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Symmetry Park Bicester Phase 3 Unit E

211272

LZC Feasibility Report for BREEAM

Sustainability at our core.

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Contents

1.0 Introduction

Couch Perry Wilkes has been appointed to appraise the renewable and low carbon technology energy options currently available for the proposed new Symmetry Park Bicester Phase 3, Unit E. The client is keen to target a BREEAM 'Very Good' rating for the building. This feasibility report has been carried out at RIBA stage 2 (outline proposals).

The planned new development of approximately 15,807.6m^2 Gross Internal Area (GIA), comprises distribution and office space with associated facilities arranged over two floors. With the current emphasis placed on energy conservation and the use of Low and Zero Carbon (LZC) technologies, the client is keen to enhance the development's sustainability credentials both from an estate and public perspective.

The general construction design standards to be adopted must exceed the requirements of the current (2021 Edition) Part L Building Regulations which stipulate an improvement on the CO_2 emissions of an aggregated 27% (for buildings other than dwellings) against 2013 standards.

To this end, the proposed design shall promote reduced CO_2 emissions from delivered energy consumption by minimising operational energy demand through passive and best-practice measures. The LZC technology energy options presented herein will potentially provide a further CO_2 reduction over and above the measures included as an integral part of the project design.

This high-level report has been compiled, in accordance with BREEAM, to appraise the renewable and low carbon technology energy options currently available for the proposed Symmetry Park Bicester Phase 3, Unit E. A summary of the findings is presented below.

2.0 Energy Benchmarking

2.1 Estimated Energy Demands and CO_2 Emissions

In order to benchmark the proposed new development, estimated energy demands and CO_2 emissions data have been calculated. These estimated energy consumptions are indicative only at this stage. They will, however, be used as a guideline to assess the percentage of the building's total energy consumption and CO_2 emissions that could be reduced or offset by applying suitable renewable and/or low carbon technology energy options.

For the purposes of BREEAM, it is prudent for this report to reflect the benchmark data derived from approved Dynamic Simulation Model (DSM) software which uses government and industry agreed National Calculation Methodology (NCM) room templates containing standard operating conditions. This is due to the fact that BRE Global will only accept results from the approved models when verifying the percentage reduction in CO_2 emissions from the building for credits Ene 1 and Ene 4 (BREEAM V6).

The estimated energy consumption and CO_2 emissions for the development, including passive low energy features but no renewable or LZC technologies, derived from approved DSM software (IES), are shown below:

The total predicted building energy consumption is: **244,205kWhr per year**

The total predicted building CO_2 emissions are: **34,930kgCO_2 per year**

Note 1. CO_2 emission factors of 0.210 for Gas and an annual average of 0.136 for electricity have been used to calculate the above and are taken from Building Regulations Approved Documents.

2.2 Assumed Utility Costs

The following utility costs have been assumed in order to assess payback periods only:

Gas	= £0.06/kWhr
Electricity	= £0.24/kWhr

2.3 Indicative Payback and Feed-in Tariffs/Renewable Heat Incentive

At this stage, it is very difficult to measure precisely the payback period of any investment in sustainability particularly when a number of measures are included within the design. Estimating payback periods for LZC technologies is even less precise due to both the volatility of the current fuel markets and rapidly changing cost of the technology.

For the purpose of this report, simple payback periods are considered which are based on current prices with no consideration for future value and comparing just annual savings against initial outlay. This is not necessarily an accurate prediction of payback, however, it does provide a constant form of comparison between the different options under consideration.

It should be noted that when considering LZC technologies, payback period should not be a primary aim or main focus of comparison. Generally speaking, none of the options considered will offer a good economic incentive; therefore, payback is used only as a simple form of comparing these technologies against each other.

2.4 Noise

Most LZC technologies considered in this report are silent in operation with the exception of wind turbines and CHP installations. In order to quantify the effects of mechanical and/or aerodynamic noise, manufacturers must undertake an environmental noise impact assessment. The main findings of these noise impact assessments are presented in the relevant sections of this report.

In addition, a site noise survey can be undertaken in accordance with the requirements of BS 4141:1997. If necessary, suitable noise attenuation measures can be specified to reduce the likelihood of complaint.

2.5 Life Cycle Costs

The life cycle cost or whole life cost encompasses all costs associated with, in this case, each LZC technology's anticipated life-span. These include capital costs, installation costs, operating costs, maintenance costs and disposal costs. For each LZC technology deemed suitable for the proposed new development, a life cycle cost analysis has been undertaken and the results presented in Appendix A.

2.6 Land Use

The south-west part of the plot itself has car parking up to the boundary. The north-east and south-east boundary are due to be landscaped. The north-west side of the plot is composed of a service yard and HGV loading.

2.7 Local Planning Requirements

In order to reduce the resource consumption of new developments, many Councils are now producing their own specific documents and policies on sustainable construction. LZC technologies such as solar photovoltaic panels, solar thermal systems and in particular wind turbines are highly visible and have an aesthetic impact on the local environment. For example, large stand-alone column mounted wind turbines are likely to meet with major objections from local residents.

