



Sandvik Osprey Development Site, Port Talbot

LZC Feasibility Report & Energy Assessment

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For

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This document contains the following information:

- LZC Feasibility Report
- Energy Assessment

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LZC Feasibility Report

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1. Executive Summary

1.1 Overview

The proposed development is for an office building, an amenity block and a production building. The office and amenity block are 2 storey with a floor area of approx. 1355m² and 795m² respectively. The production unit has a total floor area of 25655m².

This report investigates the viability of integrating a host of low and zero carbon (LZC) technologies within the proposed development. Each of the considered technologies has been assessed against several specific criteria including cost, payback period, site suitability and potential energy generation.

The outcome of this report will determine the most viable and more importantly appropriate LZC technologies to help balance this forward-looking low energy project.

The main objective is to independently evaluate and identify the most appropriate LZC's for the development, whilst maintaining an awareness of the planned use for the development now and into the foreseeable future.

1.2 Key Findings

The report concludes that several technologies are suitable for inclusion in the development which can further enhance the overall CO₂ reduction.

The most appropriate technologies at this stage for consideration are PV panels and Air Source Heat Pumps. The possibility of an electricity connection from the adjacent biomass energy plant is also viable. This would be capable of supplying

all the electricity for the proposed development, thus providing a low carbon electricity source for the site.

Biomass, CHP, Solar Thermal and Ground Source Heat Pump could be considered appropriate technologies subject to further studies.

Hydro and Wind are not considered suitable at this stage.

The report investigates fully the feasibility of incorporating all types of renewable and low carbon energy into the proposed development and meets the energy assessment requirements of Neath Port Talbot Local Development Plan policy *RE2 Renewable and Low Carbon Energy in New Development*.

2. Local policy drivers

This report has been prepared considering Neath Port Talbot County Borough Council's Local Development Plan 2011-2026 with specific reference to strategic policy *SP18 Renewable and Low Carbon Energy* and *RE2 Renewable and Low Carbon Energy in New Development*.

SP18 Renewable and Low Carbon Energy – sets out the broad measures that will be taken to ensure that national renewable energy and energy efficiency targets will be met.

Policy SP18

Renewable and Low Carbon Energy

A proportionate contribution to meeting national renewable energy targets and energy efficiency targets will be made while balancing the impact of development on the environment and communities. This will be achieved by:

1. Encouraging where appropriate, all forms of renewable energy and low carbon technology development;

RE2 Renewable and Low Carbon Energy in New Development – deals with incorporation of low/renewable carbon energy within major development.

The policy seeks to encourage the use of renewable or low carbon energy, including the connection to existing supplies, the provision and use of district heating networks and the use of on-site renewable / low carbon technology.

It also requires the submission of an Energy Assessment to determine the feasibility of incorporating any type of renewable or low carbon energy into the development.

Policy RE2

Renewable and Low Carbon Energy in New Development

Schemes that connect to existing sources of renewable energy, district heating networks and incorporate on-site zero / low carbon technology (including microgeneration technologies) will be encouraged.

The following proposals will be required to submit an Energy Assessment to determine the feasibility of incorporating such a scheme and where viable, would be required to implement the scheme:

- (a) Residential development for 100 or more dwellings;
- (b) Development with a total floorspace of 1,000 sqm or more.

In accordance with Appendix C of *Supplementary Planning Guidance: Low Carbon Energy* the content of this report includes the following information:

- ✓ The likely energy demand of the development
- ✓ The potential for renewable / low carbon energy generation on the site
- ✓ The availability and potential to connect to existing sources of renewable / low carbon energy
- ✓ The potential for incorporating or being part of a District Heating System
- ✓ The potential to share renewable / low carbon energy generated on the site

3. Energy Efficient Design Measures

3.1 Solar & Daylighting

Where possible, the proposed development is makes use of glazing to help reduce internal lighting loads.

3.2 Ventilation

The proposed development incorporates mechanical ventilation with heat recovery throughout all occupied areas. SFPs of 1.5W/l/s have been allowed for with a heat recovery efficiency of 70%. Mechanical extraction will be fitted to all WCs, shower and kitchen areas.

3.3 Lighting

All external light fittings for the building, access ways and pathways will have a luminous efficacy of at least 75 lamp lumens/circuit Watt. External light fittings will be controlled through a time switch, or daylight sensor, to prevent operation during daylight hours.

Internal lighting will be designed to provide average Lux levels appropriate to room activity. Lighting with 100 lumens per circuit watt have been allowed for throughout the buildings.

3.4 Insulation & Fabric Performance

Where possible, the external fabric of the building has been upgraded to improve the comfort and energy efficiency of the building. High performance insulation will be specified throughout and will have a GWP of <5 and zero ODP.

The proposed specification suggests the following U values:

- A floor U-value of 0.20 W/m²K in the production and amenity buildings and 0.21 W/m²K in the office block.
- A wall U-value of 0.27 W/m²K.
- A roof U-value of 0.18 W/m²K
- A window U-value of 1.80 W/m²K

3.5 Heating & Cooling Strategy

For the purposes of this report a gas boiler feeding radiators has been used to provide a baseline for the calculations. Where cooling is required air conditioning has been allowed for in these areas with an efficiency of 400%.

3.6 Hot Water Strategy

For the purposes of this report an electric instantaneous hot water system has been used for all spaces.

4. Site Constraints

Prior to the investigation into the suitability of each technology a scoping exercise has been undertaken to identify any key constraints which may affect the performance or viability of introducing any LZC technologies to the site, these have been discussed in greater detail later in the report.

4.1 Planning Constraints

The report author has not been made aware that the building falls into any of the following categories: Special Protection Area, Site of Scientific Interest or Special Areas of Conservation.

4.2 Air Quality Management Area

The proposed site falls outside of an Air Quality Management Areas (AQMA) and will not be required to demonstrate that any proposed technology contributes additional levels of nitrogen dioxide.

4.3 Geological Constraints

There are no geological constraints known onsite.

4.4 Solar Resources

Solar energy resource is available onsite, further investigation may be required to determine the level of shading from other buildings and trees.

4.5 Visual Constraints

There are no visual constraints as far as the site layout is concerned.

5. Baseline Energy Demand & CO₂ emissions

Energy performance benchmarks for the proposed development are taken from 'Energy efficiency in buildings' CIBSE Guide F (2004 and updated 2012) and where appropriate data from relevant design team members and thermal modelling calculations.

5.1 Methodology

To correctly size the LZC technologies that are being investigated, it is important to determine the likely energy demand profile that is expected for the development.

The calculation methodology for this followed current Part L2a compliance and was modelled using IES dynamic simulation software.

5.2 Fuel Factors

The following standard CO₂ emission factors have been referenced from UK Government Greenhouse Gas Conversion Factors 2016:

- Natural gas: 0.20 kg/CO₂/kWh
- Grid electricity: 0.41 kg/CO₂/kWh

5.3 Assumed Fuel Costs

The following assumption have been made of fuel costs:

- Natural gas: £0.04 kWh
- Grid electricity: £0.14 kWh

5.4 Baseline Energy Demand

The calculation provides a total regulated baseline energy demand of 1,006,605.63kWh or 36.17kWh/m².

5.5 Baseline CO₂ Emissions

The results of all 3 units have been combined for the baseline calculations. The calculation provides a total baseline CO₂ emission of 453,667.12kg or 16.30kg/m².

