CJR Maintenance Solutions Ltd

Park Grove Medical Centre

Sustainability & Energy Statement

Ground Floor Plan 1:100 @ A1

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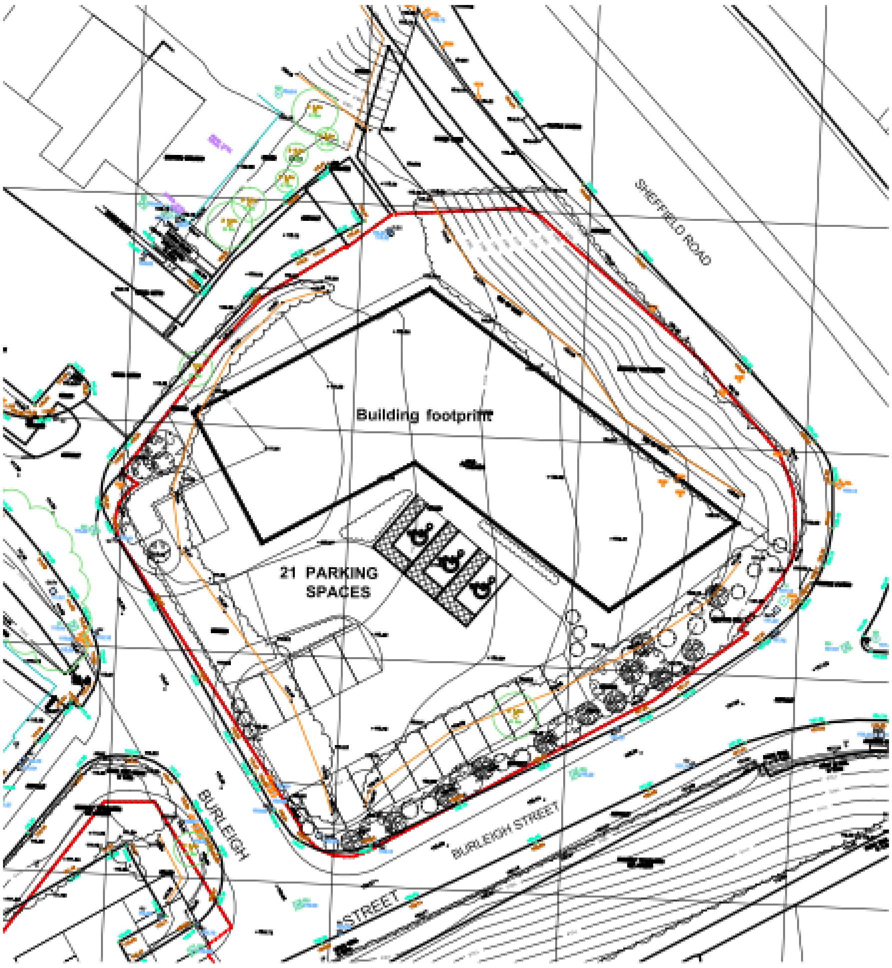
Executive Summary

CJR Maintenance Solution Ltd have been appointed on behalf of Auburn Ainsley to undertake an initial review of the proposed development on Burghleigh Street, Barnsely.



Site Plan 1:500 @ A1

The aim of this report is to identify sustainable design options, comprising architectural features and low and zero carbon renewable energy options that could be incorporated into the proposed development in order to achieve a reduction of the site's carbon dioxide emission based on the Part L target emission rate (TER) and also demonstrate a contribution of energy from renewable sources to the site's annual energy demand.

The scheme is to achieve BREEAM Very Good under the new 2014 guidance.

Tighter air leakage standards, enhanced U values of the building fabric, high efficiency lighting and lighting controls and space heating systems specified will partially meet the Part L TER emissions cut requirement with additional improvements supplemented by solar PV on-site generation.

Sustainable Design Option	Suitability
Bio Mass Boiler	No
Air Source Heat Pump	Yes
Ground Source Heat Pump	Yes depending on ground conditions
Solar Voltaic Panels	Yes
Solar Hot Water	Yes
Combined Heat & Power	No
Wind Turbine	No
Rain Water Recycling	Yes
Night Time Cooling	Yes

At this stage, the selection of systems and technologies cannot be selected completely due to the services strategy being dependent upon the final design of the building, it is recommended that the design of the services is developed with a combination of systems to contribute to the carbon reduction.