Local authorities need to be consulted at an early stage to establish any local planning policies that may apply to the proposed development. Planning issues associated with each LZC technology are conveyed, where relevant, in the main body of this report.

2.8 Available Grants

There are a number of funding opportunities available across the UK provided through regulated GOV.UK schemes or local council application portals, these schemes support different project types and have a varied criterion. The available funding supports both the design intent to various stages of RIBA design and the physical implementation of the accepted design. Below CPW have named some of the available funding streams in which we are familiar working with or have been delivered:

- SALIX – LCSF – Funding for the design of a Heat Decarbonisation Plan (HDP) which captures replacement of current boiler plant along with energy efficiency measures, renewable technologies, and fabric improvements.
- SALIX - PSDS – Funding for the implementation of the above HDP and technologies.
- GHNF - Green Heat Network Fund Supports with funding the development of low and zero carbon (LZC) heat (and cooling) networks.
- IEFT - Industrial Energy Transformation Fund investing in energy efficiency and low carbon technologies in an industrial setting.

The Government Department of Energy and Climate Change (DECC) historically provided grants for the installation of micro-generation technologies under the Low Carbon Buildings Programme Phase 2 Extended, however, this scheme was closed to new applications in May 2010.

2.9 Feasibility of Exporting Heat and Electricity

Any on-site electrical generation from the likes of solar photovoltaic panels or wind turbines will be fed into the building’s main electrical system. There is no intention of exporting electricity to the grid. Any hot water generated from e.g. solar thermal tubes will be used locally.

2.10 BREEAM

BREEAM or Building Research Establishment's Environmental Assessment Method is a voluntary scheme that aims to quantify and reduce the environmental burdens of buildings by rewarding those designs that take positive steps to minimise their environmental impacts. Projects are assessed using a system of credits. The credits are grouped within the following categories:

- Management
- Health and Wellbeing
- Energy
- Transport
- Water
- Materials
- Waste
- Land Use and Ecology
- Pollution

The assessment process results in a report covering the issues assessed together with a formal certification giving a rating on a scale of UNCLASSIFIED, PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING.

The diagram and text below describes how BREEAM scores and rates an assessed building:

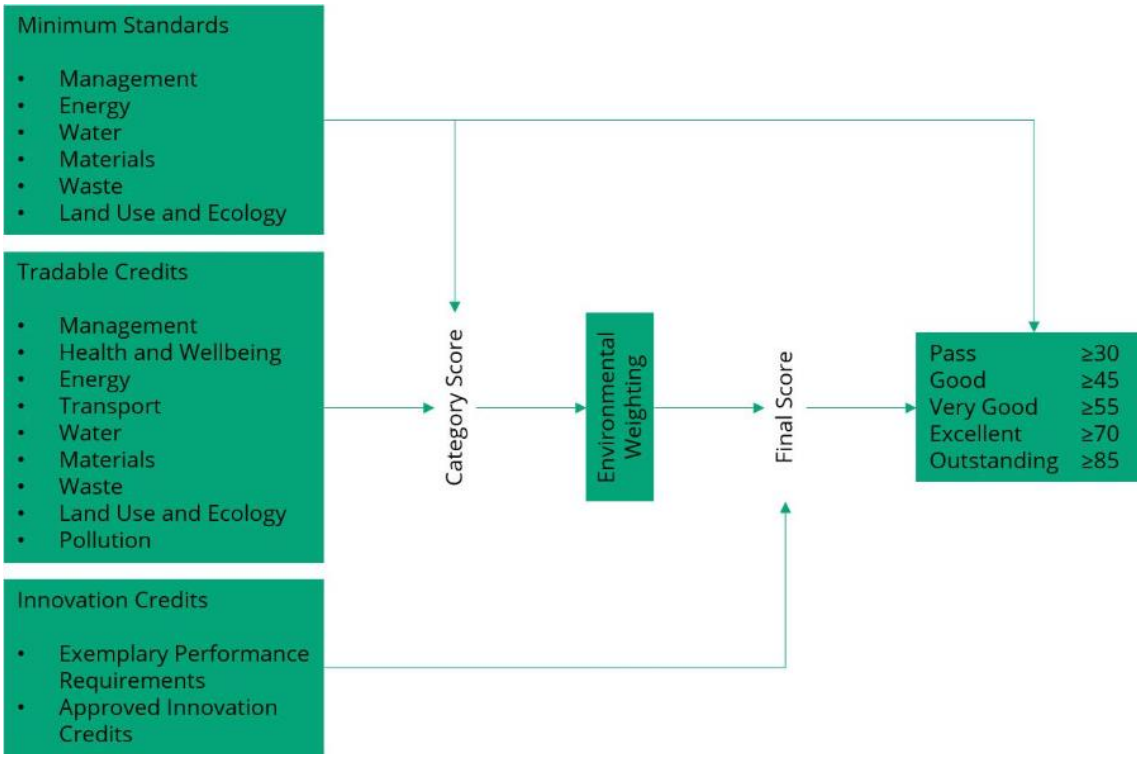

Figure 1 - Process for Awarding a BREEAM Rating

The BREEAM categories contain a number of environmental issues, which reflect the options available when designing, procuring and constructing a building.