Total internal floor area 27,833.6m ²	Wales Part L2A 2013 baseline			
	kWh/m ²	kWh total	CO ₂ Kg/m ²	CO ₂ Kg total
Heating	6.87	191,223.99	-	-
Cooling	0.58	16,013.09	-	-
Auxiliary	1.28	35,711.96	-	-
Lighting	21.90	609,625.39	-	-
Hot Water	5.53	154,031.20	-	-
Total	36.17	1,006,605.63	16.30	453,667.12

5.6 Simple Payback

Payback and energy demand calculations assume, unless stated otherwise, that the considered technology can provide 100% of the energy demand to provide an equal comparison across all technologies. This may not always be technically or otherwise appropriate.

6. Funding Availability

In July 2009, the 'UK Renewable Energy Strategy' was published and set out the Governments aspirations to comply with the EU 2009 Renewable Energy Directive. This directive committed the UK to sourcing 15% of our energy from renewable sources (in effect cutting out CO₂ emissions) and gave a clearer indication to the Governments support of micro-generation to assist in the reduction of CO₂.

The directive also provides the vehicle for delivery of two initiatives to make a carbon reduction through the installation of micro-generation projects. These are the Feed in Tariff and Renewable Heat Incentive. The Feed in Tariff was removed in April 2019 and is no longer available for new installations.

6.1 Renewable Heat Incentive

The Renewable Heat Incentive, which is the first of its kind in the world, encourages the installation of renewable heat equipment such as solar thermal technologies, biomass boilers and ground, air and water source heat pumps. Like Feed-in Tariffs it is a government environmental programme that provides financial incentives to increase the uptake of renewable heat by businesses, the public sector and non-profit organisations.

Broadly speaking it provides a subsidy, payable for 20 years, to eligible, non-domestic renewable heat generators.

The payments will be made quarterly over a 20-year period to the owner of the heat installation.

You will not be eligible for the RHI if you have received a 'grant from public funds' for the costs of purchasing or installing your renewable heat installation.

It is important to note that any available incentive is considered when estimating payback periods. Examples with and without the incentive have been provided to give the reader an informed, level benchmark, when considering all technologies.

7. Considered Technologies

In formulating this report the following technologies have been considered:

- Solar Thermal
- Solar PV
- Hydro
- Wind
- Biomass (solid)
- CHP (gas)
- Heat Pumps – Aerothermal
- Heat Pumps – Geothermal

The following technologies have not been considered:

- Biomass (bio-liquids)
- Biomass (Anaerobic Digestion)
- Hydrogen Fuel

A connection to the adjacent Western Bio Energy Power Station has also been investigated in this report. The investigation looks at whether the power station could provide heating and hot water from the waste heat and also an electricity connection.

7.1 Solar Thermal

7.1.1 Background Information

Solar water heating systems use energy from the sun to heat water and is arguably the most recognised and tested renewable source in the world with technology now well developed and a large range of equipment to suit many different applications.

It does this by retaining the radiant heat from the sun's rays and transfers this heat to a fluid, to preheat water for domestic hot water (DHW) applications. This fluid is circulated by a pump to heat up water that is stored in either a separate hot water cylinder or in a twin coil hot water cylinder inside the building. The systems can work effectively in all parts of the UK if placed in an un-shaded position, as they can work in diffuse light conditions. Typically, collectors are mounted on south facing roofs or facades but can work from southeast to southwest orientations with a reduction in performance.

A solar thermal system normally works alongside a 'conventional' water heater to ensure year-round hot water. A well-designed system will provide 50-75% of the yearly total demand with near to 100% of the summer demand. It is important not to provide over capacity which will lead to inefficiency in a system.

There are two standard types of collectors commonly available; flat plate collectors and evacuated tube collectors. Typically, flat plate collectors have a lower capital cost per unit of energy saved capital but evacuated tube collectors, although more expensive, achieve higher overall conversion efficiencies.



Example evacuated tube collector



Example flat tube collector

Solar thermal water heating systems normally operate in conjunction with a conventional heating system, the solar system pre-heats the water and the temperature is boosted to the required temperature if necessary by a paired heating system.

Flat-plate collectors are a more efficient collector but suffer from the disadvantage of losing heat to the environment when the liquid in the collector reaches a temperature far above the ambient.

Evacuated tube collectors suffer the disadvantage that their absorber plate area to gross area ratio is smaller (typically 60-80% of gross area) than for flat plates. In general, evacuated tubes work well when the ambient temperature is low (e.g. during winter) or when the sky is overcast for long period. On the other hand, in areas with much sunshine and solar heat, a plate collector may be more efficient especially if its price compares favourably with that of an evacuated tube collector.

Solar thermal systems which have been correctly sized and installed at structures such as houses, offices, factories, leisure centres etc. could save up to 70% of domestic hot water bills each year.

The most effective orientation and angle is south facing inclined at between 30-35° to the horizontal, however yield only falls off slowly as the inclination reduces or faces to the south east or south west.

The proposed pitch of the new development is approximately 15° and faces south.

The additional weight of solar thermal panels needs to be considered when undertaking structural calculations but typically does not increase loading by a significant amount.

Prior to RIBA Stage 3 it is recommended that the design team seek independent specialist advice, using accurate weather data, to identify the full extent of solar potential and likely array size requirements for 100% summer hot water demand.

7.1.2 Energy Generated

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There is a significant amount of roof space orientated South. Based on an approximate hot water demand of 827.53kWh/annum for the site it is envisaged that 100% of this summer requirement can be met by solar panels given available roof areas.

Installation size (m ²)	Typical average output (kWh/hr)
1	400-450
10	4,000-4,500
50	20,000-22,500

7.1.3 Payback

Installation size (m ²)	Estimated install cost
1	£700
10	£7,000
50	£30,000

Installation Size m ²	Annual energy generated (kWh)	Annual site carbon emissions (kg)	Reduction (CO ₂ /kg/yr)*	% saving in regulated CO ₂
1	400	453,667.12	80	0.018%
10	4,000	453,667.12	800	0.18%
50	20,000	453,667.12	4,000	0.88%

* carbon factor for grid displaced electricity as 0.41kg/CO₂/kWh and mains gas as 0.20kg/CO₂/kWh.

	Installation size		
	1	10	50
Annual output (kWh)	400	4,000	20,000
Renewable heat incentive (p/kWh)	11.19p	11.19p	11.19p
RHI revenue (£/yr)	£44.76	£447.60	£2,238
Annual cost saving (based on gas cost at 4p/kWh)	£16	£160	£800
Total annual saving inc. RHI revenue	£60.76	£607.60	£3,038
Payback period inc. RHI (yrs)	11.52 years		
Payback period ex. RHI (yrs)	43.75 years		

7.1.4 Land Use

There are no specific land use issues as this system is generally installed on the roof of a building.

7.1.5 Local Planning Requirements

Additional planning permission is not normally required for small scale micro-generation that is already covered under the primary application, and no local planning constraints have been identified that would prohibit the use of a solar thermal array on the proposed development. Clarification should be sought prior to any detailed design work.

7.1.6 Noise

There are no issues with regards to noise with this type of LZC technology.

7.1.7 Feasibility of Exporting

This system is designed to generate heat locally for the use of the development. There is no electricity produced therefore feasibility of exporting energy is not possible.

