligations under Part L of the Building Regulations, other than those relating to the extension.

However, the extension works do give rise to the requirement for consequential improvements under Section 6 of the Building Regulations, and these will be delivered through the delivery of this report's findings.

As a refurbishment/extension project, the energy efficiency requirements and the assessment of the associated building emissions are assessed under the requirements of Building Regulations Approved Document L2B (Part L2B) and the requirements of the Non- Domestic Heating Compliance Guide as set out in Tables 1 & 2:-

Table 1 – Elemental Standards

Element	AD L2B U-Value Standard
Retained Walls (where upgraded)	0.30
New Walls	0.28
Retained/New Roof - pitched	0.16
Retained/New Roof - flat	0.18
floors	0.22
Windows	1.8
Doors	1.8
Air permeability	15m ³ /Hr/m ²

Table 2 – Controlled services and fittings

Controlled Service	AD L2B Compliance Requirement
Mains Gas Boilers	86% Efficient
DHW	Nominal loss at 2.6Kwh/day at 300l
Controls	Programmer, Stat, TRVs & Interlock
Lighting	60lux with local manual switching

The Government approved assessment methodology is the Simplified Building Energy Model (SBEM) is again used with the same assumptions as under 3.3.

To consider the subject building performance against Approved Document L2B) SBEM utilises the methodology as set out in the National calculation Method (NCM) and the minimum fabric values and fixed services efficiencies set down by AD L2B and the Non-domestic Compliance Guide to create our “baseline” Building Emissions Rate (BER).

Mechanical cooling as assumed for the baseline model in line with best practice for the preparation of energy statements.

4.3 Unregulated Energy Use

The unregulated energy use for the retail space can be derived from the BRUKL outputs under section “Energy Consumption by End Use” – “Equipment”.

The unregulated energy use per sqm is summarised in Table 3 below.

Table 3 – Unregulated Energy Use

Unit	Unregulated Energy Use
	Kg/sqm
Refurbished Commercial	19.02
New Commercial	20.26

The un-regulated emission rates are added to the baseline regulated emission rates (as calculated above) in order to set the total baseline emission rates before then applying the energy hierarchy in line with Reading Local Plans policies: -

Table 4 – Baseline energy consumption and CO2 emissions

Unit	Target Emission Rate (regulated energy use) Kg/sqm	Unregulated Energy Use Kg/sqm	Total baseline emissions Kg/sqm	Total baseline emissions Kg
Refurbished Commercial	35.80	19.02	54.82	362,842.62
New Commercial	19.10	20.26	39.36	127,912.13
Total				490,755

The baseline BRUKL TER & BER outputs (which summarise the key data) are attached at **Appendix A**.

5.0 Design for Energy Efficiency

The first step in the 'Energy Hierarchy' as laid out in Section 5 of The London Plan, 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.

This section sets out the measures included within the design of the development, 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 CO₂ produced by the building after the energy efficiency measures have been included. From these figures the overall reduction in CO₂ emissions, as a result of passive design measures, can be calculated. To achieve reductions in energy, demand the following measures have been included within the design and specification of the building:

5.1 Passive Design

The NPPF emphasises the need to take account of climate change over the longer term and plan new developments to avoid increased vulnerability to the range of impacts arising from climate change. The UK Climate Impacts Programme 2009 projections suggest that by the 2080's the UK is likely to experience summer temperatures that are up to 4.2°C higher than they are today."

Accordingly, designers are to ensure buildings are designed and constructed to be comfortable in higher temperatures, without resorting to energy intensive air conditioning.

Clearly, as a predominantly refurbishment project, the options to the design team for 6-8 Market Place are more limited than with a new build project, however the team have taken guidance from Reading's Sustainable Design and Construction Supplementary Planning Document: -

5.1.1 Solar Gain

Passive and active solar gain can make a significant contribution towards the lighting and heating of a building. Different approaches to maximising passive and active solar gain are needed depending on the size and use of buildings.

Given the limited aspect to the main southern elevation, solar gain has been maximised via the large areas of glazing to all aspects of the development to the main exposed east and west facades, which also enhances natural daylight where possible. (see below).

The fenestration generally has to respect the conservation area and as such, external shading and/or brise soleil are not considered appropriate. However, an element of shading from the peak summer sun is provided via bays featuring a red brick corbel and grey brick pier surrounding a full height window panel.

