



South Yorkshire Police Barnsley Custody Suite

Low and Zero Carbon Technology Report

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EXECUTIVE SUMMARY

This document has been produced to provide an overview of the Energy Strategy for the proposed new police custody suite in Barnsley.

The approach to energy follows the energy hierarchy which follows three steps in order to improve the energy efficiency of the building.

Step 1: Lean Building – Firstly optimize the building form, orientation and building fabric to make the building as energy efficient as possible.

Step 2: Mean Building – Secondly optimise the performance of the building services, using good design and highly efficient services

Step 3: Green Building – Lastly make use of the most appropriate Low and Zero Carbon (LZC) technologies



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1.0 INTRODUCTION

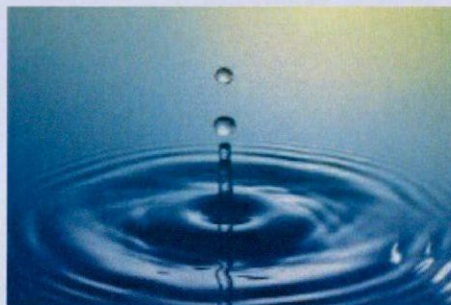
The development comprises an extension to the existing station for South Yorkshire Police consisting of custody suite with 20 cells, interview, search and evidence rooms.

The Client's aspirations are for the creation of a high quality and environmentally friendly development in terms of both energy efficiency and sustainable construction.

With pressure from central government to improve its environmental credentials we are seeing a major emphasis on the construction of new developments to address sustainability issues. This is being reinforced by legislation such as the revised Building Regulations 2013 and local council planning policies.

This report has been prepared at planning stage by: Peter O'Sullivan.

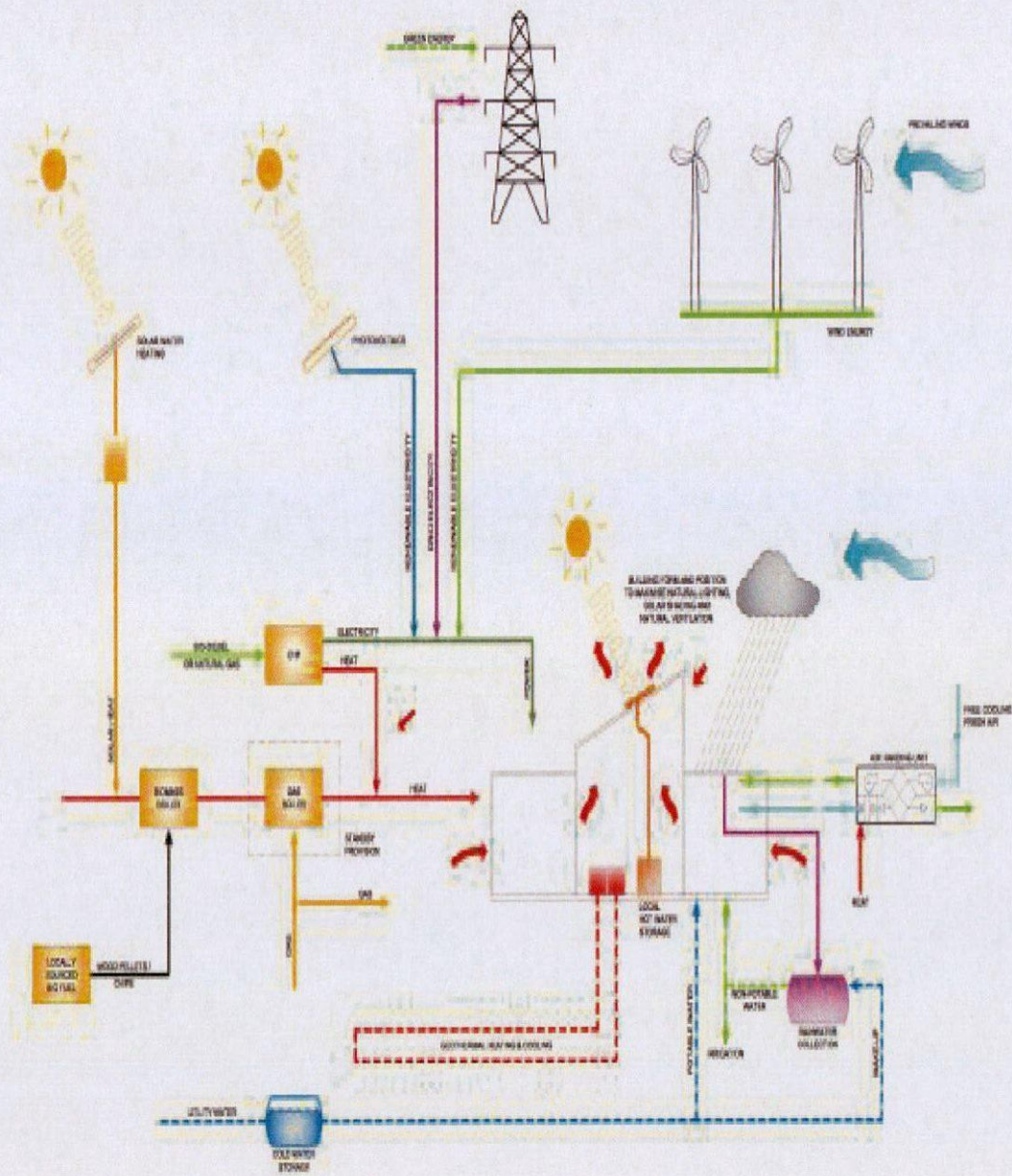
Peter is a Senior Mechanical Engineer with a particular interest in sustainable design techniques. A CIBSE qualified Low Carbon Consultant, Competent SBEM Assessor and accredited EPC Assessor, Peter now takes specific responsibility for delivering technical support to the practice's design teams on sustainable design and renewable energy issues. Peter is not professionally connected to a single Low or Zero Carbon Technology or manufacturer.