7.1.8 Available Funding

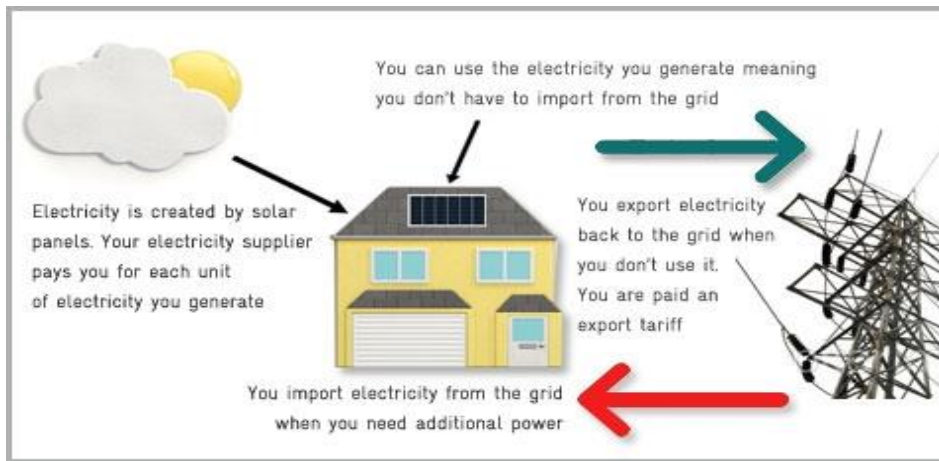
Non-domestic installations that qualify under the Micro-generation Certification Scheme (MCS) will be measured under the Renewable Heat Incentive.

7.1.9 Technology Suitability

Solar thermal designs depend on panel size and the amount of available solar radiation. The location has been deemed adequate for solar panel installation. However, consideration must be made to the overall DHW demand of the buildings, which is likely to be low at this development.

7.2 Photovoltaic (PV)

7.2.1 Background Information



Solar energy involves the use of the sun's free energy (solar radiation) to provide electricity through using photovoltaic panels (PV). Solar PV converts the energy from the sun into electricity through semi-conductor cells connected together and mounted into modules. These modules are then connected to an inverter that converts direct current (DC) into alternating current (AC) so that it can be connected to the building main electricity distribution board. PV panels require only daylight and not direct sunlight to generate electricity, however shading and obstructions can significantly affect the overall performance levels.

The PV system can provide electricity to a building when it's generated or when building demand in insufficient surplus electricity can be exported to the national grid and generate an income.

They can be installed to the roofs or facades of individual buildings in the form of separate panel units or as solar slates which have a lower visual impact. There is an increasing trend to mount larger arrays on the ground when roof space is restrictive. The most effective orientation and angle is south facing inclined at between 30-35° to the horizontal, however yield only falls off slowly as the inclination reduces or faces to the south east or south west.



The proposed pitch of the new development around 30% and faces West/East.

The additional weight of solar PV needs to be considered when undertaking structural calculations but typically does not increase loading by a significant amount.

Currently the most common commercially available solar cells are:

Monocrystalline Silicon Cells – Wafer thin slices cut from a single cylindrical crystal of silicon. These cells have typical efficiencies of 15-20%. The manufacturing process is complex and therefore the costliest.

Polycrystalline Silicon Cells – Made from wafer thin slices cut from ingot of melted and re-crystallised silicon. Typical efficiencies are around 13-16%. The manufacturing process is less complicated which results in a less expensive product.

Thin Film Cells – Comprising of amorphous silicon, this is composed of silicon atoms in a thin homogenous layer deposited on a rigid or flexible metal plate. Although typical efficiencies are 6-9%, these cells have a better efficiency in diffuse light than the types above and can have a greater yield per kW installed depending on geographical location. This may be a good option if area is not a constraint. The manufacturing process is the least complex of the systems available and is therefore normally the cheapest PV product available.

Hybrid Silicon – Combines both monocrystalline and thin-film silicon to produce cells with the best features of both technologies. Typical efficiencies are >20% which gives the greatest yield per m². However, the manufacturing process is complex and therefore results in a more expensive product.

PV installations have no moving parts and require minimal maintenance. However they need to be kept clean for optimum performance and regular cleaning to remove dust accumulation may be needed. Systems can be designed and located so that they can 'self-clean' when it is raining.

Consideration needs to be given to replacement of inverter during the anticipated life expectancy of the PV.

The durability of PV cells varies according to the type of cell used. For silicon based PV modules the following lifespan can be expected:

PV Type	Lifespan
Monocrystalline	25-30
Polycrystalline	20-25
Amorphous	15-20

Prior to RIBA Stage 3 it is recommended that the design team seek independent specialist advice, using accurate weather data, to identify the full extent of solar potential.

7.2.2 Energy Generated

With an amount of roof space orientated south, it would be possible to generate a significant amount of electricity from PV panels.

The performance figures below for PV are based on a monocrystalline array being installed at peak performance and are based on guidance from CIBSE TM25 '*Understanding Building Integrated Photovoltaics*'. Based on an approximate electricity demand of 661,350.44kWh/annum for the site it is envisaged that a large proportion of this could be met by PV panels given available roof areas.

It can be anticipated that over the lifespan of a panel there will be a loss of efficiency between 15-30%.

In average UK weather conditions, a PV system rated at 1kWp will produce between 700-900kWh of electricity per year.

Installation Size m ²	Rated Output (kWp)	Annual Output (kWh)
10	1.25	875
50	6.25	4,375
100	12.50	8,750
400	50.00	35,000

7.2.3 Payback

For an installation of 100m² the install cost is approximately £18,750 against an approximate yearly annual output of 8,750kWh. Based on electricity costs of £0.14 per kWh this would provide an optimum simple payback of 15.31 years.

However not all electricity generated will be used at source and any excess electricity produced will be fed back in to the national grid at a reduced cost.

The following tables are based on a 60/40 payback i.e. 60% of the electricity produced being used at source and 40% of the electricity produced being exported to the national grid. It has been assumed there are no additional operational requirements other than occasional checks on performance. Maintenance is limited to annual cleaning of the panel with an anticipated replacement of the inverter during the lifespan.

Installation Size m ²	Rated Output (kWp)	Installed Cost at £1,500 per kWp
10	1.25	£1,875
50	6.25	£9,325
100	12.50	£18,750

Using outputs from the thermal modelling calculation the total annual carbon emissions for the proposed development is 453,667.12kg for the site.

Installation Size m ²	Annual energy generated (kWh)	Annual site carbon emissions (kg)	% saving in regulated CO ₂	Reduction (CO ₂ /kg/yr)*
10	875	453,667.12	0.079%	358.75
50	4,375	453,667.12	0.40%	1,793.75
100	8,750	453,667.12	0.79%	3,587.50

* carbon factor for grid displaced electricity as 0.41kg/CO₂/kWh

	Installation size		
	10	50	100
Annual output (kWh)	875	4,375	8,750
Used on site kWh (estimated 60%)	525	2,625	5,250
Exported to grid kWh (estimated 40%)	350	1,750	3,500
Annual cost saving (based on gas cost at £0.04/kWh) based on 60%	£63.00	£315.00	£630.00
Annual cost saving (based on 40% export of 5.50p/kWh)	£19.25	£96.25	£192.50
Total annual saving	£82.25	£411.25	£822.50
Payback period (yrs)	22.79	22.67	22.80

7.2.4 Land Use

There are no issues regarding land use other than the area of roof required to accommodate the quantity of PV to meet the energy demand for the building. If additional capacity is required, it is feasible to ground mount panels however given the location and activities of the proposed development there is a high potential for vandalism. A ground mounted option therefore is not practical to be considered for this development.

7.2.5 Local Planning Requirements

Additional planning permission is not normally required for small scale micro-generation that is already covered under the primary application, and no local planning constraints have been identified that would prohibit the use of a PV array on the proposed development. Clarification should be sought prior to any detailed design work.

7.2.6 Noise

There are no issues with regards to noise with this type of LZC technology.

7.2.7 Feasibility of Exporting

Depending on the building occupancy there is potential to export electricity back into the national grid during times of low electricity use. Alternatively, battery storage can be utilised where the energy generated is used to charge a battery bank which in turn supplies power on site at an appropriate time. The grid connection is straightforward and makes this a cheaper option than battery storage. However, since the Feed in Tariff has stopped, the financial benefits of exporting electricity to the grid has greatly reduced.