The specification of the glazing has also been considered to further reduce excessive solar gain, with a g-value at 0.4 or better.

5.1.2 Natural Day Lighting

Coupled with solar gain, natural day lighting can reduce the energy demand for new buildings through the controlled entry of natural light through windows, skylights, atria, sun pipes and other building envelope components. The day lighting benefits of large areas of glazing need to be considered against the thermal and other properties of glazing.

As a deep floor plate office scheme, the design team have sought every opportunity to maximise natural daylight to the internal spaces, indeed a specific façade study is included within the design information.

This enables perimeter lighting to be daylight controlled and thus make significant energy saving on lighting circuits.

In order to ensure reduced heat losses through this highly glazed façade, the specification of the glazing will meet a u-value of 1.4w/m²k

5.1.3 Ventilation

Maximising natural ventilation is appropriate in most circumstances and is usually a more sustainable option than air conditioning systems, albeit that a building should be able to be made airtight to reduce energy demand for heating or cooling in extreme weather.

Although maximising natural ventilation is appropriate in most cases, the ventilation of office space and the quality of the internal environment is essential to the comfort of the occupants and in-turn their productivity; levels of CO₂ above 1,000ppm can have a significant impact upon cognitive ability.

With existing floor plates at depths of 20m +, the use of a fully natural ventilation scheme cannot provide the level of natural ventilation as required within the guidance of CIBSE AM10.

Accordingly, the design team are proposing a mixed mode approach, with perimeter areas utilising natural ventilation via opening windows or louvers.

Inner areas of the building will be provided with mechanical supply and extract ventilation where natural ventilation is not possible.

5.1.4 Thermal Mass

The use of internally exposed thermally massive materials with a high specific heat capacity can have beneficial effects through their ability to absorb solar radiation received during the winter months and to store cool air absorbed during the night in the summer months. Generally, heavy materials such as stone and concrete have a high specific heat capacity.

The existing office structure has a heavyweight re-enforced concrete frame and floor and floor slabs, offering high levels of thermal mass able to assist in the control of internal temperatures.

This is enhanced with the use of exposed concrete soffits to the office areas, as well as exposed brickwork to the central cores.

New construction elements will be of a steel frame and poured concrete floors with a similar design specification including exposed soffits.

5.1.5 Insulation

To maximise energy efficiency the heat losses from the building envelope must be kept to a minimum with high levels of airtightness. Heat loss can be prevented by applying high levels of insulation to the roof, walls, and floors.

The project at Market Place, Reading will be highly insulated in line with the details outlined in section 4.4 (below); way beyond the minimum standards expected within the parameters set out in Part L of the Building Regulations.

Not only does good insulation reduce heat losses during the heating season, it also reduces heat gains through the building fabric during the summer months.

5.2 Heating system

For the “notional” energy efficient model, the primary heating system for the dwellings and retail units will consist of high efficiency central gas boilers providing LTHW heating via fan coil units.

- A-Rated pre-mix gas condensing boiler – (94% seasonal efficiency)

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 weather compensation system

Domestic Hot Water (DHW) in the commercial/office spaces will be assumed to be via a secondary return loop servicing the 2 x toilet cores.

5.3 Fabric heat loss

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

- Existing walls will be internally insulated to meet a u value at 0.30
- New wall constructions will be of an insulated brick cladding within the steel frame and will target a u-value of 0.24 or better.
- New roof structures and existing roofs will be insulated to a level achieving an overall a u-value of 0.18 will be targeted.
- Any newly laid basement and ground floors to the commercial units will achieve a minimum u value at 0.25,

Glazing

- New glazing for windows and doors and have area weighted average U-Values of $1.4\text{W/m}^2\text{K}$ or better

Air Tightness

- Where feasible, the new build elements will be tested for air tightness with a target value of $5\text{m}^3/\text{hr/m}^2$.

Construction Details

- Heat loss via non-repeating thermal bridging will be minimised by the use of Accredited Construction Details for these new build elements.

5.4 Ventilation

The potential for a natural ventilation strategy has been detailed under 4.1.3 Passive Design, above.

The proposed development will include a centralised mechanical ventilation system, incorporating a thermal wheel heat recovery system to ventilate the central office areas, utilising a mixed mode strategy with perimeter ventilation via opening windows.