Tradable Credits

Each environmental issue has a set number of 'credits' available and these credits are awarded where the building demonstrates that it complies with the requirements of that issue.

Minimum Standards

A number of issues within a category have set minimum standards, i.e. a minimum number of credits that must be achieved in order for a particular BREEAM rating level to be met.

Innovation Credits

Innovation credits provide additional recognition for a building that innovates in the field of sustainable performance, above and beyond the level that is currently recognised and rewarded by standard BREEAM issues. Innovation credits are awarded for either complying with pre-defined BREEAM issue exemplary level requirements, or via application to BRE Global to have a particular building feature, system or process recognised as 'innovative'.

Within each of the BREEAM categories outlined above, there are a number of credit requirements that reflect the options available to designers and managers of buildings.

An environmental weighting is applied to the scores achieved under each category, as shown below, in order to calculate the final BREEAM score. The weighting factors have been derived from consensus based research with various groups such as government, material suppliers and lobbyists. This research was carried out by BRE Global to establish the relative importance of each environmental issue.

The environmental weightings are as follows:

BREEAM Section	Weighting (%)
Management	11.0
Health and Wellbeing	8.0
Energy	14.0
Transport	11.5
Water	7.0
Materials	17.5
Waste	7.0
Land Use and Ecology	15.0
Pollution	9.0
Innovation (additional)	10.0

Table 1 - BREEAM V6 New Construction Section Weighting

The BREEAM rating bands are as follows:

BREEAM Rating	Score (%)
UNCLASSIFIED	<30
PASS	≥30
GOOD	≥45
VERY GOOD	≥55
EXCELLENT	≥70
OUTSTANDING	≥85

Table 2 - BREEAM Rating Bands

Although, at this stage, it is very difficult to predict exactly the number of BREEAM credits likely to be achieved by each LZC technology when applied to the current development, it is worth noting that these technologies have an influence over the following:

Ene 01	**Reduction of CO_2 Emissions** – Up to 9 (+5 Innovation) credits are available.
Ene 04	**Low Carbon Design** – One credit is available.
Pol 02	**NO_x Emissions** – Up to 2 credits are available.

3.0 Appraisal of Renewable and Low Carbon Technology Energy Options

3.1 Financial Expenditure Available for Renewable and Low Carbon Technology Energy Options

The current budget for expenditure specifically on LZC technologies has not yet been defined or approved. For the purposes of this report, various options will be given, where relevant, to target varying levels of energy/CO_2 reduction.

3.2 Summary of the Technical Feasibility Assessment of Renewable and Low Carbon Technology Energy Options

The technical feasibility of installing each LZC technology at the Symmetry Park Bicester Phase 3, Unit E, has been assessed in order to discount any unsuitable options at an early stage. A summary of the feasibility process is tabulated below and an overview of each technology is given in Section 3.3.

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Solar Photovoltaic	Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.	Low maintenance/no moving parts Easily integrated into building design	Any overshadowing reduces panel performance Panels ideally inclined at 30° to the horizontal facing a southerly direction	Yes
Solar Thermal	Solar thermal energy can be used to contribute towards space heating and hot water requirements. The two commonest forms of collector are panel and evacuated tube.	Low maintenance Little/no ongoing costs	Must be sized for the building hot water requirements Panels ideally inclined at 30° to the horizontal facing a southerly direction	No, limited domestic hot water requirements
Ground Source Heat Pump (GSHP)	GSHP systems tap into the earth's considerable energy store to provide both heating and cooling to buildings. A number of installation methods are possible including horizontal trench, vertical boreholes, piled	Minimal maintenance Unobtrusive technology Flexible installation options to meet available site footprint	Large area required for horizontal pipes Full ground survey required to determine geology	No, prohibitively expensive installation costs