7.2.8 Available Funding

The removal of the Feed in Tariff mean that there are now no available funding sources for PV

7.2.9 Technology Suitability

Solar PV designs depend on panel size and the energy from solar radiation. The location has been deemed adequate for solar panel installation. Solar PV technology would be suitable for this project, as there will be a demand for electricity for heating, lighting, hot water and auxiliary use.

7.3 Hydro

7.3.1 Background Information

Water power can be harnessed in many ways; tidal flows can be utilised to produce power by building a barrage across an estuary and releasing water in a controlled manner through a turbine; large dams hold water which can be used to provide large quantities of electricity; wave power is also harnessed in various ways. It is a technology that has been utilised throughout the world, by a diverse range of societies and cultures, for many centuries.

Hydropower is a well-proven technology, relying on a non-polluting, renewable and indigenous resource. China alone has more than 85,000 small-scale, electricity producing, hydropower plants.

Micro-hydropower generally refers to water flowing from a higher level to a lower level to drive a turbine connected to an electrical generator. The energy generated is directly proportional to the volume of water and vertical drop or head.

This technology would not be viable as there is not a large enough water source with a viable head height to facilitate the construction of a hydro power turbine.

Tidal or wave power would not be viable as the development is inland.

7.3.2 Energy Generated

No available resource.

7.3.3 Payback

No available resource.

7.3.4 Land Use

No available resource.

7.3.5 Local Planning Requirements

Hydro power plants would require planning permission due to the noise that could be generated and due to the potential size of them.

7.3.6 Noise

For hydropower projects which depend on vast amounts of water travelling from one location to another, there will be a substantial amount of noise most of which comes from the water that has been displaced.

7.3.7 Feasibility of Exporting

Depending on the size of the hydro plant and the amount of energy generated exportation of power to the grid would be a possibility, however, in this case as there are no hydro power sources there wouldn't be an opportunity to produce any energy.

7.3.8 Available Funding

Hydro power currently benefits from a Feed in Tariff incentive which provides a long-term fixed rate for all actual electricity production.

7.3.9 Technology Suitability

For this project, there are no available water sources to enable hydropower technologies to be considered as a viable option. Therefore, no necessary calculations will be considered and the technology will be disregarded altogether.

This technology has zero suitability and is unsuitable for this site.

7.4 Wind

7.4.1 Background Information

40% of all the wind energy in Europe blows over the UK making it the windiest country in Europe. In 2007 wind energy overtook hydropower to become the largest renewable generation source and currently contributes over 10% of the UK's electricity supply, with onshore wind comprising the bulk of this.

Wind turbines convert the power from within moving air mass (wind) into electricity by rotating a shaft. Power increases threefold as wind speeds increase. Small scale wind turbines (generally up to 50kW) can be used to power a small building or to provide a proportion of a building's or communities' electricity demand.

Wind turbines are historically one of the most cost-effective LZC technologies, with a simple payback period of around 20 - 25 years on a suitable site.

Wind turbines consist of four main components:

- a tower
- a nacelle (mounted on the tower and houses the generator and gear box)
- a hub (rotor)
- blades (attached to the hub)

An inverter is required to convert the electricity produced from DC (direct current) to AC (alternating current) for build use or feeding into the grid.

There are two types of wind turbine – horizontal axis turbines and vertical axis turbines. Vertical axis turbines tend only to be most suited at the micro scale, with

turbines designed to perform more efficiently at the lower, more turbulent wind speeds typically found in built up areas. Horizontal axis turbines are the more familiar 'windmill' type where the blades rotate in a vertical plane about a horizontal axis and the turbine is dynamically rotated on its tower to face the wind.



Turbines can be installed with a free-standing mast or building mounted. Free standing versions tend to be larger and make a far greater contribution to energy demand. They are generally unsuitable for urban developments.

Modern free-standing small-scale turbines of 6-20kWp (or bigger) are suitable for suburban and rural areas. Turbines of this scale would be an appropriate size for locating in a large car park or open space near the development.

Turbines generally operate between a range of wind speeds defined by the cut-in and cut-out wind speed which is specific to the turbine model, but typically 3.5m/s to 25 m/s.

A wind turbine suitability checklist includes the following:

- The area needs to be windy enough i.e. at least 4.5m/s for building mounted and at least 5m/s for free standing turbines and not be disrupted by surrounding tall trees or buildings or other features that will create turbulence.
- There should be an unobstructed roof aspect for roof mounted turbines to be fixed to i.e. a gable end, edge of building or flat roof, if a free standing turbine is not considered appropriate.

The Department of Energy and Climate Change wind speed database (NOABL) contains estimates of the annual mean wind speed throughout the UK. This gives an indication of average wind speed in different parts of the country. However, the accuracy of the wind speed at a proposed site for a small wind system, particularly in urban or built up areas is best achieved through on-site investigations. If wind speed at the site is not in the range at which an 11kWp (used for the Payback study) capacity turbine is rated (i.e. an 11kWp capacity turbine is at 9.5m/s) then the system may deliver less electricity than expected. Likewise, if wind speeds fall below a certain level (2.5m/s for an 11kW turbine) there is no output.

Reference to the NOABL wind speed database confirms that the annual average wind speed for the development site at 10m from ground level is 4.3m/s.

It is strongly recommended that a full wind speed study should be undertaken prior to installing any turbine on this site. This study should include for detailed on-site monitoring over a minimum 12 month period.

7.4.2 Energy Generated

All assumed performance figures are based on a 11kW horizontal floor mounted turbine based on an average wind speed of 4.3m/s. Based on an approximate

electricity demand (lighting, cooling and auxiliary only) of 661,350.44 kWh/annum for the site it is envisaged that a total of 100% of this requirement would require several turbines. A single turbine typically produces around 30,000Wh/annum. This is subject to a well-located site free from obstruction and causes of turbulence.

It is unlikely given the immediate topography and surrounding buildings that a floor mounted turbine on this site would be free from obstruction or turbulence therefore these examples are for illustrative purposes only.

7.4.3 Payback

A typical 11kWp turbine system costs in the region of £40,000 to install and commission.

If the turbine was to perform within the scope of its estimated wind speeds the average payback period would range between 10.51 and 22.13 years.

Turbines have an expected service life of 20 years and require a yearly service and maintenance check.

	Turbine size 11kW Average wind speed m/s		
	4.5	5.5	6.5
Average power output (kWh)	2.17	3.42	4.57
Estimated annual output (kWh)	19,000	30,000	40,000
Used on site kWh (estimated 50%)	9,500	15,000	20,000
Annual cost saving (based on grid electricity cost at 14p/kWh)	£1,330	£2,100	£2,800
Exported to grid kWh (estimated 50%)	9,500	15,000	20,000
Annual cost saving (based on export tariff of 5.50p/kWh)	£522.50	£825	£1,100
Payback period (yrs)	21.59	13.68	10.26

Average wind speed m/s	Annual energy generated (kWh)	Annual site carbon emissions (kg)	% saving in regulated CO ₂	Reduction (CO ₂ /kg/yr)*
4.5	19,000	453,667.12	1.72%	7,790
5.5	30,000	453,667.12	2.71%	12,300
6.5	40,000	453,667.12	3.61%	16,400

* carbon factor for grid displaced electricity as 0.41kg/CO₂/kWh.

7.4.4 Land Use

Ideally, stand-alone turbines should be sited as far away as possible from buildings or trees, which may block the wind and cause turbulence. Typically, turbines should be about twice the height of obstructions in the immediate front of it (for at least the prevailing wind direction). In general, the turbine should be above the height of nearby obstructions that are within 10 to 20 meters of the tower heights. It is unlikely that a suitable location is available near the proposed site.