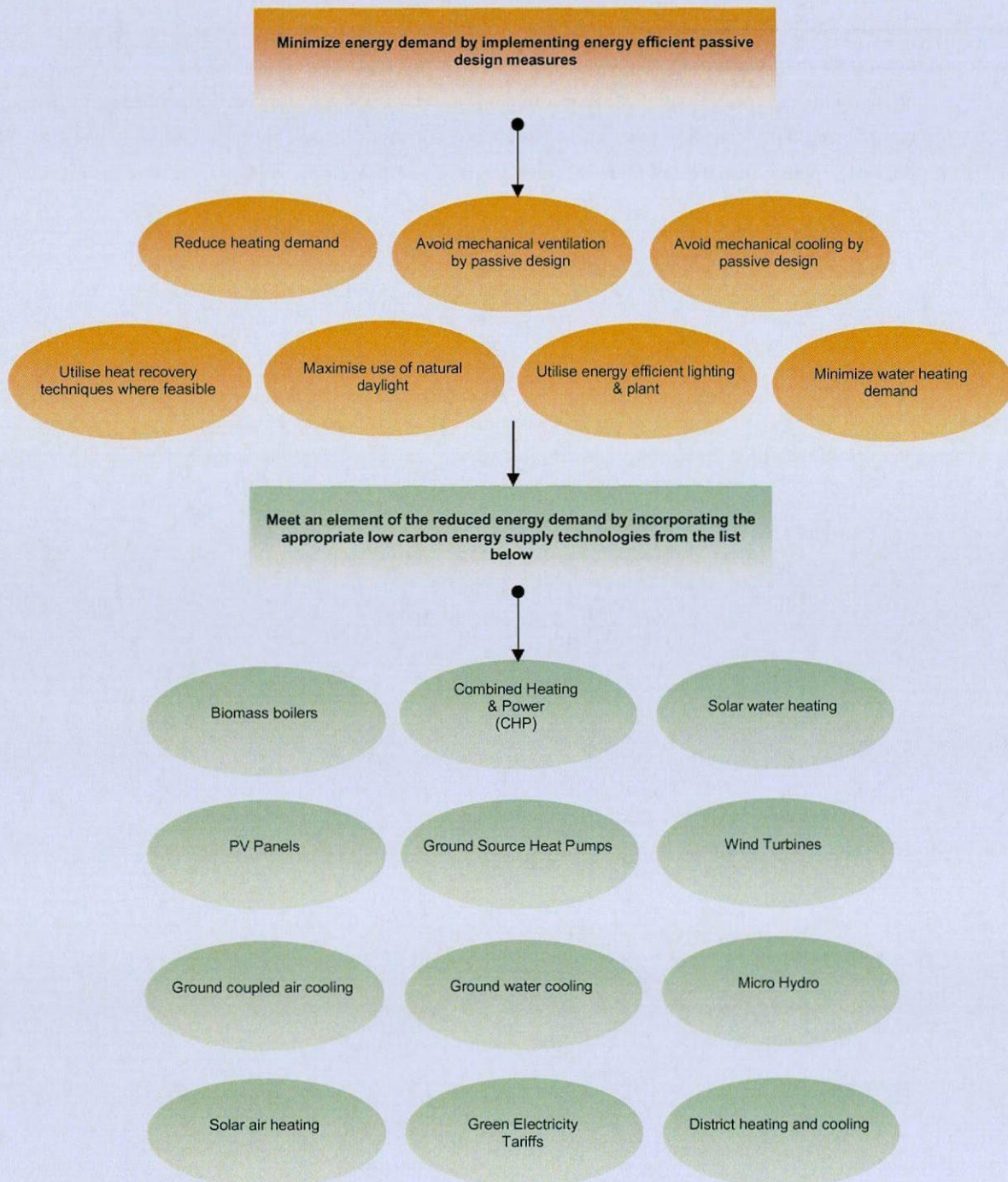
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2.0 OVERVIEW OF ENERGY STRATEGY