5.5 Lighting

A 100% of internal light fittings throughout the development will be dedicated low-energy LED lighting.

The office lighting will be of a particularly high specification, with LED fittings achieving a minimum of 120l/cw .

The same office & commercial spaces will be zoned to enable local control of occupant lighting, as well as perimeter zones featuring daylight dimming to further enhance lighting system efficiency.

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

5.6 Energy efficiency results

The following table shows a comparison between the baseline scheme assessed under the SBEM methodology Part L minima and the scheme following the introduction of energy efficiency measures (not including energy from renewable sources).

Table 5 – Energy consumption and CO2 reductions

Unit	Building Emission Rate (regulated energy use) Kg/sqm	Unregulated Energy Use Kg/sqm	Total emissions Kg/sqm	Total emissions Kg
Refurbished Commercial	19.00	19.02	38.02	251,646.78
New Commercial	16.90	20.26	37.16	120,762.57
Total				372,409

The results show that, for the proposed refurbishment and extension development with the passive design & energy efficiency measures, the reduction in CO₂ emissions is **24.12%**.

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

6.0 Supplying Energy efficiently

The second stage in the 'Energy Hierarchy' is to ensure efficient and low carbon energy supply – Be Clean. In particular, this concerns provision of decentralised energy where practical and appropriate.

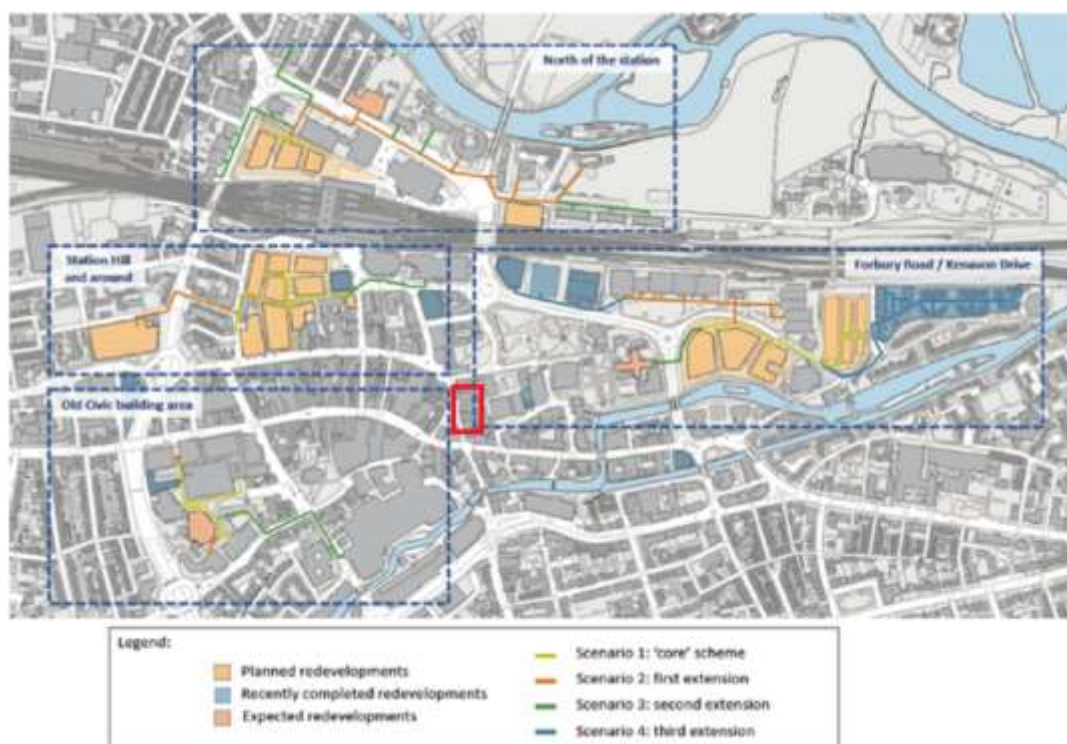
Policy CC4 of Reading's Local Plan deals with decentralised energy, and expects non-residential development of over 1,000m² to consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

It also expects non-residential development of 1,000m² or more to link into an existing district energy network, where one is present within the vicinity of an application site or demonstrate why this is not feasible.

The current HVAC proposals for the Market Place development are already assuming centralised plant to services all area; therefore, this report must consider the availability – now or in the future – of heat networks in the Reading Town Centre area.