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
	foundations (energy piles) or plates/pipe work submerged in a large body of water. The design, installation and operation of GSHPs is well established.		More beneficial to the development if cooling is required Integration with piled foundations must be done at an early stage	
Air Source Heat Pump	Electric or gas driven air source heat pumps extract thermal energy from the surrounding air and transfer it to the working fluid (air or water).	Efficient use of fuel Relatively low capital costs	Specialist maintenance More beneficial to the development if cooling is required Requires defrost cycle in extreme conditions Some additional plant space required	Yes, as part of the base build
Wind Turbine *(Stand-alone column mounted)*	Wind generation equipment operates on the basis of wind turning a propeller, which is used to drive an alternator to generate electricity. Small scale (1kW – 15kW) wind turbines can be pole or roof mounted.	Low maintenance/ongoing costs Minimum wind speed available Excess electricity can be exported to the grid	Planning issues Aesthetic impact and background noise Space limitations on site Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site
Wind Turbine *(Roof Mounted)*	As above	Low maintenance/ongoing costs Minimum wind speed available Excess electricity can be exported to the grid	Planning issues Aesthetic impact and background noise Structural/vibration impact on building to be assessed Proximity of other buildings raises issues with downstream turbulence Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Gas Fired Combined Heat and Power	A Combined Heat and Power (CHP) installation is effectively a mini on-site power plant providing both electrical power and useful heat. CHP is strictly an energy efficiency measure rather than a renewable energy technology.	Potential high CO_2 saving available Efficient use of fuel Excess electricity can be exported to the grid Benefits from being part of an energy centre/district heating scheme	Maintenance intensive Sufficient base thermal and electrical demand required Some additional plant space required	No, limited domestic hot water requirements
Bio-fuel Fired Combined Heat and Power	As above.	Potential high CO_2 saving available Efficient use of fuel Excess electricity can be exported back to the grid Benefits from being part of an energy centre/district heating scheme	Maintenance intensive Sufficient base thermal and electrical demand required Significant plant space required Biomass fuelled systems are at early stages of commercialisation Large area needed for fuel delivery and storage Reliable biomass fuel supply chain required	No, not suitable on this site
Bio-Renewable Energy Sources *(Automated feed – wood-fuel boiler plant)*	Modern wood-fuel boilers are highly efficient, clean and almost carbon neutral (the tree growing process effectively absorbs the CO_2 that is emitted during combustion). Automated systems require mechanical fuel handling and a large storage silo.	Stable long term running costs Potential good CO_2 saving	Large area needed for fuel delivery and storage Reliable fuel supply chain required Regular maintenance required Significant plant space required	No, not suitable on this site
Fuel Cells and Fuel Cell Combined Heat and Power	Fuel cells convert the energy of a controlled chemical reaction, typically involving hydrogen and oxygen, into electricity, heat and water vapour. Fuel cell stacks operate in the	Zero CO_2 emissions if fired on pure hydrogen and low CO_2 emissions if fired on other hydrocarbon fuels Virtually silent operation since no moving parts	Expensive Pure hydrogen fuel supply and distribution infrastructure limited in the UK	No, expensive, emerging technology

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
	temperature range 65°C – 800°C providing co-generation opportunities in the form of Combined Heat and Power (CHP) solutions.	High electrical efficiency Excess electricity can be exported back to the grid Benefits from being part of an energy centre/district heating scheme	Sufficient base thermal and electrical demand required Some additional plant space required Reforming process, used to extract hydrogen from alternative fuels, requires energy; lowering overall system efficiency	

Table 3 - Summary of Renewable and Low Carbon Technology Energy Options

3.3 Technical Feasibility Study of Renewable and Low Carbon Technology Energy Options

3.3.1 Solar Photovoltaic (PV) Panels

Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.

Figure 2 - CPW Photovoltaic Installations: Project Epic (BREEAM Excellent Office –left) and Castle Wood (BREEAM Excellent School –right)

Photovoltaic panels are available in a number of forms including mono-crystalline, polycrystalline, amorphous silicon (thin film) or hybrid panels (discussed later). They are fixed or integrated into a building's un-shaded south facing façade or pitched roof ideally at an incline of 30º to the horizontal for maximum energy yield.

Figure 3 - Solar PV Louvres on the South Facade

It is essential that the panels remain un-shaded, as even a small shadow can significantly reduce output. The individual modules are connected to an inverter to convert their direct current (DC) into alternating current (AC) which is usable in buildings.

Although sloping rooftops provide an ideal site for fixing PV panels using traditional mounting frames, there are a number of alternative solutions whereby PV panels can be incorporated into the actual building fabric of the development.

Solar louvres use PV panels to provide solar shading on the south façade of buildings as part of the brise soleil (see above), and this can be a highly effective way of controlling overheating and help reduce glare.

Solar glazing uses a combination of solar PV and glass, where the PV cells are laminated between two panes of specialised glazing (see above). The resulting glass laminate serves the dual function of creating energy and shade at the same time, reducing the risk of overheating.