Rooftop-mounted turbines can generally be mounted on either the side or on top of buildings and should be installed so that the vibrations from it will not be transmitted to the building. Local turbulent airflow around the building, which causes reduction in generated output and could damage the turbine, must be considered as well. In general, the less turbulent and varying the wind, the better the wind power generation. The ideal location for a wind turbine is at the top of a gentle slope and the worst location is just to the downwind side of a large building.

The proposed site is unlikely to have the potential space for a turbine (at approx. 11kW).

7.4.5 Local Planning Requirements

Many local authorities will require the undertaking of a comprehensive wind study for a larger type turbines. Clarification should be sought prior to any detailed design work.

7.4.6 Noise

Noise Levels	dB(A)	Comparator
at 30 m	50	Conversational speak, 50-60 dB(A)
at 60 m	45	Living room dB(A)
over 100m	<40	Rural night time background, 20-40dB(A)

A wind turbine creates noise therefore minimum distances to habitable buildings needs to be maintained. The actual distance however will depend upon several factors, including the local terrain, trees and the background noise in the area. Planning authorities vary in their requirements and it is therefore important to seek clarification prior to any detailed design work being undertaken. In general, a turbine should be sited where it will not impact neighbouring properties either visually or with noise.

There are numerous residential properties within 100m of the proposed development which would be affected by a floor mounted turbine.

7.4.7 Feasibility of Exporting

Because of the long-term unpredictability when suitable wind speeds will affect the site there is a strong potential to export electricity back into the national grid

during times of low occupation or usage. Alternatively, battery storage can be utilised where the energy generated is used to charge a battery bank which in turn supplies power on site at an appropriate time. The grid connection is straightforward and makes this a cheaper option than battery storage.

7.4.8 Available Funding

Following the removal of the Feed in Tariff scheme, there are currently no available funding sources for this technology.

7.4.9 Technology Suitability

Although wind power is a very effective renewable energy source there are two issues using this technology for this site.

There are potential problems obtaining planning permission as the project is located close to a built-up area. Noise pollution and visual disruption (flicker and view) could cause occupant discomfort to other building users in the area.

Also, as the site is within an area where wind speeds may be disrupted by surrounding structures causing turbulent air flow and significantly reducing performance.

7.5 Biomass

7.5.1 Background Information

The term 'biomass' covers solids, bio-gas and bio-liquids but generally refers to an energy resource derived from organic matter, including wood from forests, waste wood source, farmed coppices and approved farmed energy crops or farm and factory waste. It does not include fossil fuels.

Benefits of a biomass system include zero net contribution of CO₂ to the atmosphere, diversity of fuel supply, plus the benefit of using a fuel source that is predicted to fall in price whilst conventional energy sources such as natural gas and electricity are set to rise. Bio-liquids are not a defined LZC technology under European Directive 2009/28/EC. This section of the report considers both solid and bio-gas but generally content is focused on solid biomass being the most common.

Biomass is generally regarded as carbon neutral. The CO₂ released during the generation of energy from biomass should be balanced by the CO₂ absorbed during the fuel's production. However, unlike most other renewable energy sources biomass fuel is not abundant or free.



However, this report considers the carbon emissions associated with sourcing, processing, and transportation of the biomass. A CO₂ emission factor of 0.013kg/CO₂/kWh has been assumed for biomass.

The most common application of biomass heating is one or more boilers in a sequenced installation that normally includes an alternative fuel boiler (such as gas or oil) to provide security of heat supply.

Solid fuel boilers have a limited capacity of modulating their outputs and it is often recommended that a buffer vessel is included in an installation to ensure that a biomass boiler works at a relatively constant load.

For efficient, low emission combustion biomass needs to be burned fast, at a high temperature. Although most modern wood chip and wood pellet boilers are designed to allow modulation of the output down to perhaps 30% of maximum output, biomass is not well suited to this mode of operation and if continuous, low level output is routinely required biomass may not be the optimum choice. This also means that it is very important not to over specify biomass boilers.

Where seasonal operation varies between high level output for winter heating and low-level output for summer hot water, a biomass boiler supplemented by a small gas boiler might offer a suitable combination. This may also allow the biomass boiler to be specified for commonly required maximum output, using the supplementary boiler to meet peak demand required for just the few coldest days of the year as well as summer hot water.

There are several key considerations when designing a biomass boiler system. Most of these surround the supply and storage of the fuel. It is essential that an established supplier can provide assurance of security of supply to the site.

As with all delivered fuels, potential issues surrounding delivery need to be considered.

Once on site the biomass would need to be housed within an adequately sized fuel store providing a dry secure environment. Current floor plans do not currently indicate an area of dedicated storage however it is anticipated a suitably sized area could be accommodated.

The current plans show a suitably sized plant room for the biomass boiler to be housed, consideration would need to be given to the storage of the fuel.

7.5.2 Energy Generated

Typically to ensure that installation is as cost efficient as possible, boilers are not sized to serve 100% of the *peak heat load* of the development as the peak heat load of a building is rarely realised. Analyses of building heating loads confirm that a boiler sized at 50% of the peak heating load is expected to provide over 90% of the annual heating demand.

The annual heat load of the proposed development is 191223.99kWh/yr.

Reduction in Annual CO₂ emissions:

- Annual energy output delivered 191,223.99kWh/yr
- Combined efficiency of biomass boiler 90%
- Biomass fuel consumed 210,346.39kWh/yr
- CO₂ emissions (biomass at 0.013kg/CO₂/kWh) 2,734.50kg/yr
- Equivalent CO₂ emissions of gas at 0.20kg/CO₂/kWh 42,069.28kg/yr
- Savings 39,334.78kg/yr

7.5.3 Payback

The capital cost of installing an automatically fed biomass boiler is approximately £200,000. In addition, a full maintenance package costs approximately £1,000 per year for operation and maintenance costs.

There are no significant annual fuel savings for biomass against natural gas. Any annual saving would not cover the capital cost of £200,000 (not including maintenance costs) over the estimated technology life of 20 years.

The Renewable Heat Incentive attracts a payment of 2.22p/kWh which would provide an estimated revenue of £4,245.17pa.

The simple payback period is therefore 47.11 years not including annual maintenance costs.

7.5.4 Land Use

The requirement for a suitable fuel storage area and the boiler feed, which could be problematic as these can take up a considerable amount of space.

Ideally the fuel store should be located immediately adjacent to the boiler although a short separation distance can be accommodated through use of a conveyor system. Suitable access for delivery is required although fuel pellets can be pumped up to 30mtr if vehicle access is limited.

7.5.5 Local Planning Requirements

There are no specific issues which are likely to affect planning requirements. The building is outside of any Air Quality Management Area (AQMA).

A biomass heating system, due to level of NO_x and SO_x (nitrogen and sulphur oxides) emissions produced, is required to incorporate a flue above the roofline of the building.

7.5.6 Noise

The only issues with regards to noise with this type of LZC relate to the impact of noise from lorries delivering the biomass fuel and the noise of the pellets/wood

chips being deposited into the storage area. Otherwise, the running noise from the boiler is comparable to that of a conventional gas boiler.

7.5.7 Feasibility of Exporting

This system is designed to generate heat locally for the use on the development and therefore the feasibility of exporting heat/electricity from this system is not applicable.

7.5.8 Available Funding

Non-domestic installations that qualify under the Micro-generation Certification Scheme (MCS) will be measured under the Renewable Heat Incentive. At the time of writing the RHI tariff is 2.22p/kW.

7.5.9 Technology Suitability

To be a viable option the technology needs to be suitable for use with the preferred heating distribution method (i.e. a central heating plant) however additional studies would need to be undertaken to determine more accurate heat loads.