The approach favoured to meet the 10% low and zero carbon contribution is to heat the building using air source heat pumps and to provide solar photo voltaic panels to meet a proportion of the on-site electrical load as well as having the ability to feed on to the grid.

This would allow the feed in tariff for this technology to be taken advantage of.

The use of heat pumps could necessitate acoustic treatment of the plant area to meet the conditions specified by the acoustic report.

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This report is an initial overview assessment of the likely site requirements. The report will require further development as the design progresses and the assumed energy consumption figures are confirmed by the detailed energy modelling. This may lead to a change in the viability of suggested systems and must be considered as a necessary element of design development.

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Introduction

This report has been produced in order to identify potential sustainable and renewable technology design options that can be utilised in the project. These design options are preliminary and shall be developed further as the design process continues. Considerations regarding the options available at this early stage of the project are to be integrated with other design issues such as building layout, orientation and glazing.

Design Options

The various potential renewable technologies for the scheme are described below.

Biomass

Biomass is an alternative solid fuel produced from forest products, untreated wood and energy crops such as short rotation coppice such as willow plant. Biomass differs from fossil fuels in that the organic matter is of recent origin and provided products are continually re-grown this makes it sustainable and almost carbon neutral.

The main fuels used are wood logs, pellets and wood chip. Logs are the most common form of wood fuel. A log burning system needs manual feeding every few hours, whereas wood chip can provide a high level of automation. However, for both systems large storage facilities are required. Wood chip systems are generally suited to systems that have an output of 20kW or greater. Wood pellets are a compact form of wood with low moisture content and a high energy density. Wood pellets are more expensive than wood chip or logs but are easier to handle, store and are ideal for automated systems.

Advantages

- Very low carbon emissions when compared to gas and electric heating systems. Can be a major contributor to reducing carbon emissions of overall scheme.
- Biomass boilers can provide heat at flow temperatures matching traditional heating systems and therefore can be included into heating systems.
- Biomass boilers score well on the BREEAM assessment

Disadvantages

- Large plant areas are required for the boilers, accumulator vessels and fuel storage areas;
- The delivery cost for the fuel needs to be factored into the running costs for the building;
- Boilers do not have a good turn down ratio and therefore need to have suitably sized buffer vessels to smooth out demand variations;
- Boiler return temperatures are higher than standard condensing boiler systems and therefore this needs to be considered if standard boiler efficiencies are to be maintained and/or the biomass boiler is to be protected from condensation; and
- There is a rising concern over the level of pollution emitted from biomass boilers into the atmosphere as well as local carryover of ash particles.

During the initial assessment the use of biomass boilers on the site has been considered, and it has been concluded that biomass is not practical or cost effective, that space for plant and fuel storage would prove prohibitive and there could be difficulties for large delivery vehicles accessing the site.

It is therefore recommended that Biomass is not utilised on this scheme.

<u>Air Source Heat Pump</u>

The air source heat pump system utilises the same technology as the ground source heat pump systems with the exception that the energy is drawn from the air and not from the ground.

Advantages

- Cheaper installation;
- Large expanses of land are not required; and
- Pump energy losses are reduced.

Disadvantages

- Lower efficiencies and coefficients of performance (COPs) as the air temperature can go lower than ground making it more difficult to extract useful energy;
- External plant areas are required; and
- External plant provides a risk of external noises

The assessment of the site has shown that this technology is suitable. A refrigerant to water energy exchanger would be needed due to the size of the buildings but given the technology is classed as a renewable by virtue of its ability to take energy from the ambient air and its overall efficiency in terms of carbon dioxide emissions.

It is therefore considered that this option could be utilised on the scheme if other aspects of the design compliment this system.

Ground Source Heat Pump

Ground source heat pumps transfer the renewable heat stored in the ground into a building to provide space heating and possibly a preheat to domestic hot water demand. The ground temperature a few metres down remains at a constant 11°C - 12°C throughout the year. Utilising the constant temperature from the ground as a heat source and passing this through the refrigeration cycle, this 11-12°C heat can be upgraded to a flow temperature of 30-40°C that can then be supplied to the building's heating system. This type of system is best suited to underfloor heating systems that run at a lower flow temperature.

There are two main options for the ground loop (the external pipes) and these are to bury the pipes in trench at depth of around 2 metres, or alternatively, vertical bore holes can be drilled straight downwards.

Advantages

- The system has a good efficiency, operating up to the 4:1 level of performance (4kW of heat output for every 1kW of electricity used in the generation of this heat).
- The plant associated with this system is relatively small.
- There are no planning implications as the plant is housed within the building.