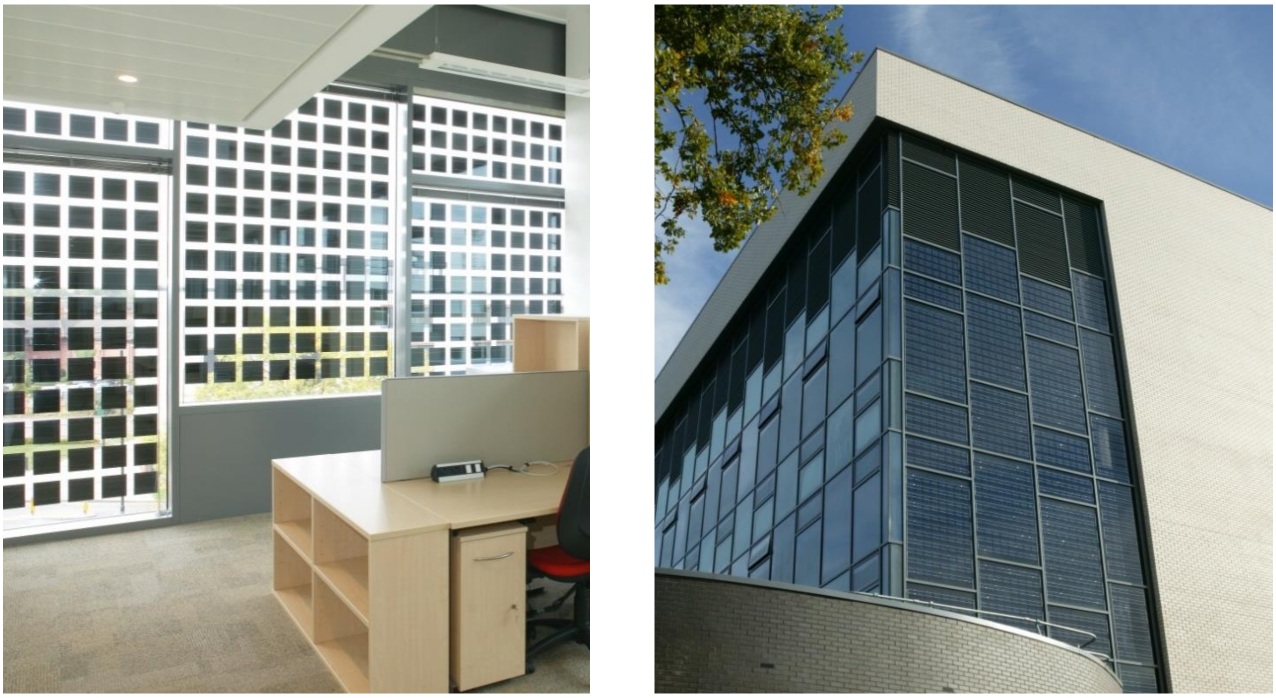

Figure 4 - CPW Solar Glazing Installation, University of Warwick - Materials and Analytical Sciences Building

Solar glazing can be used wherever conventional glass would be specified, especially in atria. Bespoke designs allow for varying light penetration by changing the spacing between individual cells. Typically, a combination of 50% PV and 50% translucent glazing is used.

Vertical solar facades can be used to directly replace conventional rain screen cladding materials providing a smooth, flat facade surface for the building. Where circumstances allow, the PV panels can be tilted towards the sun to maximize the energy yield.

As mentioned earlier, there are a number of types of PV cell:

Mono-crystalline Silicon Cells: These are made using cells saw–cut from a single cylindrical crystal of silicon. The principle advantage of mono-crystalline cells is their high efficiency, typically around 15 – 24%, although the manufacturing process required to produce mono-crystalline silicon is complicated, resulting in slightly higher costs than other competing technologies.

Polycrystalline Silicon Cells: These are made from cells cut from an ingot of melted and re-crystallised silicon. In the manufacturing process, molten silicon is cast into ingots of polycrystalline silicon. The ingots are then saw-cut into very thin wafers and assembled into complete cells giving a granular textured finish. Polycrystalline cells are cheaper to produce than mono-crystalline types, due to the simpler manufacturing process but tend to be slightly less efficient, with average efficiencies of circa 13 – 16%.

Thick-Film Silicon: This is another polycrystalline technology where the silicon is deposited in a continuous process onto a base material giving a fine grained, sparkling appearance. Like all crystalline PV, this is encapsulated in a transparent insulating polymer with a tempered glass cover and usually bound into a strong aluminium frame.

Thin-Film Amorphous Silicon: Amorphous silicon cells are composed of silicon atoms in a thin homogenous layer rather than a crystalline structure. Amorphous silicon absorbs light more effectively than crystalline silicon, so the cells can be thinner. For this reason, amorphous silicon is also known as a 'thin film' PV technology. Amorphous silicon can be deposited on a wide range of substrates, both rigid and flexible, which makes it ideal for curved surfaces and 'fold-away' modules. Amorphous cells are, however, less efficient than crystalline based cells, with typical efficiencies of around 6%, but they are easier and, therefore, cheaper to produce.

Other Thin Films: A number of other promising materials such as cadmium telluride (CdTe) and copper indium diselenide (CIS) are now being used for PV modules. The attraction of these technologies is that they can be manufactured by relatively inexpensive industrial processes, certainly in comparison to crystalline silicon technologies, yet they typically offer higher module efficiencies than amorphous silicon. New technologies based on the photosynthesis process are at early stages of commercialisation.

Photovoltaic technology may be feasibly incorporated into the building design with little/no maintenance or on-going costs. Installations are scaleable in terms of active area; size being restricted only by available façade and/or roof space.

Consider roof mounted mono-crystalline PV panels with a peak output of 370kW as determined by the BRUKL model data.

- Capital cost circa £266,400
- Savings circa £70,346 per year
- Simple payback 4 years
- Energy saving circa 293,107kWhr/yr
- % Energy saving 120.0%
- CO_2 saving 32,956kgCO_2/yr
- % CO_2 saving 94.3%

A particular advantage of solar PV, even over other types of LZC technology, is that running costs are very low (requires no fossil fuel for operation) and, since there are no moving parts, very little maintenance is required.

