

Industrials REIT

Rose Kiln Court, Reading

Low and Zero Carbon Feasibility Study

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1.0 Introduction

The purpose of this report is to assess the feasibility of incorporating Low and Zero Carbon technologies within the proposed new units at Rose Kiln Court, Reading.

The proposed development comprises 11nr new speculative units to be constructed across 2nr blocks. These new units will range from 256m² – 526m² individually, delivering an approximate 4,080m² flexible employment space

Each technology has been assessed to determine the feasibility for inclusion within the development and are discussed across the subsequent sections.

It is currently proposed that an ‘all-electric’ services strategy will be adopted for the development.



Existing Site – Plan View



Proposed Site – Ground Floor Plan

The development will be assessed under the following key criteria pertaining to sustainability;

Sustainability Drivers	Requirement
Building Regulations	Part L2A 2013 with 2016 amendments
Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction	BREEAM 2018 NC 'Very Good' Rating
Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy	Opportunities for on-site decentralised and/or renewable energy sources

1.2 Low and Zero Carbon Technologies

The following low or zero carbon technologies have been considered for use within the development:-

- i) Air Source Heat Pumps (ASHPs).
- ii) Wind Power.
- iii) Photovoltaics.
- iv) Solar Water Heating.
- v) Biomass Heating.
- vi) Combined Heat and Power (CHP).
- vii) Ground Source Heat Pumps (GSHPs).

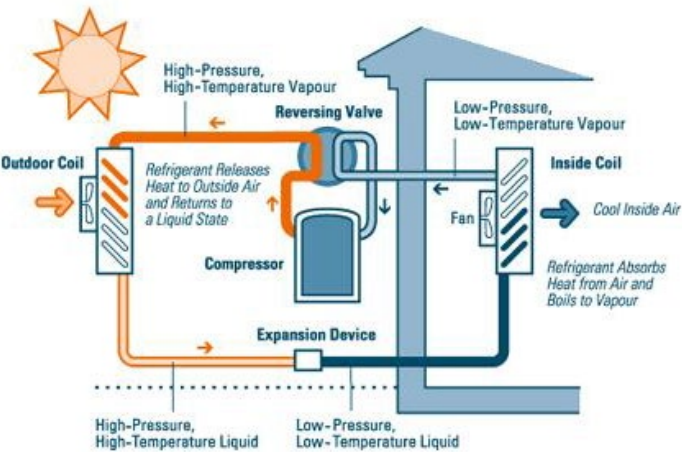
Each technology has been considered in the subsequent pages to determine the suitability to allow an informed decision as to whether they would be beneficial to the development.

2.0 Air Source Heat Pumps

Heat pumps extract thermal energy from a variety of renewable sources, including the air, earth or water, and upgrade it to a higher, more useful temperature. If the heat source for the system is the air then it is known as an air source heat pump. The use of heat pumps can lead to savings on fossil fuels and a subsequent reduction in the emission of greenhouse gases.

Air source heat pumps supply more useful energy than they consume. By extracting heat from the surrounding air, the heat energy released can be up to 5 times, the energy required to power the equipment.

An air source heat pump system consists of a compressor and a carefully matched evaporator coil and heat exchanger. A refrigerant liquid which circulates within the system has a boiling point as low as minus 40°C and evaporates when absorbing heat from the outside air. It is possible to extract considerable heat from the air at temperatures as low as minus 15°C. The resulting refrigerant gas is then compressed adding more heat energy and raising its temperature to around 75°C. Of course the cycle is reversible for the provision of cooling into the space, i.e. the refrigerant liquid which circulates within the system evaporates when absorbing heat from the air within the space. The resulting refrigerant gas is then compressed adding more heat energy and raising its temperature to around 75°C and heat is expelled to the atmosphere via the air cooled condensers.



This system process can be used to provide space heating through underfloor heating utilising heat pump boilers located internally or by heating the air using fan coil systems. Consideration would have to be given to noise generation from the floor mounted condensing units and the final plant and equipment selection will need to incorporate noise attenuation where necessary to ensure any planning conditions stipulating external noise levels are not exceeded and the system operation does not cause nuisance to adjacent buildings (including nearby residential properties).