Element Energy was commissioned by Reading to undertake a heat mapping and energy master planning study for Reading town centre. The number of anticipated redevelopment sites and existing density of domestic and non-domestic energy uses present an opportunity to establish heat network schemes.

Based on heat mapping and constraints analysis, the following four clusters were identified as potentially suitable for heat network schemes:



A detailed technical and economic assessment identified several potentially deliverable heat network scheme options centred on the four clusters as identified in the above map.

Almost all scheme options in all four clusters were found to be viable, some with additional financial support and some without; all four clusters are entering detailed feasibility analysis.

It can be seen that the project site at 6-8 Market Place (highlighted in red) falls between the identified clusters.

To bring any form of DEN connection specifically to the Market Place development will be financially non-viable and any such DEN stand-alone extension loop would suffer high heat losses and would not be compatible with a low emission strategy.

7.0 Renewable Energy Options

The final element of the 'Energy Hierarchy' requires development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible – Be Green.

Renewable energy can be defined as energy taken from naturally occurring or renewable sources, such as sunlight, wind, wave's 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.

The energy efficiency measures and the sourcing the energy efficiently outlined above have the most significant impact on the heating and hot water energy requirements for the development, and the associated reduction in energy consumption.

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.

7.1 Government incentives

7.1.1 Feed in Tariff

The Feed in Tariffs (FiTs) were withdrawn in April 2019.

7.1.2 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, 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, commencing in July 2011, with domestic schemes introduced in April 2014.

7.2 Wind turbines

Wind turbines come in two main types'- horizontal axis and vertical axis. The more traditional horizontal 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 is surrounded by other properties of similar height in all directions. To overcome these obstructions and to receive practical amounts of non-turbulent wind, the blades of a

wind turbine would need to be placed significantly above the roof level of the surrounding buildings and project site itself.

It is inconceivable that any wind turbines of this size would be considered acceptable in this location.

7.3 Solar Energy

The development at 6-8 Market Place has areas of flat roof that could accommodate solar panels orientated to the south.

In general, the roofs will have an unrestricted aspect, so there is scope therefore to site solar photovoltaic (PV) or water heating equipment at roof level.

7.3.1 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.

Both collector types can capture heat whether the sky is overcast or clear.

Depending on location, approximately 900–1100 kWh of solar energy falls on each m² of unshaded UK roof surface annually. The usable energy output per m² of solar panel as a result of this amount of insolation ranges from between 380 – 550 kWh/yr.

Solar hot water systems are of course, displacing the energy used for DHW provision, and due to the low demand for DHW in the commercial spaces, it would require a very large system to compete with the off-setting of electricity use afforded by PV panels.

Accordingly, the use of solar thermal systems is dismissed.

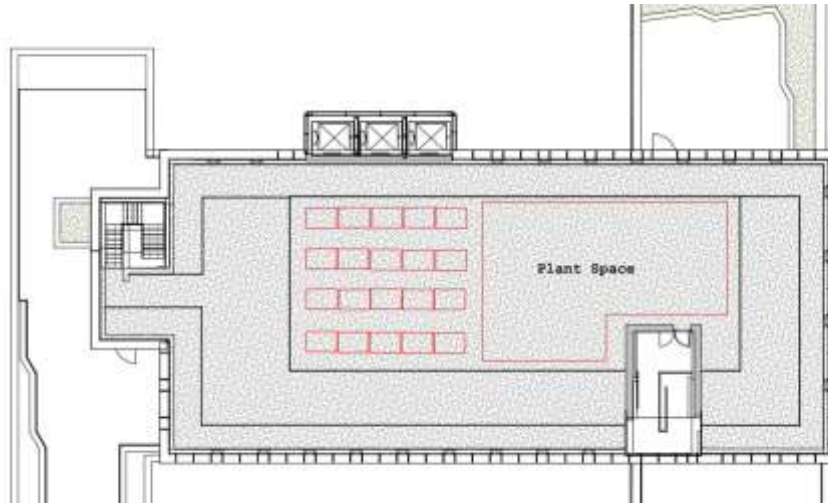
7.3.2 Photovoltaics (PV)

A 1kWp (1 kilowatt peak) system in the UK could be expected to produce between 790-800kWh of electricity per year based upon a south east orientation according to SAP2005 methodology used by the Microgeneration Certification Scheme (MCS). The figure given in the London Renewables Toolkit is 783 kWh per year for a development in London.