3.3.2 Solar Thermal

Solar thermal energy can be used to contribute towards space heating and hot water requirements. In the UK, most applications focus on hot water installation as the solar availability during the space heating season is limited.

Figure 5 - CPW Solar Thermal Evacuated Tube Systems: William Brookes School (left) and Police Federation Headquarters (right)

The use of solar water heating installations is widespread throughout Europe. The systems use a heat collector, generally located at roof level on support frames, orientated in a southerly direction to maximise solar heat absorption.

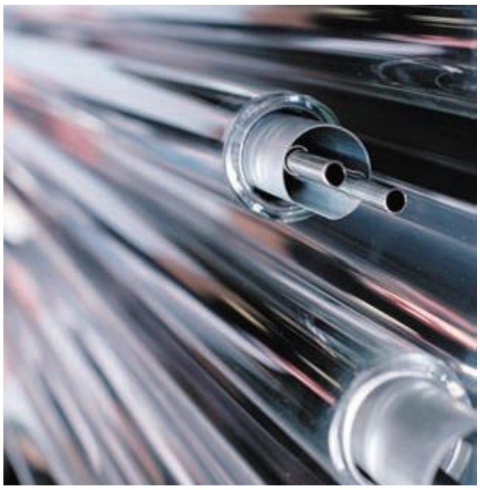

Figure 6 - Evacuated Tube Type Collectors

A working fluid is used to heat water that is stored in either a separate hot water cylinder or more commonly a twin coil hot water cylinder with the second coil providing top-up heating from a conventional boiler.

The two most common forms of collector are panel and evacuated tube.

The panel type collectors are generally more robust and reliable while manufacturers claim that the evacuated tube versions offer better winter all-round performance.

The design of the flat plate panels is relatively straightforward; consisting of water tubes arranged behind solar glass and an absorber plate. The absorber plate absorbs the sun’s rays and transfers energy to the water flowing through the tubes. In contrast, the evacuated tube type collectors are more complicated consisting of double wall glass tubes with a space in the centre containing a heat pipe and a liquid.

Coatings on the inner glass ensure that around 93% of the absorbed heat is retained within the system and the vacuum prevents loss of heat through conduction and convection. The circular design helps maximise the potential to collect solar energy all year round when the sun is at different angles.

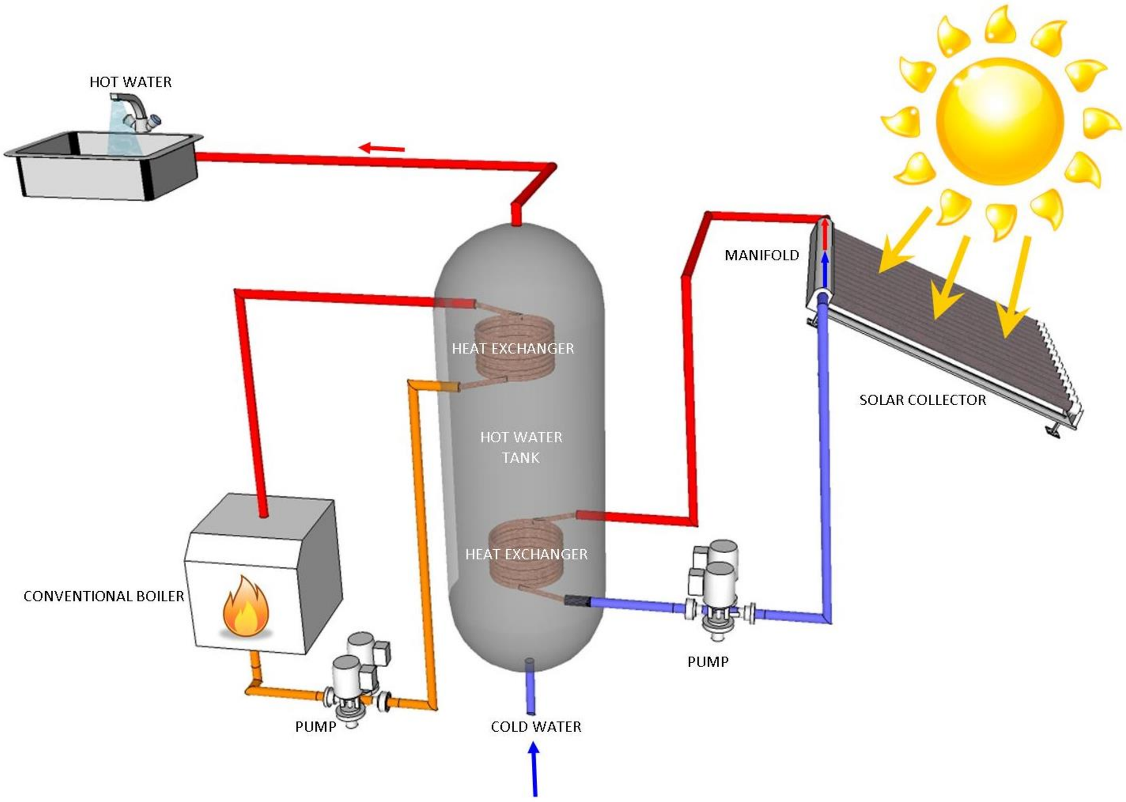

Figure 7 - Schematic Diagram of Solar Thermal Energy Transfer and System Operation