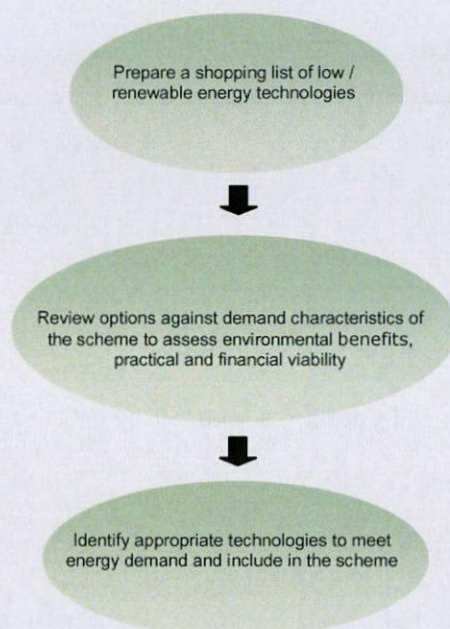
The diagrams below describe the approach that the design team are adopting to define the energy strategy for the development. It shows that the team will take all steps practicable to firstly minimise energy use within the development by adopting passive low energy design techniques. The diagram then shows how part of this reduced energy demand will be provided by the utilisation of innovative low carbon technologies.



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Overview of the strategy for selecting the appropriate LZC technology

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3.0 EFFICIENT BUILDING FORM AND ORIENTATION

The layout of the development is restricted by the confines of the site, however, the nature of the building dictates that very little fenestration will be provided out with the office areas and as such the orientation of the building is not critical to the buildings overall energy consumption.

The principle glazed areas are to the first floor office accommodation and these areas will be provided with daylight dimming to reduce the lighting energy consumption whenever the natural lighting levels permit.

Solar shading and enhanced glazing 'g' factors will be provided to the South East and West facing facades.

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4.0 CAREFUL SELECTION OF BUILDING FABRIC

The choice of building fabric will have a large impact on the requirement and size of the heating and cooling systems and will form an important part of the energy saving strategy that is to be implemented. The following fabric details have been used as a basis for the preliminary compliance calculations.

Description	UK 2013 Building Regulations Standards*	Proposed Standards for this Project	Improvement over current UK standards
External Walls	0.35W/m ² /K	0.26W/m ² /K	25%
Roof	0.25W/m ² /K	0.18W/m ² /K	28%
Ground Floor	0.25W/m ² /K	0.22W/m ² /K	12%
Windows & doors (whole element)	2.20W/m ² /K	1.6W/m ² /K	27%
Building Envelope Air Tightness	10/m ³ /h/m ²	<3m ³ /h/m ²	70% +

*Minimum allowable standards

A building air tightness figure of 3m³/hr.m² at 50 Pa is being targeted.