The area of panelling required to achieve 1kWp is dependent upon the efficiency of the system, but in the case of the Market Place project, with areas of flat roof space at 4th, 5th & 6th floor level; a high efficiency panel such as the Canadian Solar 325p series, which have a rating of 330w from 2.0m² of panel area would optimise the roof space available.

The withdrawal of the Feed in Tariff has now rendered such investments less attractive, however, there is still the benefit and carbon savings derived from the electricity produced – currently some 4.5 x as expensive as mains gas – so returns can still achieve in excess of 5%.

Accordingly, the installation of a PV array at upper roof levels is recommended for the Market Place project; a 20 panel south facing array is proposed, which will generate circa 5,298Kwh/annum, offsetting 2.8t of CO₂/annum.



7.4 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 – which can be very bulky items. There also needs to be a local source of biomass fuel that can be delivered on a regular basis. There are also issues with fuel storage and delivery which mitigate against this technology.

Additionally, 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_x emissions, as well as other pollutants and would therefore have to be considered carefully against the high standard of air quality requirements in Reading, as the whole borough has been designated as an Air Quality Management Area. Accordingly, the use of biomass is not considered appropriate for this project.

7.5 Combined Heat & Power

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

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.

The key benefit from running a CHP engine is that it produces electricity, which can displace grid supplied electricity, which has significant carbon savings. It is for this reason that CHP is designed to run for as many hours of the year as possible.

Clearly, as a large-scale office development with a very limited year-round base load, i.e. very limited DHW demand to support a CHP installation, the use of a CHP based boiler solution cannot be justified.

Further to the above, CHP units produce (waste) heat relatively inefficiently, but this is compensated for by the locally generated electricity. When the emissions related were considered against SAP2012 emissions levels (0.519Kg/Kwh), this would offer a considerable reduction in building emissions.

However, when considering the technology against the latest SAP10 data for grid based emissions, the emissions related to the electrical generation are more than halved, and in combination with relatively inefficiency heat generation, the benefits of CHP are all but lost.

The high level of NOx emissions associated with CHP engines in this key town centre location further mitigates the use of this technology.

7.6 Ground source heat pump

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 underfloor 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

Clearly, there is insufficient land area to install low level collector loops, leaving deep bore GSHP as the only potential option.

Normally the boreholes would need to be 6 to 8 metres apart and a 100-metre deep borehole will only provide about 5kW of heat. The borehole should also be formed around 3m away from the perimeter of the building and most specialists do not recommend using the structural boreholes.

Clearly, in the case of the proposed development at 6-8 Market Place, there is no scope for the locating of the ground collector devices and as such, ground source heating cannot be considered.

7.7 Air Source Heat Pump

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.

Given the requirement to future proof the development against future overheating potential, the design team are proposing the use of variable refrigerant (VRF) flow air-to-air heating and cooling system which incorporates inter-zone heat recovery.

VRF systems can have numerous indoor units, served by a single outdoor unit, in both heating and cooling modes simultaneously. This mixed mode operation leads to energy savings as both ends of the thermodynamic cycle are delivering useful heat exchange. If a system has a cooling COP (Coefficient of Performance) of 3, and a heating COP of 4, then heat recovery operation could yield a COP as high as 7.



It should be noted that this perfect balance of heating and cooling demand is unlikely to occur for many hours each year, but whenever mixed mode is used energy is saved. In mixed mode the energy consumption is dictated by the larger demand, heating or cooling, and the lesser demand, cooling or heating is delivered free.

The high internal gains in office areas makes the project an ideal candidate for a VRF system, particularly during the heating seasons, when the heat recovery mechanisms can recover the warmer air from these areas and deliver it to other areas requiring heat.

Accordingly, the design team are proposing the use of a new three pipe heat recovery VRF system utilising externally mounted condensing units, centralised branch selector boxes and void mounted fan evaporator units and/or ceiling cassettes. Whole system seasonal efficiencies (to be confirmed at commissioning) are expected to be at circa 4.9 for heating and 6.3 for cooling.

The use of these highly efficient electrically driven HVAC systems also offer the benefit of having a zero contribution to local environment's nitrous oxide and particulate levels; this is considered to be a significant advantage.