Disadvantages

- The system requires external trenching or bore holes to lay the external ground loop pipework.
- The system flow temperatures are not as high as a traditional heating system, requiring underfloor heating systems or oversized radiators.
- The system is more expensive than a traditional system to install.
- Electrical consumption of the system can be high and therefore carbon emissions can be higher than comparable other technology systems.
- The system benefits to the BREEAM assessment is limited as electricity is used as the main driving fuel source.

Ground source heat pumps are suited to this type of building application, where low flow temperature systems can be successfully accommodated into some of the building operation. However, ground source heat pumps will not be able to fully replace traditional boiler systems as these will still be needed to serve the higher temperature circuits such as the domestic hot water systems.

The suitability of this proposal would also depend on ground conductivity.

The selection of this system would make underfloor heating and cooling the most viable option due to lower water temperatures.

The ground source heat pump system could be combined with the solar collector system to serve a common heating and hot water system thereby maximising the efficiency of these two installed systems

It is therefore recommended that due to being cost prohibitive this system is not utilised on this project.

Solar Voltaic Panels

Photovoltaic cells convert sunlight directly into electricity with no waste and no emissions. When the light from the sun hits the silicon in the PV cell direct current electricity (DC) is created. The DC is collected in a central location and converted to alternating current (AC) so that it can be used to supply standard electrically operated appliances.

During daylight hours electricity produced from PV panels would be supplemented by the local distribution network operator (DNO). If, however, excess electricity is produced then electricity can be fed back into the electricity grid.

The previous Renewable Obligation Certificates (ROCs) system was superseded by the Feed in Tariff system in 2010. The tariff applicable is dependent on the installed capacity and classification of building i.e. new build or retrofit.

This type of system depends on the roof area available facing predominantly south with a horizontal angle of up to 40°. Roofing products that can replace conventional roof tiles or framed systems attached to the roof can be installed.

PV cells are a relatively new technology and therefore there is no firm and proven research into the maximum life expectancy of the cells. The cells themselves have no mechanical parts and are therefore not susceptible to any wear and tear that limits the life expectancy of such systems as fans and pumps etc.

However the current estimated advised by PV cell manufacturers is that the operating efficiency of the cells will decrease to 90% after the first ten years followed by a further decrease to 80% output after 25 years.

With regard to maintenance, the systems can be regarded as low maintenance items that only require periodic cleaning of the panels to ensure maximum sunlight is getting through to the panels.

The individual cells embedded within the glass are wired in series circuits therefore any failure of a single cell would render the whole pane non operative. Individual panes are best cabled in parallel circuits however, to ensure that the loss of one PV/Glass panel would not affect the operation of the other units.

Advantages

- The system is simple to operate with very low maintenance requirements;
- Contributes to offsetting the electrical consumption of the building and therefore offsets the highest carbon emitting energy source;

Disadvantages

- Plant space requirements can be large for a storage system;
- System does not operate at night;
- The installation may require planning consent;
- Life expectancy of the PV cells are unproven;
- The cost of PV cells is high.

The overall suitability of the system depends on the final building form, shape and orientation. However, in general, photovoltaic cells can be accommodated on almost every building and therefore, if implemented at an early stage, there does not appear to be any reason why PV cells cannot be successfully accommodated into the scheme.

The carbon dioxide emissions offset benefit that PV technology brings is considered as necessary on this scheme to achieve compliance with the planning conditions

Solar Hot Water Panels

Solar Hot water systems are well established in many countries however the perception that the UK weather is not sunny enough has reduced their use in the UK. However solar thermal systems do not actually require direct sunlight and therefore do in fact work very successfully within the UK.

The system uses the thermal energy from the sun collected in solar thermal panels on the roof of the building to heat water that is passing through pipes fixed to the solar plates.

These systems are generally operated with a backup source of heat as for a traditional system, such as gas or electricity.

There are two types of solar collectors, flat plate collectors or evacuated tube collectors. Evacuated tube collectors are more efficient but also tend to be more expensive. If flat plate collectors are installed the ideal tilt of the collector would be 40°. If evacuated tubes are used the angle is less critical.

During the summer months, in general, almost all of the hot water demand can be met by a sufficiently sized solar hot water system, with a significant reduction in the amount in winter months when there is less solar energy available.

As with the photovoltaic system the optimum location for the panels are on a sloped roof with a southerly orientation, however east and west orientations are also acceptable.