The main advantages and disadvantages of this system are:-

Advantages

- Low capital cost
- Increased cooling output
- High efficiency
- Proven technology

Disadvantages

- Increased use of refrigerant gas
- Increased plant space requirements
- Medium/High running costs
- Medium/High maintenance costs
- Only considered renewable in heating mode

Summary Table - Air Source Heat Pumps

Air Source Heat Pumps	
Appropriateness of technology to the site/System viability	System could provide heating and comfort cooling to the office areas, however due to speculative nature of the buildings and relatively small size of offices the system is considered for implementation during the next stages of design.
Lifetime & Payback	Lifetime:15 – 20 years Payback: No Payback
Land Use	External plant enclosure local to the office area to house external condensers.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy Opportunities for on-site decentralised and/or renewable energy sources
Carbon savings	Grid electricity 0.519 kg CO ₂ /kWh OR gas 0.216 kg CO ₂ /kWh (*SAP 2012 Version 9.92)

Technology Considered Viable

Technology to be considered for incorporation into scheme during the next stage of design

3.0 Wind Power

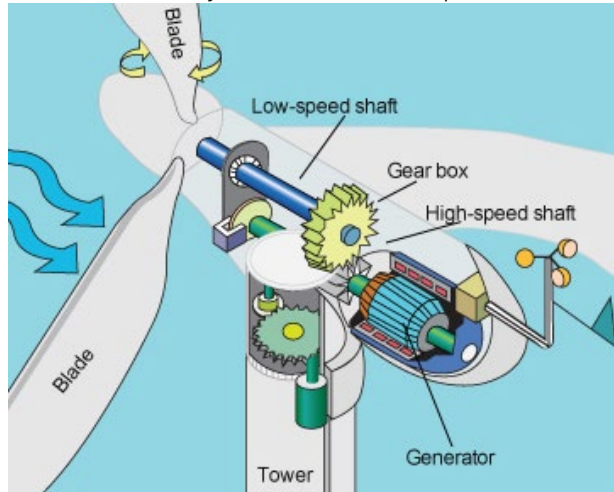
Power can be harnessed by the use of wind turbines. Harnessing wind as a renewable energy source involves converting the power within a moving air mass (wind) into rotating shaft power which in turn generates electricity.

Wind turbines are commercially available in various sizes and outputs from a few hundred Watts (battery charging systems for boats and homes) to 2-3 Megawatts (wind farm turbines connected to the National Grid).

Most small turbines generate a direct current (DC) and need to be connected to an inverter to convert the direct current to alternating current (AC). There are two main types of wind turbine systems, grid connected systems and off grid systems.

Off grid systems incorporate batteries to store the energy produced by the turbine, an extra controller is required to ensure the batteries do not become over or under-charged. The controller diverts the electricity produced by the turbine to other electrical appliances when the batteries are fully charged (for example space and or water heaters).

Grid connected systems do not incorporate batteries and require a controller and inverter to ensure that electricity is produced at a quality acceptable to the grid. Surplus electricity can be exported back to the electricity grid via an export meter and sold back to the electricity supply company.



Small variations in wind speed can produce large changes in energy output. Wind speed increases with height and it is essential that the knowledge of the local wind resource is comprehensive to maximise the potential of the turbine.

Wind turbines are rated to a certain capacity in kW; however this output is only achieved for the time that the wind is at its optimum level. As an approximate guide a good wind site will provide an average of 30% of the rated capacity of the turbine.

The following needs to be fully considered when assessing the viability of using wind turbines as a possible low or zero carbon technology for incorporation within the warehouse development:-

- The suitability of location of mounting a wind turbine. Roof mounting would be most suitable.
- Wind turbines have a visual impact and require planning approval
- Wind turbines generate noise in operation
- Average wind speed in the area of the project needs to be in excess of 6.5 metres/second for the turbine to be feasible.



System Viability

Turbines should not be located in areas where the annual mean wind speed is less than 6.5 meters per second when measured at 40 metres above ground level.

Location

- Latitude: 51.445756927808965
- Longitude: -0.9754120514971554
- Height above sea level: 169 m

Wind Speeds

- estimates from NOABL data*
- At 10m above ground level 4.8 m/s
 - At 25m above ground level 5.6 m/s
 - At 45m above ground level 6 m/s

Wind speed data at RG2 0BY (Source: NOABL wind map)

Wind speed local to the proposed development is therefore too low to be viable.

Summary Table – Wind Turbines

Wind Turbines	
Appropriateness of technology to the project/System viability	Wind speed local to the development is insufficient.
Lifetime & Payback	Lifetime: 20 years. Payback: Not calculated as system is not viable
Land Use	Wind turbine(s) would have to be roof mounted due to the restricted development site area.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy Opportunities for on-site decentralised and/or renewable energy sources
Noise	Plant noise attenuation requirements to be reviewed by the acoustic consultant and attenuation included within the design and installation as necessary to prevent noise egress.
Grant	The Feed-in Tariff ended in April 2019. Smart Export Scheme available as of January 2020. Rate not guaranteed.
Carbon savings	Not calculated due to system being considered as non-viable.