Heat pumps will also replace the need for gas/fossil fuels to generate the projects domestic hot water requirements at an efficiency at circa 290%.

7.8 Final Emissions Calculation

Given the outcome of the feasibility study above, the developer is proposing the use the VRF heat pump systems to deliver the heat and coolth and DHW to the proposed development.

In addition, a 20 panel, 6.6Kwp PV array is to be installed to the roof area – this will produce circa 5,298Kwh per annum, saving an additional 2.8t of CO₂/annum

The final table – Table 6 – summarises the final BRUKL outputs; attached at **Appendix C**

Table 6 – “Be Green” emission levels

Unit	Emission Rate (regulated energy use) Kg/sqm	Unregulated Energy Use Kg/sqm	Total emissions Kg/sqm	Total emissions Kg
Refurbished Commercial	12.00	19.02	31.02	205,315.18
New Commercial	11.50	20.26	31.76	103,213.65
Total				308,529

The data at Table 6 confirms that overall emissions – including unregulated energy use - have been reduced by **37.13%** over and above the baseline model, with a **17.15%** reduction in emissions directly from the use of energy generating and renewable technologies, i.e. over and above the energy efficient model.

Excluding the un-regulated use, i.e. considering emissions controlled under AD Part L, then the reduction equates to **60.94%**.

Taking account of the impending introduction of the updated Part L Building Regulations, the emissions calculated under the Part L 2013 (SAP2012 methodology)

have been converted to SAP10 emissions levels for gas and grid electricity; as can be seen from the below spreadsheet extract, this results in a reduction in emissions of the Part L baseline compliant project of over **70%**.

SAP 10 Conversion												SAP 12		SAP 13		
Project	2012 Data						SAP10						Total	Regulated	Total	Regulated
	Heating	Cooling	Auxiliary	Lighting	DHW	Equipment	Heating	Cooling	Auxiliary	Lighting	DHW	Equipment				
	Fuel	Elec	Elec	Elec	(Bivalent)	Elec					(Bivalent)					
6-8 Market Place																
Baseline Gas Boiler	4.75	14.64	0.86	14.58	0.84	19.02	4.62	6.57	0.38	6.54	0.91	8.54	54.78	15.76	27.57	19.02
Be Lean Gas Boiler	4.83	7.80	0.64	5.77	0.77	19.02	4.68	3.14	0.29	2.99	0.75	8.54	38.03	19.01	20.00	11.46
Be Green VRF	2.38	2.81	0.64	5.77	0.57	19.02	1.07	1.17	0.29	2.99	0.16	8.54	30.98	11.97	13.91	5.37
Be Green VRF + PV	2.38	2.81	0.64	5.77	0.57	19.02	1.07	1.17	0.29	2.99	0.16	8.54	30.14	11.12	13.53	4.99

8.0 Conclusions

This report has detailed the baseline energy requirements for the proposed development, the reduction in energy demand as a result of energy efficiency measures and the potential to achieve further CO₂ 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, taking into account unregulated use, the total amount of CO₂ emissions would be **490,755Kg/year**.

Following the introduction of passive energy efficiency measures into the development, as detailed in section 4, the total amount of CO₂ emissions would be reduced to **372,409/year**, a reduction of **24.12%**.

There is also a requirement to reduce CO₂ emissions across the development using renewable or low-carbon energy sources. Therefore, the report has considered the feasibility of the following technologies:

- Wind turbines
- Solar hot water
- Photovoltaic 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 most suitable solution to meeting reduction in CO₂ emissions would be via the use of an 24.09Kwp PV array at roof top level and VRF driven heating and cooling for the offices spaces.

This has been used in the final BRUKL models (reproduced at **Appendix C**) for the development which have also been detailed above in Table 6, which show a final gross emission level of **308,529Kg/year**, representing a total reduction in emission over the baseline model, taking into account unregulated energy, of **37.13%**.

In addition, the BRUKL outputs demonstrate that the building achieves an overall improvement in emissions over the Building Regulations Part L standards for regulated emissions of minimum of **60.94%**.

Appendix A

Baseline/Un-regulated Energy Use: -

BRUKL Outputs – Building & Target Emission Rates

Appendix B

Energy Efficient Design: -

BRUKL Outputs - Building Emission Rates

Appendix C

Generating energy on-site: -

Final BRUKL Outputs - Building Emission Rate