The heat pipes are connected to a manifold containing circulating water (see Figure 7 above). The liquid in the heat pipe is evaporated by the suns energy and rises to a heat exchanger within the manifold where it condenses and gives up its latent heat energy to the water. This heated water is then pumped to a coil in the hot water cylinder sized to meet the demand of the installation. Evacuated tube systems deliver higher temperature water than flat plate types, with little decrease in efficiency, making them more effective with thermal storage solutions.

As a general rule, the evacuated tube collectors can deliver around 700kWhr/m^2/yr when in optimum orientation (inclined at 30^o to the horizontal facing a southerly direction). This compares to around 580kWhr/m^2/yr for the flat plate collectors under similar conditions.

Solar thermal installations can be designed to fit the available roof space and/or building façade. Each evacuated tube is approximately 2m in length with an external diameter of 58mm. They weigh around 2kg each and can be spaced from 10mm to 500mm apart in an array. A typical panel array, 2.1m x 1.0m, will provide around 1.33m^2 of absorber area and weigh approximately 45kg. Bespoke mounting frames can be fashioned to provide the ideal inclination of 30º to the horizontal facing a southerly direction. Access to the roof mounted solar collectors will be necessary for occasional cleaning of the active tubes.

Solar thermal technology on a large scale is often difficult to support where there is a limited domestic hot water demand. As the office will have minimal hot water demand, a solar thermal installation will not be considered further on this project.

3.3.3 Ground Source Heating and Cooling

The design, installation and operation of Ground Source Heat Pumps (GSHPs) is well established. These geothermal systems tap into the earth's considerable energy store to provide both heating and cooling to buildings. They take advantage of the fact that at a depth of a few metres, the temperature of the ground remains at a constant 12ºC throughout the year.

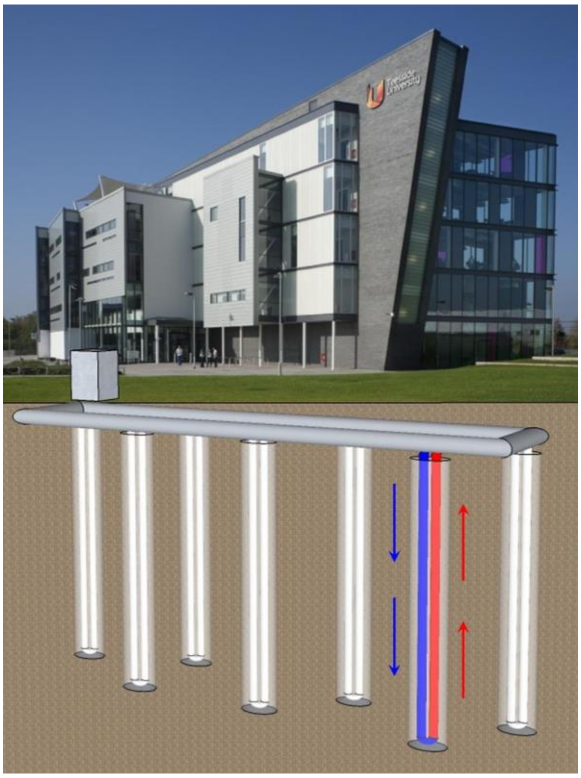

Figure 8 - Ground Source Heat Pump Schematic

In heating mode, GSHPs absorb energy from the earth and transfer it into the building using highly efficient heat pumps. The effectiveness of heat pumps is measured by the ratio of the heating capacity to the power input, referred to as the Coefficient of Performance (COP). Typically, manufacturers state that for every 1 unit of electrical energy used to drive the pump, around 4 to 5 units of thermal energy can be produced. When operating in cooling mode, during the summer months, the system reverses its cycle and heat is extracted from the building and dissipated into the earth.

The ground loops can be installed either vertically in boreholes (typically 50m – 100m deep), or horizontally in trenches at a depth of 1.5m – 2.0m. Either method is dependent upon local geology conditions and space available. The system also benefits from the fact that most of the components are hidden below ground or in plant room enclosures.

Costs for drilling vary according to the location and ground conditions. A preliminary site investigation, by means of a desktop study, can usually determine the viability of a ground source heating and cooling system. Fine tuning of the design may be required once actual site ground conditions are established.

It should be noted that GSHPs generally deliver water at a temperature approaching 50ºC (which would be ideal for under floor heating). Additional heat sources would be needed to satisfy the requirements for domestic hot water to raise the temperature well above 60ºC.