Technology Considered Non-Viable

Technology not to be incorporated into scheme

4.0 Photovoltaics

Photovoltaic means electricity from light. The photovoltaic (PV) process converts free solar energy the most abundant energy source on the planet - directly into electricity. Photovoltaic systems use daylight to power ordinary electrical equipment, for example, household appliances, computers and lighting.

A PV cell consists of two or more thin layers of semi-conducting material, most commonly silicon. When the silicon is exposed to light, electrical charges are generated and this can be conducted away by metal contacts as a direct electrical current (DC).

The electrical output from a single cell is small, so multiple cells are connected together and encapsulated (usually behind glass) to form a module (sometimes referred to as a "panel"). The PV module is the principle building block of a PV system and any number of modules can be connected together to give the desired electrical output.

In the UK, the sun's energy delivers about 950kWh/yr for every m² of southerly facing surface. PV panels are between 10% and 15% efficient at converting sunlight into electricity, which means you gain about 150kWh/yr of DC electrical energy for every m² of PV on your roof. This is converted to AC 220V and provides

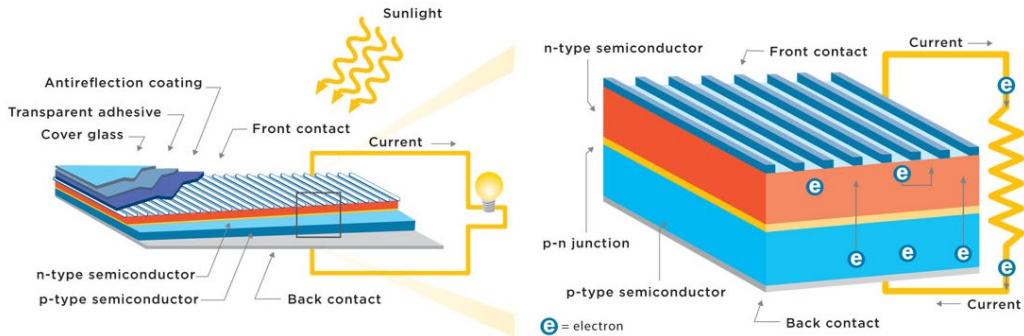


approximately 110kWh/yr/m² if the panels are installed on a south facing facade with a pitch of approximately 35 degrees. East or West facing PV panels provide approximately 80 percent of that yielded from a South facing PV panel.

PV equipment has no moving parts and as a result requires minimal maintenance. It generates electricity without producing emissions of greenhouse or any other gases, and its operation is virtually silent and unlikely to create a nuisance to the adjacent buildings and in particular the residential buildings.

PV systems can be incorporated into buildings in various ways: on sloped roofs and flat roofs, in facades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are available which can be fitted in place of standard tiles.

PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable alternating current (AC) form. The alternative is to source DC motors for plant and equipment such as fan and filter motors whereby the electricity produced by the PV panels can be used directly.



The following issues have been considered when assessing the viability of using photovoltaics as a possible low or zero carbon technology for incorporation within warehouse development:-

Disadvantages

- External area allowance required to locate PV panels
- PV panels will have a visual impact and would require planning approval
- Extremely high capital expenditure

Advantages

- Electricity produced can be sold back to the grid during periods of low demand within the building
- Low maintenance cost
- Mature technology

Summary Table - Photovoltaics

Photovoltaics	
Appropriateness of technology to the site/system viability	Electricity generated by the PV array could be utilised within the units to reduce the consumption of grid electricity. System can be easily integrated into the building and can be used as a bolt on technology alongside other LZCs and is not influenced by the building services strategy. Requires fixed building services to be installed within the warehouse to make best use of this technology, not appropriate for use in conjunction with the base build fixed building services.
Lifetime & Payback	Lifetime: 25 years Payback: Subject to calculation as part of any fit-out works.
Land Use	Usually installed at roof level at an incline of 30 - 45° and south facing. Steel uplift to be designed into the roof to handle increased load associated with PV panels.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy <i>Opportunities for on-site decentralised and/or renewable energy sources</i>
Noise	Not an issue with this type of system.
Grant	The Feed-in Tariff ended in April 2019. Smart Export Scheme available as of January 2020. Rate not guaranteed
Carbon savings	Grid electricity 0.519 kg CO ₂ /kWh (*SAP 2012 Version 9.92)