The proposed glazing will not only provide a low 'U' value, but will be selected to provide high levels of light transmission along with low levels of solar radiation. This will increase the contribution of natural daylight and reduce peak cooling loads. Preliminary calculations have been based on glazing with a light transmittance factor of 0.64 and a g value of 0.39. It may be necessary to reduce the glazing g factor still further in isolated areas. This will be explored in greater detail during the design process.

5.0 ENERGY EFFICIENT SERVICES AND EQUIPMENT

The correct selection and energy efficiency of services systems, plant and distribution is of great importance to the energy efficiency strategy of the development. As well as some standard measures to optimise the efficiency of the services it was decided that measures over and above the norm would be necessary to achieve the client's requirements for a sustainable development.

- i. **Ventilation Heat Recovery:** VHR will be provided to the central air handling units by thermal wheels to provide the maximum heat recovery efficiency
- ii. **Variable Speed Fans:** Variable speed drives will be incorporated into the air handling units to reduce energy consumption during part-unoccupied periods. Motorised dampers will be provided to enable the isolation of the system on a floor by floor and zonal basis. Fan speed will be controlled via a duct mounted pressure transducer within the main supply and extract ductwork leaving each air handling unit. Each air handling plant will utilise duty and standby fan motors.
- iii. **Reduced Levels of Air Leakage:** In order to minimise energy that is wasted through air leakage within the ductwork distribution system and air handling plant, the highest levels of leakage testing will be achieved. Ductwork will conform to CEN classification class B and air handling units will achieve CEN leakage standard class L1.
- iv. **Variable Speed Pumps:** A variable volume LTHW heating system will be provided in order to maximise the energy savings afforded by the use of variable speed pumps in conjunction with 2-port control valves and field mounted pressure sensors. Automatic balancing valves will be provided in order to alleviate as much as possible any problems associated with variable volume water systems.
- v. **Domestic Hot Water Balancing Valves:** Automatic thermostatic balancing valves shall be installed on the domestic hot water return branches to each final circuit. The valves ensure that the domestic hot water circulation system is automatically controlled, ensuring reduction in dead leg lengths and hence providing a more energy efficient delivery of domestic hot water.
- vi. **High Efficiency Lighting:** High efficiency lighting will be installed to reduce electrical energy consumption while maintaining the desired lighting levels. Internally LED and high output TS fluorescent lamps will be employed, externally high output light sources such as CosmoPolis and Metal Halide will be used where appropriate. In addition to efficient light sources, luminaires with high light output ratios using high efficiency optic and reflector technology will be used to optimise the useable output from the lamps.

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- vii. **Lighting Controls:** Lighting controls will be added throughout the development. This includes daylight dimming and switching where appropriate as well as presence detection.
- viii. **Power Factor Correction:** Power factor correction equipment will be installed to maximise the efficiency of the incoming electrical supply.
- ix. **Metering Strategies:** Metering of the building energy systems will be provided as recommended by CIBSE TM39.

The measures undertaken to make the building both lean and mean, i.e. careful selection of building fabric and form (lean) and energy efficient services and equipment (mean) and give us the lowest possible base energy usage before we start to consider the addition of LZC technologies.

The next stage is to look at making the building green, which requires an appraisal of the possible LZC technologies which may be applicable for the building.

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6.0 APPRAISAL OF LOW AND ZERO CARBON TECHNOLOGIES

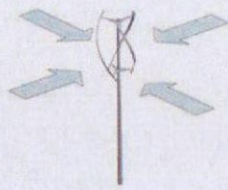
- i. **Solar Hot Water:** Solar hot water heating is a technology that is proven to be reliable, cost effective and provide low to medium CO₂ savings. Panels are positioned on roofs and use the sun's energy to provide domestic hot water. Panels provide an optimum performance when mounted facing due south and inclined at an angle of 30-40°. During periods where the solar intensity is not high enough to provide the required amount of domestic hot water, the LTHW heating system will provide the shortfall. Systems which use larger volume cylinders to store the hot water operate more efficiently, as this allows for more solar hot water to be generated during periods of low domestic hot water use. These systems need very careful design and commissioning and also leave a high maintenance legacy however the development will have a reasonably high domestic hot water usage pattern and as such the use of solar water heating has not been discounted at this stage and will be considered again once the final building form and usage is confirmed. In order to maximise the output from the panels, evacuated tube type collectors would be used. With use of this technology there should be no planning issues with the collectors on the roof as these would be strategically located so as to impact as little on the aesthetics of the building and not cause any issue with neighbouring properties. The collectors shall be situated on the roof and will not affect the land use. This technology will cause no site noise issues.