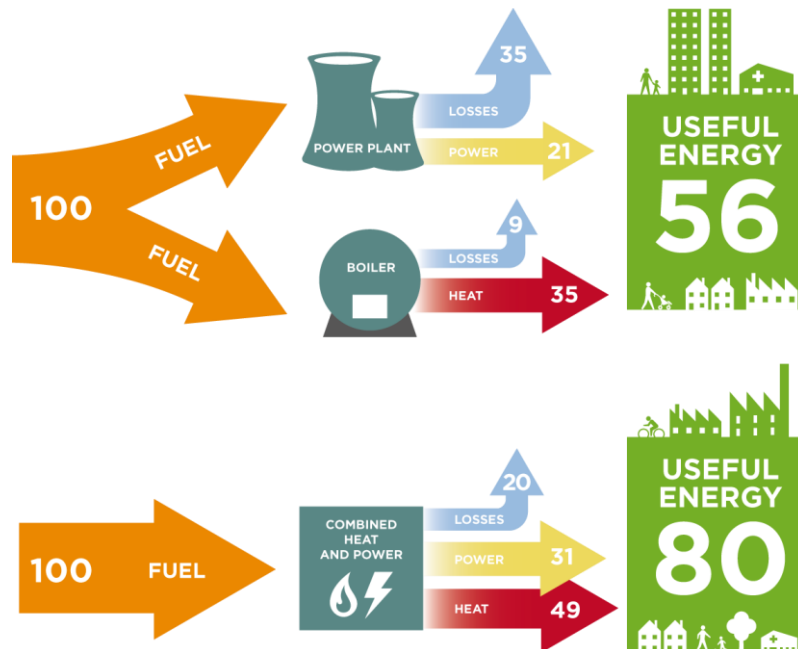
There is an additional higher capital cost (a back-up boiler will also be required) that cannot be offset with reduced annual running costs.

Overall, the technology is considered suitable, providing that suitable storage spaces can be found for the fuel.

Combined Heat and Power (CHP)

7.5.10 Background Information

Combined Heat and Power (CHP) or co-generation is the production of electricity and useful heat in a single process. In CHP plants the heat produced during the generation of electricity can be put to good use at source, rather than being wasted or benefitting other activities as is the case for centralised power generation.



The plant when operated on natural gas is approx. three times cheaper per kWh than power generated from the grid. Significant carbon savings are achieved as power generated at source does not suffer grid power transmission losses.

Their relative sophistication means that the overall efficiency of CHP plants can reach more than 80% at the point of use. This compares with the efficiency of combined cycle gas turbine plants, which in the UK is just over 50%.

Where schemes are above 50kWe they must be certified under the Combined Heat and Power Quality Assurance (CHPQA). The electricity generated can be used on site or exported to the grid.

The process of co-generation produces heat and power; however, during the summer months the heat generated may not be fully utilised on site.

Tri-generation is a combination of co-generation and absorption chilling, by using the excess heat to operate an absorption chiller, which is linked to the cogeneration unit, the tri-generation CHP can provide electricity heating and cooling for air conditioning.

In most cases CHP systems primarily generate electricity and heat is a by-product. With the development of smaller gas/oil-fired/bio-diesel micro-CHP (delivering less than 50kWe of electricity) this gives the opportunity for single or multiple unit plants which are driven by heat demand and electricity is the useful by-product. These are generally suited to smaller non domestic development.

Small scale CHP can operate in either heat or power lead modes. In most cases though units are operated in power lead mode and are controlled to modulate electrical power generation to match site demand. It is designed to modulate output between heat and electric and can be operated in either mode.

The systems can be used with a variety of fuels including natural gas, biomass, sewerage gas and other bio-gases.

7.5.11 Energy Generated

CHP systems work best when there is a significant demand for electricity and heat (for heating or hot water generation) within a building. This is best demonstrated in leisure centres, care homes and other high energy consuming buildings.

Typically, a small-scale CHP plant will produce twice the amount of heat energy as electricity energy and this equates to the thermal model provided.

For example, a CHP unit that has 100kW input energy will 'lose' 15kW through operational losses. The remaining 85kW will provide approximately 55kW heat load and 30kW power load.

The equivalent figures using a gas fired boiler and mains electric would 'lose' less through operational losses (as only 55kW is converted on site instead of 100kW) however a greater proportion of the power load is lost away from site (up to 60% would have been lost in transmission from the power station). The effect of this is higher cost per kWh of electricity over gas in 'traditional' supply scenario.

In summary, the energy generated is linked to the overall energy demand as the heat and electricity generation are very much dependent on each other.

7.5.12 Payback

The capital cost of installing a CHP boiler capable of heating this development is approximately £50,000 in addition a full maintenance package costs approximately £1,000 per year.

The capital cost of installing a comparable conventional heating system is £35,000 in addition a full maintenance package costs approximately £1,000 per year.

CHP systems require consistent, high loads of electricity and heat. Based on the electricity load and heat load of the building, it is likely that there would be a sufficient load for the use of CHP, therefore it is likely that CHP would be suitable for the site. Further investigations would be required into the likely heat and electricity loads.

7.5.13 Land Use

A suitably located plant room would be required for a CHP boiler. CHP plant is typically slightly larger than a conventional boiler plant but does not require any additional housing requirement. No provision has yet been made to house a CHP plant internally, but it is likely that the current space allocation for plant would be sufficient. Alternatively, an external plant room may also be an option.

7.5.14 Local Planning Requirements

The same requirements as for a conventional boiler plant apply for CHP plant. If a separate plant room is required, then this should form part of the original application.

7.5.15 Noise

There are no issues with regards to noise with this type of LZC compared to a traditional condensing boiler system. A CHP unit relies on a running engine which has an associated mechanical noise; however, the unit is fully enclosed to attenuate the potential impact of running noise.

7.5.16 Feasibility of Exporting

CHP is designed to modulate power load depending on demand. There is therefore no opportunity to export excess electric to the national grid.

7.5.17 Available Funding

Only small-scale Biomass CHP units currently benefit from the Renewable Heat Incentive. At the time of writing the tariff for this technology is 4.60p/kW.

7.5.18 Technology Suitability

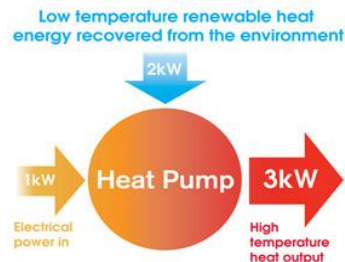
It is likely that there would a sufficient heat and electricity loads for CHP to be considered for the site. If CHP were to be considered further, it is suggested that accurate calculations are provided to establish base heat loads and anticipated occupation levels.

7.6 Aerothermal (Air Source)

7.6.1 Background Information

An air source heat pump (ASHP) extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can extract heat from the air even when the outside temperature is below freezing. Although heat pumps require electricity to operate, they are considered a low carbon technology.

The measure of efficiency of a heat pump is given by the Coefficient of Performance (CoP), which is defined as the ratio of heat output, divided by the quantity of electrical energy put in. The CoP depends on the temperature difference between internal and external conditions. Unlike the ground external air is much less stable therefore lower CoP's are achieved during the heating season. On a mild day when external air temperatures are around 20°C typical CoP can be greater than 4. However, in winter as temperatures drop to below 0°C the CoP will drop to nearer 1.



Additionally, when external temperatures drop for longer periods below 0°C moisture in the air may condense and form ice on the heat exchanger. This affects

the heat transfer coefficient and must be melted periodically using a 'defrost cycle' which uses energy to warm the exchanger but providing no useful heat gain within the building.

When used as space heating devices ASHP's achieve the best CoP when operating on low flow and return temperatures (40/30°C) such as under floor heating.