Technology Considered Viable

Technology to be incorporated into scheme

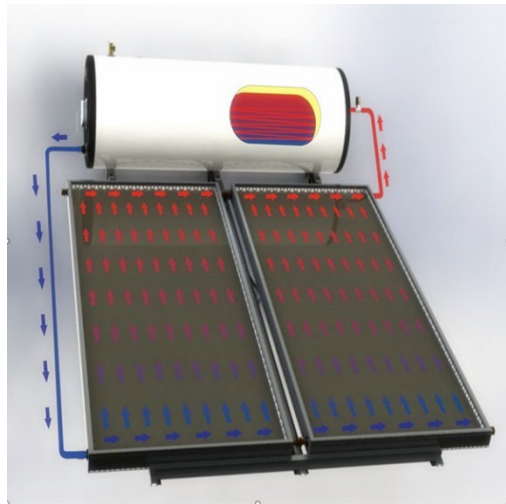
5.0 Solar Thermal Water Heating

Solar thermal water heating uses heat from the sun to warm up an energy absorbing media pumped through a solar absorbing panel usually situated on the roof of the building served. The heated media is then pumped through a heat exchanger typically to heat hot water within a storage cylinder. Solar Water heating is more efficient at yielding energy from the sun than photovoltaics.

The hot water demand requirements of the building served and size of the hot water storage vessel have a significant effect on the viability of a solar water heating system.

The major applications for this type of system are associated with the generation of low-grade hot water, often in the range of 30°C – 50°C, dependant on the geographical location of the installation. The media used as an energy absorber is usually water or a water/glycol mixture.

There are two main options when considering solar water heating. These are either flat plate or evacuated tube systems.



An evacuated solar heat pipe collector is a more efficient system (approximately 40% in comparison with a flat plate system which has an efficiency of approximately 30%) and uses a refrigerant as the transfer media. This allows higher-grade heat energy to be produced (typically 50°C – 70°C in summer.) In simple terms, an evacuated solar heat pipe collector is effectively a boiler that works throughout the day, whether you need it to or not. The heat it generates needs to be removed and used immediately. Long stagnation will damage collectors permanently. The performance of the collector is directly related to the amount of light (solar radiation) that it receives.

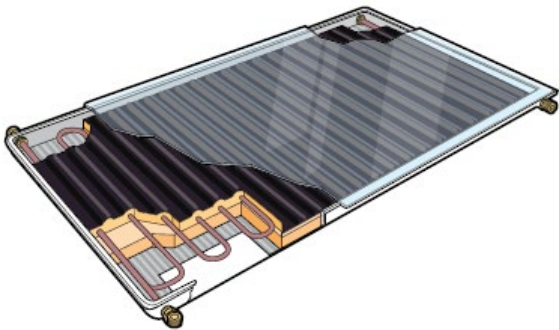
The collector transfers the heat to a copper pipe in the manifold via thermal clamps. This eliminates collector contact with the fluid (water), and provides a double-walled heat exchanger that allows the manifold to accept water company

water pressures.

A closed loop system uses a transfer fluid, usually non-toxic propylene glycol, to transfer the heat from the collector to a heat exchanger through a pressurised closed loop, as well as controller and pump this system needs a heat exchanger or a tank with a coil, expansion tank, pressure relief valve, air vents and possibly a check valve to stop night time thermosyphoning. The glycol provides excellent protection against freezing.

It is possible to power the circulation pump directly by photovoltaics, eliminating the need for a controller, making the system truly independent. If the system can be designed with the manifold below the heat exchanger, the system will thermosyphon, and the pump can be eliminated.

The peak irradiation level is achieved by a South facing solar panels at 45 degrees inclination. Solar panels are not normally installed at less than 20 degrees inclination.



The operational noise from a solar thermal panel array is virtually silent and unlikely to cause any disturbance. The following issues have been considered when assessing the viability of utilising solar hot water as a renewable energy technology within the building:-

- Constant hot water demand is required throughout the year.
- Large external area required to locate solar panels.
- Solar panels have a visual impact and would require planning approval.
- Hot water storage plant space required local to the solar panels.
- Relatively high capital expenditure.