The design intention is not to employ under floor heating on the scheme. This, coupled with the fact that there is no available space on site for sinking of boreholes and/or trenching for pipe work, means that a GSHP system cannot be considered further on this project.

3.3.4 Air Source Heat Pumps

Electric driven air source heat pumps extract thermal energy from the surrounding air and transfer it to the working fluid (air or water). Like GSHPs they can provide both heating and cooling to buildings and have an associated Coefficient of Performance (COP). This is typically around 3 to 4 for heat pumps driven by compressors powered by electric motors and incorporating Variable Refrigerant Flow (VRF) technology. With VRF technology, there is an opportunity to heat and cool separate spaces and recover the heat between them.

Care should be taken when mounting the units to avoid any acoustic problems associated with operating the fans. The outdoor units normally operate with sound levels typically in the range 55 - 60dB(A).

Figure 10 - Air Source Heat Pump

A downside of electric driven air source heat pumps is that they require a defrost cycle in extreme conditions which impacts on the system efficiency. Heating capacity also falls off as the ambient temperature drops below 5ºC but still maintains 80% capacity at -5ºC.

Units are either roof or ground mounted and coupled to a thermal buffer store with additional back-up electric immersion heaters in the cylinder, to make up any shortfall. Alternative heat pump solutions can be supplied for internal installation within a plant room.

Air source heat pump systems are scaleable to meet the specific demands of the development, but for the purposes of this comparative study, assume that office heating and cooling demand is being targeted, although for BREEAM, only heating can be taken into consideration.

An air source heat pump system features as part of the base build solution for this project, so no further savings will be taken as part of this report.

3.3.5 Wind Turbines

Wind generation equipment operates on the basis of wind turning a propeller, which is used to drive an alternator to generate electricity. Small scale wind turbines are typically in the range of 1kW – 15kW, with rotor diameters of 2.5m – 9.0m respectively. These systems can be stand-alone or, in some cases, building mounted.

Figure 11 - CPW Designed Helical Roof Mounted

The efficiency and effectiveness of wind turbines depends on many factors, not least the average wind speed and wind pattern of the proposed site. Exposed sites, free from obstacles such as buildings and greenery, are more viable than sheltered sites. Column mounted (stand-alone) wind turbines installed at a suitable height above the building line are more effective than wind turbines located at roof level. There are often some planning difficulties associated with the use of wind turbines. Background noise and a phenomenon known as shadow flicker are also potential issues.

Typical noise levels measured 20m from the base of an operating 5kW wind turbine (both upstream and downstream) in the range 4m/s to 8m/s are 48 – 50dB(A). At 100m, the predicted noise level would be below 35dB(A).

The use of wind turbines is often seen as an obvious statement of a development’s dedication to the use of sustainable technologies.

The proposed development does not lend itself to small-scale stand-alone or roof mounted wind turbines due to the high density of multi-storey buildings, obstacles and greenery causing problems with downstream turbulence. At this stage, assume that a large stand-alone column mounted wind turbine will meet with major objections from local residents. For the reasons outlined above, the installation of wind turbines on the site is not practical and will not be considered further.

3.3.6 Combined Heat and Power (CHP)

A CHP installation is effectively an on-site mini power plant providing both electrical power and thermal heat. CHP is strictly an energy efficiency measure rather than a renewable energy technology. A CHP system operates by burning a primary fuel (normally natural gas) by use of either a reciprocating engine or turbine, which in turn drive an alternator to generate electrical power. The heat emitted by the engine and exhaust gases is recovered and used to heat the building or to provide hot water.

Figure 12 - Gas Fired CHP System

The viability of CHP is dependent upon the building base load requirements for both heat and power. 24 hour buildings with high heat demands and constant power demands lend themselves to CHP.

The noise levels associated with a CHP installation should not be overlooked. Typically, acoustic enclosures and upgraded low noise attenuators are employed to ensure noise levels don't exceed 65dBA when 1m from the unit. On confined sites, the plant room structure can be enhanced and attenuators fitted to the mechanical ventilation to prevent any noise issues.

An initial evaluation indicates that the base heating load, associated with the domestic hot water requirements, does not support the installation of a CHP system. As such, CHP plant will not be considered further on this project.

3.3.7 Bio-fuel CHP

Consideration has been given to the possibility of utilising a bio-gas, bio-diesel or dual fuel CHP engine.

Figure 13 - Schnell Dual-Fuel Biomass CHP System

A dual fuel engine (normally based on field-proven diesel engine technology) can run on oil alone, or a mixture of gas and oil.

It should be noted that the engine cannot run on gas alone because it doesn't have a spark ignition system.

Schnell (Germany) supply a range of dual fuel 6 cylinder Scania turbo CHP engines that can be driven on diesel oil, vegetable oil or a mixture of biogas and oil.

ENER-G supply a series of 6 to 20-cylinder turbo charged reciprocating CHP engines for biogas applications. As an option, natural gas can be connected into the system, albeit via a separate unit, to provide back-up electrical and heat energy, if required. Dual fuel engine options (biogas and natural gas) are available, but this requires a special upgrade on the engine management system.