An air-to-air system extracts heat/coolth from the external air and transfers it to the building where it is circulated by fans typically as an air-conditioning system.

An air-to-water system uses the same process as an air-to-air system but transfers the heat/coolth to a wet central heating system.

7.6.2 Energy Generated

Typically, ASHP's are only used in application where the flow/return temperatures are low (40/30°C). They can operate at much higher temperature, but the efficiencies will be greatly reduced and given that grid electric has a fuel factor of 0.41kgCO₂/kW against a fuel factor for natural gas of 0.20kgCO₂/kW the fuel and CO₂ savings when utilising the technology in this way, will be drastically reduced.

An ASHP system would provide 40% of the peak heat load and over 90% of the annual heat load.

Potential reduction in Annual CO₂ emissions:

- Annual energy output delivered 191,223.99kWh/yr
- CoP of ASHP in heating mode 3.00
- Electricity required by ASHP system 63,741.33kWh
- CO₂ emissions (grid electric at 0.41kg/CO₂/kWh) 23,133.95kg/yr

- Equiv. CO₂ emissions (gas at 0.20kg/CO₂/kWh and 90% efficiency) 42,071.48kg/yr
- Savings 18,937.53kg/yr
- Baseline overall CO₂ emissions for the building 453,667.12kg/yr
- % reduction in total CO₂ emissions 4.17%

7.6.3 Payback

Annual fuel savings:

- Cost of gas @ 90% efficiency (£0.04/kWh x 210,346.39kW) £8,413.86
- Cost of grid electric @300% efficiency (£0.14/kWh x 63,741.33kW) £8923.79
- Annual net savings in fuel cost -£509.93/yr

Annual net savings using an ASHP over a conventional gas fired boiler are negative. Install cost for ASHP technology is equal to or greater than a conventional gas fired boiler therefore payback is not feasible.

7.6.4 Land Use

Air Source Heat Pumps can be wall, floor or roof mounted depending on size, however, consideration needs to be given to the positioning of air intakes/oeuvre and external space will generally be required for the heat exchanger. There do not appear to be any constraints to site this type of technology.

7.6.5 Local Planning Requirements

At present this would need to be part of the planning application and it will need to be demonstrated that noise will not be a problem.

7.6.6 Noise

Typical operating noise levels of a compressor are 50-55dBA at 1m.

7.6.7 Feasibility of Exporting

This system is designed to generate heat locally for the building occupants and therefore the feasibility of exporting heat from this system is not applicable.

7.6.8 Available Funding

Non-domestic installations that qualify under the Micro-generation Certification Scheme (MCS) will be measured under the Renewable Heat Incentive. At the time of writing, the tariff for this technology was 2.79p/kW.

7.6.9 Technology Suitability

ASHP's are usually sited in areas where a heating and cooling demand is present or heated areas with low temperature flow and return (such as UFH). If the proposed scheme were to utilise a system of underfloor heating then the technology is suitable.

7.7 Ground & Water Source

7.7.1 Background Information

Ground and water source systems use the relatively constant year-round temperature of the ground or water to provide heating (they can also be used for cooling). However, heat pumps use electricity in their operation and like ASHP's are not a zero-carbon source of energy. The effect on running costs is variable depending on local conditions and alternative fuel options; in some cases, they may deliver carbon savings without necessarily reducing energy costs.

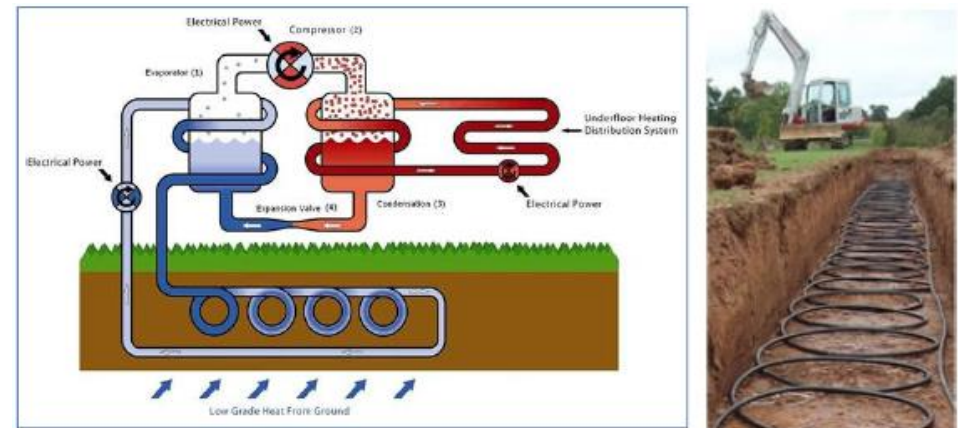
Heat pumps take low temperature heat and upgrade it to a higher, more useful temperature.

A few metres below surface level, the ground maintains a constant year-round temperature of 8 - 13°C because of its high thermal mass. Although the ground temperature may not necessarily be higher than ambient air temperature in winter, it is more stable compared to the wide temperature range of ambient air. This makes system design more robust.

Likewise, with water sources such as lakes and rivers the year-round temperatures are far more stable than air and additional with a flow or circulation of the water providing a quicker energy replacement.

Water (or other fluids) is circulated through pipes buried in the ground and passes through a heat exchanger in the heat pump that extracts heat from the fluid. The heat pump then raises the temperature of the fluid via the compression cycle to supply hot water to the building as a conventional boiler would.

The measure of efficiency of a heat pump is given by the Coefficient of Performance (CoP), which is defined as the ratio of the heat output, divided by the quantity of electrical energy put in. CoP's of 3 or more should be achievable giving good energy and running cost savings.



A GSHP system consists of three main elements:

Ground Loop – this comprises lengths of plastic pipe buried in the ground, either in a borehole or a horizontal trench. The pipe is a closed circuit and is filled with a mixture of water and antifreeze which is pumped round the pipe absorbing heat from the ground. Trench systems have a coiled pipe network which is buried at around 2.0m depth below ground level, thus requiring a large area of open space depending on the size of the system and for vertical borehole systems, the pipes are placed in holes bored straight into the ground to a depth of 50 - 100m depending on ground conditions and size of system. Vertical systems require less ground space but do require access for the drilling rig at the construction stage, though this is unlikely to be greater than for normal construction vehicles. On this development, a horizontal trench system would not be feasible due to lack of

suitable space. The borehole system may not be appropriate due to drilling the site and disturbing the Ecology on the site, in addition the borehole system is more expensive and may be financially prohibitive compared to other technologies.

Heat Pump – is a device which uses the evaporation and condensing of a refrigerant to move heat from one place to another. This works in a similar way to fridges and air-conditioners and uses one or more compressors to transport the heat, hence the need for mains electricity.

Heat Distribution System – consists of under floor heating or radiators for space heating and water storage for hot water supply. If the difference in temperature between the source and the sink is too great, then this will limit the operational performance of the heat pump. The smaller the temperature difference, the better is the performance. Hence systems work best with low temperature heat distribution systems, such as under floor heating with delivery temperatures of around 30 – 45°C.

7.7.2 Energy Generated

Typically, GSHP's are only used in application where the flow/return temperatures are low (40/30°C). They can operate at much higher temperature but the efficiencies will be greatly reduced and given that grid electric has a fuel factor of 0.517kgCO₂/kW against a fuel factor for gas of 0.198kgCO₂/kW will become less cost and emission efficient than a gas fired central heating plant.

A GSHP system would provide 40% of the peak heat load and over 90% of the annual heat load.