Summary Table – Solar Thermal Water Heating

Solar Thermal Water Heating	
Appropriateness of technology to the site/System viability	The hot water generated by solar collectors could be utilised for domestic usage within the buildings, however the office areas will have a low DHW demand and therefore the technology would have little impact in reducing CO ₂ emissions and therefore it is deemed to not be viable in this instance.
Lifetime & Payback Payback	Lifetime: 20 years. Payback: Not calculated as system is not viable.
Land Use	Solar collectors generally installed at roof level, south facing at an incline of 30 - 45°.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy Opportunities for on-site decentralised and/or renewable energy sources
Noise	Not an issue with this type of system.
Grant	Non-Domestic Renewable Heat Incentive (RHI) ended in March 2021. This is likely to be replaced by the Clean Heat Grant in 2022.
Carbon savings	Not calculated due to system being considered as non-viable.

Technology Considered Non-Viable
 Technology not to be incorporated into scheme

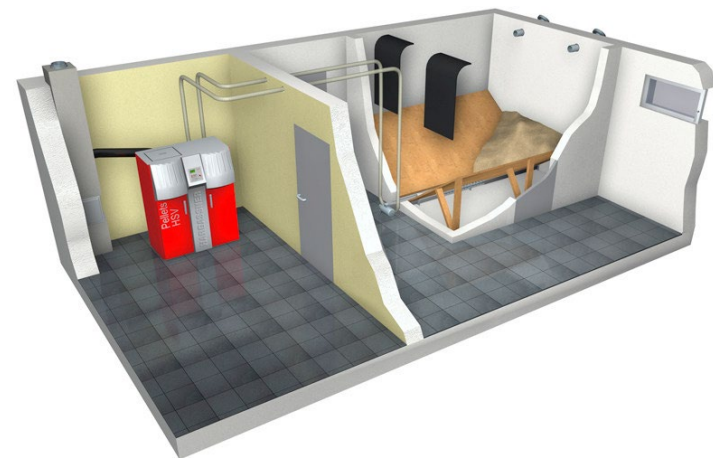
6.0 Biomass Heating

Biomass, also known as bio fuels or bio energy, is obtained from organic matter, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products (logs, wood chips, pellets, etc.).

The use of biomass is generally classed as a 'carbon-neutral' process because the carbon dioxide released during the generation of energy is balanced by that absorbed by plants during their growth. However, it is important to account for any other energy inputs that may affect this carbon-neutral balance on a case-by-case basis, for example any use of fertiliser, or energy consumed in vehicles when harvesting or transporting the biomass to its point of use.

Biomass boilers require additional space for fuel storage which can be significant and arrangements for flues are more onerous than those for gas or oil boilers, access will also be required for ash removal. Outside access to the plant room and storage is important for handling the delivered fuel, which should be appropriate to its means of transportation. The noise and disruption associated with the delivery of the biomass fuel could cause a nuisance to the adjacent residential building.

Sufficient fuel storage is required to cover the time between deliveries. The quantity of fuel in a single delivery will depend upon the size of the boiler and the cost and reliability of fuel supply. The fuel type also needs to be considered as logs and wood chips take up more space than pellets for the same heat output.



Biomass boilers have to run for some time before they achieve the desired output temperature and hence some form of heat storage is desirable to provide instant heating and hot water. Heat storage also allows the boiler to operate at a higher efficiency as lower temperatures over a longer burning time is a better and more sustainable regime.

As biomass boilers are more expensive than gas or oil boilers with the same heat output, it is both safer and cheaper to size the biomass boiler to meet a base load, and to provide additional top up/back up gas or oil boilers.

Biomass fuel prices vary as to its availability and the quantity of fuel purchased. Bulk buying of fuel means that it can be purchased at a more competitive rate. It should also be noted that CO₂ is emitted in the transportation of the biomass fuel. If the fuel is being transported long distances then the carbon emitted and associated environmental effect in doing this must be taken into account.



System Viability

The use of biomass heating to reduce CO₂ emissions is not considered to be a viable solution for the proposed warehouse for the reasons as detailed:-

- Increased plant space requirements for storage of biomass fuel.
- Noise issues associated with biomass fuel delivery.
- The availability of biomass fuel local to the development is currently unknown.
- CO₂ emissions associated with fuel delivery if the fuel is not sourced locally.
- Reliability of biomass heating plant.
- Increased maintenance requirements.
- High capital cost.
- Possible higher insurance premium commensurate.
- Fuel costs marginally cheaper than gas, however, boiler efficiencies and maintenance costs mean higher running costs.