- ii. **Photovoltaics:** The use of PV materials will be explored along with the optimum location, orientation and inclination for greatest generation performance. Monocrystalline PV systems are considered to be the most appropriate given their increased efficiency. The use of PV systems at this site would be practical given the vast area of roof that is not shaded throughout the year. The optimum incline and orientation for maximum performance is 30 degrees incline from the horizontal facing south. PV arrays will interface with the LV distribution system and an export facility to the grid will be established. With use of this technology there should be no planning issues with the PV panels on the roof as these strategically located as to impact as little on the aesthetics of the building and not cause any issue with neighbouring properties. The PV panels will be situated on the roof outside of the secure custody area and will not affect the land use. This technology will cause no site noise issues.



- iii. **Small Scale Hydro Power:** Not suitable for this site due to the lack of available water source.
- iv. **Tidal Power:** Not suitable for this site due to the lack of available water source.

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- v. **Wave Power:** Not suitable for this site due to the lack of available water source.
- vi. **Earth Tubes:** These tubes supply air via buried ducts which alter the air's cooling or heating temperature before it enters the building. In the summer the air transfers its heat to the surrounding soil therefore cooling the supply air before it enters the AHU. If the soil surrounding the tubes is warmer than the air within, the air acquires heat therefore becoming warm air when it reaches the AHU. Earth tubes require a significant amount of land to be buried in however this land may still be utilised once the earth tubes have been installed. It is not considered that earth tubes would be a cost effective solution for this development and as such further analysis has not been carried out.
- vii. **Wind Turbines:** Vertical wind turbines are considered to be the most appropriate for urban environment and it is estimated that the average wind speed that could be achieved at this location is relatively low. The use of multiple wind turbines is therefore not recommended and the inclusion of a single turbine would be more suited. The operational viability for wind generation on site is low and as wind speed increases with height so does the viability of the turbine. The wind turbine will be interfaced with the LV distribution network. The use of wind turbines could be a potential planning issue as the neighbouring properties would likely be against the aesthetics of this equipment as well as the noise generated by this equipment. The noise level requirement for the site may also be a troublesome issue and again be a potential planning issue. The use of wind turbines is not being actively considered for this project.
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- viii. **Biomass Boilers:** Biomass boilers use either wood chips or wood pellets as the fuel source. The use of biomass as an energy source has become more widespread in recent years. Biomass offers a high CO₂ saving, with a high reliability of plant. Though biomass plant is more expensive than gas fired plant, it has the potential to provide the majority of the heating load almost CO₂ free. Local planning authorities should approve the use of a biomass boiler, however the 'dust' particles from the delivery of the biomass fuel may be an issue for neighbouring properties as well as the frequency of the deliveries of the fuel and what impact that may have on locals roads and residents. The noise generated by the delivery of the biomass fuel may also be an issue for local residents. Biomass is not being actively considered for this project.
- ix. **Combined Heat and Power:** CHP units convert fuel into heat energy and electrical energy via one unit. The technology is similar to that of a car engine and though this technology is widely used, its commercial viability requires favourable conditions. The capital cost of CHP is high compared to the equivalent boiler technology, and to make

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best use the unit should operate at close to full capacity for much of the year. This requires that both a constant electrical base load and heating load are present throughout the year. During the summer period buildings have a low heating base load, which is generally provided by the domestic hot water. During periods when the building does not have a sufficient heating base load for the unit, the waste heat is rejected to atmosphere. Although this development may have a relatively high domestic hot water load which could act as a summer base load, the proposed servicing strategy for the building relies on low grade heat for the most part and the high grade heat produced by a CHP unit does not fit well with this philosophy. Local planning authorities should not object to use of a CHP unit, provided it is housed in an internal acoustically treated enclosure so that background noise levels are not affected at any time. This technology will cause no site noise issues.