Potential reduction in Annual CO₂ emissions:

- Annual energy output delivered 191,223.99kWh/yr

- CoP of GSHP/WSHP in heating mode 4.0
- Electricity required by GSHP/WSHP system 47,806.00kWh
- CO₂ emissions (grid electric at 0.41kg/CO₂/kWh) 19,600kg/yr
- Equiv. CO₂ emissions (gas at 0.20kg/CO₂/kWh and 90% efficiency) 42,071.48kg/yr
- Savings 22,471.48kg/yr
- Baseline overall CO₂ emissions 453,667.12kg/yr
- % reduction in total CO₂ emissions 4.95%

7.7.3 Payback

Installation costs would be expected to cost circa £2,500/kW to install.

Annual maintenance costs are estimated to be approximately £500.

Annual fuel savings:

- Cost of gas @ 90% efficiency (£0.04/kWh x 210,346.39kW) £8,413.86
- Cost of grid electric @ 400% efficiency (£0.14/kWh x 47,806kWh) £6,692.84
- Annual net savings in fuel cost £1,721.02/yr
- Annual RHI contribution (47,806kW x £0.0134) £640.60/yr
- Annual net savings in fuel cost £2,361.62/yr

Annual gross savings using an GSHP/WSHP over a conventional gas fired boiler are £1,721.02/yr. Including the RHI contribution overall net savings are £2,361.62 annually. Install cost for GSHP technology is approximately £50,000 greater than a conventional gas fired boiler. Total payback is 21.17years.

7.7.4 Land Use

A large enough area of open land or a suitable body of water is required. Alternatively, a vertical or borehole system could be used but this is dependent on ground conditions being suitable for drilling vertical boreholes, including underground obstructions/type of strata and level of the water table. Boreholes are around 100mm in diameter and can be arranged in a line or grid formation. They usually need to be positioned approximately 6m apart to avoid thermal interference. GSHP's are very much reliant on the ground conditions. This will determine the thermal conductivity of the ground and therefore govern the suitability of the installation of this LZC technology.

Based on the use of the building and the significance of the nature and ecology of the site, it is unlikely that boring drill holes or installing trenches for the ground loop system would be considered on the site.

7.7.5 Local Planning Requirements

Planning permission is not normally required for a GSHP system; however the local planning authority should be made aware of the intention to drill borehole due to drainage and underground obstructions and in addition the EA should be notified due to potential underground aquifers in the locality. Likewise, with a water source system advice should be sought from the relevant body in the first instance (either NRW or Environment Agency).

7.7.6 Noise

There are no issues with regards to noise with running this type of LZC.

7.7.7 Feasibility of Exporting

This system is designed to generate heat locally for the building occupants and therefore the feasibility of exporting heat from this system is not applicable.

7.7.8 Available Funding

Non-domestic installations that qualify under the Micro-generation Certification Scheme (MCS) will be measured under the Renewable Heat Incentive. At the time of writing the tariff for this technology is 1.34p/kW.

7.7.9 Technology Suitability

GSHP's and WSHP's are usually sited in areas where a heating demand is present with low temperature flow and return (such as UFH). However, based on the ecology and nature of the site, it is unclear whether boreholes or trenches would be suitable, therefore, the system would require further investigation in this instance.

7.8 Western Wood Biomass Energy Plant

7.8.1 Background Information

The Western Wood Biomass Energy Plant is located adjacent to the proposed site.

The plant uses wood, which is chipped and then used as fuel in a boiler. The boiler heats water to 512°C to convert it to superheated steam at 92bar.

High-pressure steam is passed on to the turbine chamber to drive a two-shaft steam turbine to generate electricity. The air-cooled condenser cools the steam emanating from the turbine room into water, which can be fed back to the boiler through the condensate system.

The plant produces around 14MWe per annum, which is enough to power 31,000 homes.

7.8.2 Connection Opportunities

The plant produces electricity, which is typically fed back into the electricity grid, the development could connect directly to the energy plant and use the electricity

directly from the source. This would reduce energy losses associated with the electric grid and would provide low carbon electricity for the site.

The plant may also be able to provide waste heat for the development, which could be used for heating and hot water. However, further investigation would be required into the security of the supply of the waste heat and backup systems are likely to be required.

7.8.3 Carbon Savings

The plant reduces carbon emissions by 47,000t a year when compared with those generated by an equivalent fossil fuel power station. By utilising the electricity produced by the plant the proposed development would be using low carbon energy for all its electricity.

7.8.4 Feasibility

Discussions have been ongoing with the energy plant and the possibility of an electricity connection. The energy plant has confirmed it has the capability of providing the proposed development with all its electricity.

Further investigation of using the waste heat from the power plant for the development's heating and hot water will be required,

7.8.5 Costs

Potential costs for connection to the energy plant and for the electricity are still being discussed.

7.8.6 Security of Supply

Although the energy plant has the capability of supplying all the electricity required by the development, this may not always be possible. Therefore, a secondary connection to the electricity grid would also be installed. This would allow the development to maintain the electricity connection, even if the energy plant were down or the connection is lost.

8. Summary

Technology	Suitable	Requires further investigation	Unsuitable	Summary
Solar thermal		☹️		Solar Thermal panels are a suitable technology for the site, however, the low hot water demand would mean that payback could be considerable. Therefore, further consideration needs to be given to the DHW loads of the buildings.
Photovoltaic	☺️			Solar PV panels are considered suitable for the site, the roof size would be suitable to house a significant number of panels. The panels could provide a large reduction in energy costs and CO ₂ emissions.
Hydro			☹️	This technology has deemed to be not suitable based on the location of the site.
Wind			☹️	This technology has deemed to be not suitable based on the location of the site.
Biomass		☹️		A Biomass boiler may be suitable for the site, but further consideration would need to be given to the storage of the fuel.
Combined Heat & Power		☹️		CHP systems could be suitable for this development based on the overall heat and electricity loads of the building
Air Source Heat Pump	☺️			An Air source Heat Pump could be used for providing heat and hot water for the site, especially since there will be no gas connection on the site.
Ground & Water Source Heat Pump		☹️		A Ground Source Heat Pump would require further investigation to determine whether boreholes or trench pipes would be suitable on this site.
Connection to Western Wood Biomass Energy Plant	☺️			A connection to the adjacent power plant would provide low carbon electricity for the development, thus reducing the overall carbon emissions for the site.

9. Conclusion

SBEM calculations have been carried out to determine the regulated loads of the 3 buildings. The overall energy use for the buildings is 1,006,605.63 kwh per annum.

To aid in reducing these energy loads and the overall carbon emissions from the site, the use of energy generating technologies and the feasibility of using said technologies on this development has been considered above. The most suitable technology identified for this would be Solar PV panels, as there are large areas of suitable roof space available. If on site low carbon energy generating technologies were to be utilised on site, the export of any energy generated would be feasible. However, based on the process electricity load so of the development and in particular the Production Unit, it is likely that all of the energy generated on the site would be used on the site, with little being exported to the grid.

Another source of low carbon energy identified was the Western Wood Biomass Energy Plant located adjacent to the development. This plant produces electricity by burning biomass fuel and would therefore be a low carbon energy source. Initial discussions with the plant confirm that there is potential to provide all the development's electricity requirements meaning that the development could remain 'off grid' and connect to a low carbon source of electricity.

Based on the heating loads of the buildings, a district heating system for the 3 buildings is potentially feasible. Further consideration would be required into the uses, heating loads and occupancies of the 3 buildings as the varying requirements for heat and hot water may cause some issues with sizing of the plant. All the LZC technologies identified in the report above that could be used for a site district heating scheme would also need further consideration into their feasibility.

The Western Wood Biomass Energy Plant may have waste heat that could be utilised on the site for heating purposes, however, further investigations will be required into the feasibility of this. Back up systems would be required if this were to be utilised to ensure that, if the energy plant was unable to supply all the heat required, the heat load within the development could still be met.