Summary Table – Biomass Heating

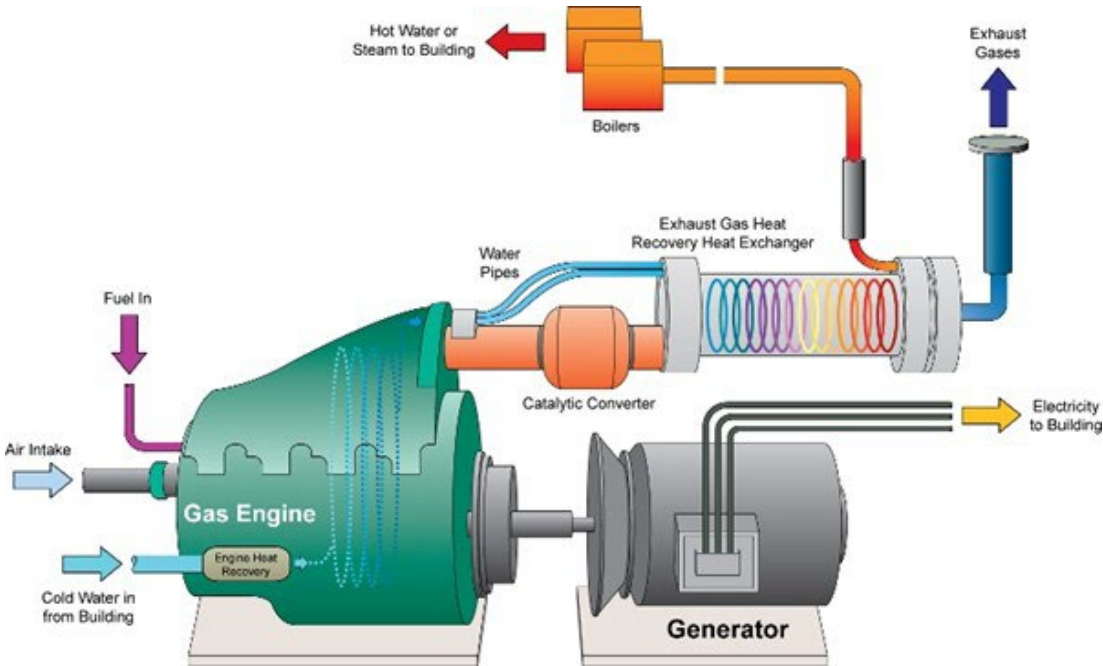
Biomass Heating	
Appropriateness of technology to the site/system viability	Biomass boilers could be utilised to heat the building, however the current plans do not provide enough plant space to allow for the fuel storage to be provided.
Lifetime & Payback	Lifetime: 15 – 20 years Payback: 9 years based on RHI contribution
Land Use	Biomass boiler plant and the associated fuel storage would have to be accommodated internally within the building due to the restricted plot site area for the each unit.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy <i>Opportunities for on-site decentralised and/or renewable energy sources</i>
Noise	Possible issue associated with the delivery of the biomass fuel.
Grant	Non-Domestic Renewable Heat Incentive (RHI) ended in March 2021. This is likely to be replaced by the Clean Heat Grant in 2022.
Carbon savings	Not calculated due to system being considered as non-viable.

Technology Considered Non-Viable

Technology not to be incorporated into scheme

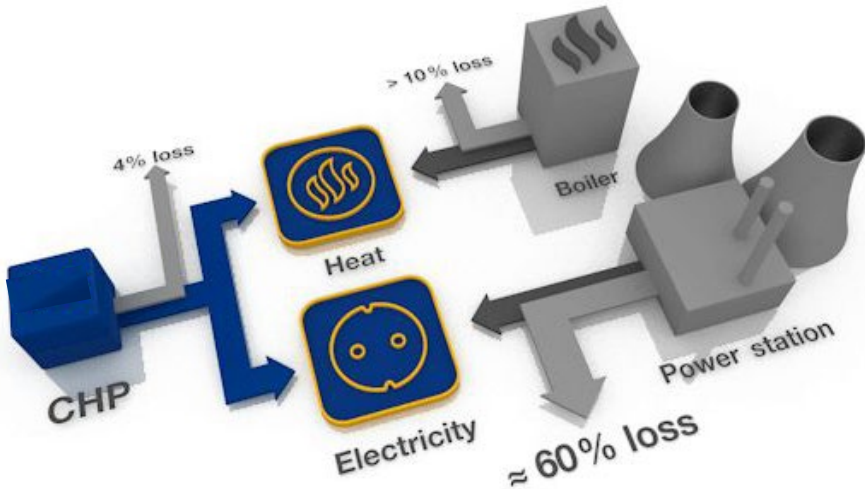
7.0 Combined Heat and Power (CHP)