- x. **Ground Source Heat Pumps:** Ground source heat pumps use the earth as a thermal sink and provide a source of cooling as well as heating. Ground source heat pumps use either vertical bore holes or horizontal pipework systems as the source of heating and cooling and have extremely good efficiencies, generally converting 1kW of electrical energy into 4.75-5.5 kW of heating and cooling. These efficiencies mean that ground source heat pumps provide a medium CO₂ benefit. Horizontal buried pipeline systems or vertical boreholes are required. This additional capital cost may make them commercially non viable however and a detailed investigation into their suitability would be required. Local planning authorities should not have an issue with the use of GSHP as long as the ground works and future ground movement will not affect any neighbouring properties. Land use may be effected due to the siting of the boreholes/slinky. However if a horizontal pipework (slinky) system is used in the car park, this could effect the ground conditions and may also effect any future use of this area of land. Ground source heat pumps are not being actively considered for this project.
- xi. **Water Source Heat Pumps:** Not suitable for this site due to the lack of available water source.
- xii. **Geothermal Heating Systems:** These systems use deep bore holes to extract thermal energy from the earth below the building. These systems are expensive and give very poor payback and are not considered for this project.
- xiii. **Air Source Heat Pumps:** Air source heat pumps operate in a similar manner to ground source heat pumps, but use ambient air as the heat sink. Air source heat pumps are much cheaper than ground source, though provide slightly lower operating efficiencies. This technology is particularly good where low grade heating is used for example, under floor heating, where the operating temperatures result in higher

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seasonal efficiencies from the system. Local planning authorities should not have an issue with this technology as long as background noise levels are not affected by the external condensers. Land use will also not be an issue as the equipment will all be situated within the building footprint. Air source heat pumps are being considered as the primary LZC technology for this scheme.

xiv. **Fuel Cells:** Fuel cells are electromechanical devices which convert the chemical energy of fuel into both electrical energy and heat. The requirements for viability are similar to those of CHP units, so it is unlikely that they would be commercially viable. The capital cost of fuel cells is higher than that of CHP units, and the technology is still relatively unproven therefore they will not be utilised on this project. This should not be a planning as LZC technology should be encouraged by the planning authority and the land use should not be affected. Fuel Cells are not being actively considered for this project.

xv. **Community Heating:** There is no community heating system currently in the direct local area.

xvi. **Available Grants:**

Available grants are to be discussed further with the client including feed in tariffs for PV, CHP and Wind Turbines and renewable heating incentives for heat pumps and biomass.

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7.0 SUMMARY

On the basis of the modelling done thus far and discussions held with the design team the following LZC technologies are being considered for this development;

- i. **Photovoltaics:** As a large proportion of both energy and CO₂ production of the building is electrical, the effectiveness of photovoltaics will therefore be good. Photovoltaics are easily integrated into the building structure but outside of any secure areas with no noise during operation. The use of photovoltaics on this development will be investigated further during detailed design.

Life Cycle Impact: The running of a PV panel uses no additional energy. The major CO₂ impact of PV panels is the embodied energy used for their manufacture. PV panels are believed to have the highest embodied energy of any of the LZC technologies, as the materials used are energy intensive in manufacture, especially silicon. The amount of embodied energy will vary from the different types of panels available, though all will have a very high embodied energy value.

Land Use: Panels will be integrated into the building, meaning no impact on land use.

Exporting to the Grid: As the building is 24 hour usage any electricity generated by the PV arrays is likely to be fully used within the building.

- ii. **Air Source Heat Pumps (Heating & Cooling):** Air source heat pumps are considerably cheaper than ground source, as no boreholes are required, though efficiencies are slightly lower, however the technology is proven and widely used and gives an excellent LZC contribution in this instance.

Life Cycle Impact: As electricity is the energy used in operation and electricity generation will become de carbonised over the short to medium term, the life cycle impact will become less significant over time.

Land Use: Little additional space is required for the installation of air source heat pumps. External condensers can be positioned on the roof.

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8.0 OVERVIEW OF ENERGY STRATEGY, CONCLUSIONS & RECOMMENDATIONS

As this stage, the lean mean and green building has been provided with air source heat pumps providing low grade heating to the building which will provide around 30% of the overall building regulated energy demand.

Likely renewables to be employed will be air source heat pumps and VRF systems for heating and cooling including energy reclaim in conjunction with solar power by photovoltaic panels (PV), where deemed necessary to satisfy the requirement for consequential improvements.