The principal is that a gas or oil fired engine drives a generator that produces electricity. The heat from the engine block, oil cooler and exhaust are absorbed into a coolant and this is used as a heat source within the building. This is not as such a “sustainable energy” but is considered highly energy efficient and reduces the production of CO2 as the heat that is usually wasted during electricity production is utilised and mains distribution losses associated with the distribution of electricity from power stations to the site are minimised. The ratio of electricity to heat production is in the region of 1 unit of electricity to 2 units of heat, though this may vary between different manufacturers of combined heat and power units.



The key to both the economic and carbon efficiency of combined heat & power is the constant requirement for the heat produced throughout the year. If the heat produced is not utilised then combined heat & power becomes less carbon efficient at producing electricity than a power station on the national electricity grid. If the combined heat & power is only used when there is a requirement for heat, thus is used infrequently the pay-back time on the unit would not make economic sense.

Noise associated with the operation of the CHP unit can cause nuisance and the final location of the CHP plant and the construction of the plantroom enclosure would have to be carefully considered and incorporate the necessary specification of noise attenuation to minimise noise breakout.



System Viability

The following issues have been considered when assessing the possibility of utilising CHP technology within the building:-

- Constant Heat Load requirement.
- Plant location (noise and vibration).
- High capital cost.
- Increased maintenance requirements.

For a CHP system to be successful, a constant requirement to utilise the heat produced must be available within the building throughout the year. The warehouse development would have a domestic hot water demand throughout the year, however the CHP plant should be sized to supply not less than 45% of the annual total heating demand. The domestic hot water demand would be very low and therefore it is unlikely that a CHP could meet this target and the CHP would only have a small impact on reducing carbon emissions.

Summary Table - Combined Heat and Power (CHP)

Combined Heat and Power (CHP)	
Appropriateness of technology to the site/system viability	Heat produced by the CHP unit could be utilised to meet a proportion of the domestic hot water demand however units will not have a large DHW requirement and therefore the benefit of installing a CHP will be small.
Lifetime & Payback	Lifetime: 15 years Payback: In excess of 20 years due to lack of constant heat demand and reduced operating period.
Land Use	CHP plant would have to be accommodated internally within the building due to the restricted development site area.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - BREEAM 2018 NC 'Very Good' Rating Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy Opportunities for on-site decentralised and/or renewable energy sources
Noise	Plant noise attenuation requirements to be reviewed by the acoustic consultant and attenuation included within the design and installation as necessary to prevent noise egress.
Grant	The Feed-in Tariff ended in April 2019. Smart Export Scheme available as of January 2020. Rate not guaranteed
Carbon savings	Not calculated due to system being considered as non-viable.

Technology Considered Non-Viable
 Technology not to be incorporated into scheme

8.0 Ground Source Heat Pumps (GSHP)

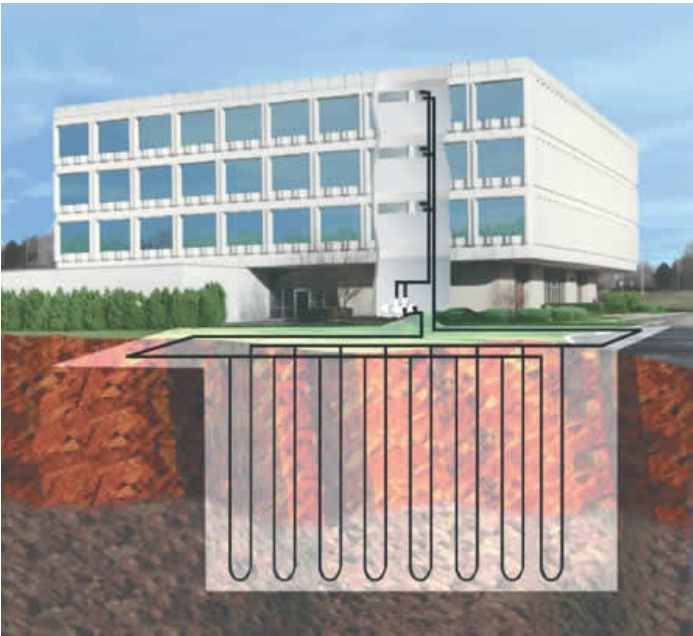
Ground source heat pumps take heat from the ground, raise its temperature and use the energy to provide heat within the building served by the system. They operate on the same refrigeration cycle principles as a fridge but use the cycle in reverse to generate spatial heating and hot water. Heat absorption is achieved by circulating water mixed with antifreeze through a closed collector pipework system. The temperature of the earth at one metre below ground level remains fairly consistent between approximately 9 - 12°C throughout the year depending on geographical location and soil type.

The advantage of using a ground source heat pump is its efficiency. The coefficient of performance of ground source heat pumps are typically between 3 and 4, therefore for every kW used to power the heat pump 3 to 4kW of energy is extracted from the ground.

A ground source heat pump installation typically consists of a heat pump, ground collector (either a bore hole or array), a manifold, circulation pumps to move the energy around the system, various automatic and manual valves, an expansion vessel, a buffer tank to store the energy, a hot water cylinder for heating domestic hot water and a control system.

The following issues have been considered when assessing the possibility of utilising a ground source heat pump installation within the building:-

- Space required for the closed collector pipework system.
- Suitability of internal heat emitters.
- High capital cost.
- Piling or bores would be required on site.



System Viability

Ground source heat pumps provide heat at a lower temperature than other forms of heating. This makes it best suited to underfloor heating applications. It is not intended to include underfloor heating within the building. The warehouse development does not have sufficient external area for installation of a horizontal collector system and therefore a geothermal piling system would be required. It is proposed that the warehouse will utilise pad foundations and therefore it will not be possible to incorporate ground source heat pumps within the design

Summary Table - GSHP

Ground Source Heat Pumps (GSHP)	
Appropriateness of technology to the site/system viability	Heat produced is at a low temperature and does not suit the proposed heating system. The system is not viable as there is no space to install collector pipework.
Lifetime & Payback	Lifetime: 20 years Payback: Not calculated as the system is not viable
Land Use	No external land use required for geothermal bore holes. Horizontal arrays require external space for installation.
Local Planning Requirements	Reading Borough Council Local Plan (2019) - Policy CC2 Sustainable Design & Construction - <i>BREEAM 2018 NC 'Very Good' Rating</i> Reading Borough Council Local Plan (2019) - Policy CC4 Decentralised Energy <i>Opportunities for on-site decentralised and/or renewable energy sources</i>
Noise	No noise issues
Grant	Non-Domestic Renewable Heat Incentive (RHI) ended in March 2021. This is likely to be replaced by the Clean Heat Grant in 2022.
Carbon savings	Not calculated due to system being considered as non-viable.

Technology Considered Non-Viable

Technology not to be incorporated into scheme

9.0 Summary

Of the low or zero carbon technologies considered, photovoltaics are considered the most appropriate technology to incorporate into the development.

It is proposed that each unit will be provided with a minimum of 3nr PV panels.

Refer to Appendix A for the energy savings based on the incorporation of photovoltaics to each unit.

The incorporation of Air Source Heat Pumps are to be investigated during the next stage of design.

The other low or zero carbon technologies investigated are not considered to be viable options due the location of the development, space limitation and payback periods.

Appendix A – Indicative Photovoltaic Energy Savings

Unit	Unit Area (m ²)	PV Panels Proposed* (nr)	Area per PV Panel (m ²)	Total Proposed PV Area* (m ²)	PV Annual Generation (kWh/m ² /annum)	PV Annual Generation (kWh/annum)	Carbon Emissions (kg CO ₂ /kWh)	Carbon Emissions Saving (kg CO ₂ /annum)
A1	391	3	1.6	4.8	150	720.0	0.519	373.7
B1	502	3	1.6	4.8	150	720.0	0.519	373.7
B2	244	3	1.6	4.8	150	720.0	0.519	373.7
B3	244	3	1.6	4.8	150	720.0	0.519	373.7
B4	294	3	1.6	4.8	150	720.0	0.519	373.7
B5	244	3	1.6	4.8	150	720.0	0.519	373.7
B6	244	3	1.6	4.8	150	720.0	0.519	373.7
B7	366	3	1.6	4.8	150	720.0	0.519	373.7
B8	386	3	1.6	4.8	150	720.0	0.519	373.7
B9	520	3	1.6	4.8	150	720.0	0.519	373.7
B10	486	3	1.6	4.8	150	720.0	0.519	373.7
Sitewide Total	3,921	33	1.6	52.8	150	7,920.0	0.519	4,110.5