Advantages

- The system is relatively maintenance free;
- The system requires very little energy to operate;
- There are potentially sizeable energy savings, dependent on the water usage patterns within the building;
- If designed correctly, the solar water heaters can be used to contribute to the space heating of the building as well as heat domestic hot water;
- There is potential to generate income through the renewable heat incentive scheme.

Disadvantages

- The systems need to be located on the roof, this can cause planning issues;
- The systems are relatively expensive in initial procurement and installation costs
- The system efficiency depends on building orientation.

Given that there is likely to be a minimal demand for domestic hot water, the benefit of this technology is limited, however it is proposed that a small solar hot water scheme is reviewed within the design.

Combined Heat & Power

There are two types of combined heat and power installation that are being considered for this project; gas fired and biomass fired systems. The only main effective difference between the systems is the fuel source used to fire the plant, one using natural gas and the other using biomass (wood chip of wood pellet). The corresponding carbon emissions are therefore different as the carbon emitted for burning one kilowatt of gas is 0.198 kg CO_2 as opposed to 0.025 kg CO_2 for biomass.

The gas fired Combined Heat and Power systems are not renewable energy systems but are considered low carbon green energy systems as waste heat generated by electricity production is used as a by product, resulting in an overall lower carbon emission for the system than if separate grid supplied electricity and gas fired boiler systems were used to provide the same electricity and heating provision to a building.

The use of biomass to fuel the CHP unit does not carry the same carbon emission factor as the gas system and is therefore a considerably lower carbon emitting system. Whilst it still does emit carbon, it is in effect considered a green, carbon neutral system, so long as the fuel deliveries are sourced locally or delivered by biofuel powered transport.

A CHP system therefore derives its name (combined heat and power) from the fact that fuel is burnt to provide power (electricity) and heat is also produced as a useful by product. The generation of two useful energy sources also leads this type of system to be called a cogeneration system. When linked to an absorption chiller unit, the water heat from the CHP plant can also be used to provide cooling (absorption chiller units are heat driven systems) and these systems are called tri-generation systems as three useful energy sources are now available.

Biomass/biofuel CHP would qualify for subsidy from the RHI (Renewable Heat Incentive).

Advantages

— Electricity is generated on site;

— Heat is provided as a free by product;

— Cooling can be provided when combined with an absorption chiller unit;

— The CHP unit can act as a standby generator set to back up essential supplies to IT servers etc.

Disadvantages

— Plant areas required can be large.

— If heat produced by the generation of electricity is not required, eg during summer, then the heat still needs to be rejected to the atmosphere and so separate heat rejection plant is needed.

— Plant requires maintaining by the client.

The viability of both biomass and gas fired CHP plant has been considered for the site and neither would be a viable solution as the likely load profile would mean that we could not use the waste heat in summer.

Wind Turbine

Wind energy has been identified and utilised for many years as a source of clean and renewable energy. The United Kingdom is Europe's windiest country and benefits from 40% of Europe's total wind energy resource. The technology exists to easily convert the wind energy directly into electricity by the use of modern wind turbines where the power of the rotating shaft is converted into electricity via a generator unit.

In similar fashion to the photovoltaic cells the electricity generated from the wind turbine can be either stored in batteries or fed direct into the building's electrical supply. Unlike photovoltaic cells the wind turbine will continue to generate after dark and therefore the electricity generated can be used to support the essential systems within the building.

Wind generated energy can also attract the subsidies from the Feed in Tariff.

There are a number of wind turbine manufacturers and the range of units available vary considerably in size from small domestic units sized at around 1.5 kW to large scale wind farm turbines that are capable of generating 3 MW (3,000 kW). However, the basic design of the units is relatively similar.

Wind turbines contain elements of moving machinery that will degrade over time as they incur wear due to usage. Therefore certain elements of a wind turbine will have differing life expectancies just the same as any other item of plant or machinery. However when viewed as a whole system manufacturers are advising that wind turbines can have a 20 to 25 year life expectancy. The operating efficiency of a wind turbine should remain constant over the life time period providing that the routine maintenance is completed fully.

A ground based wind turbine is mounted upon a mast that is fixed to the ground. The ground based system has the advantage that the full weight of the mast and the forces exerted by the operation of the turbine blades can be easily accommodated within the mast foundations. In addition, access for maintenance is simpler and can be accommodated by hinged masts. Ground based systems do however carry the disadvantage that they are close to the ground and therefore the wind speeds are lower and they can be affected by the close proximity of obstructions such as trees and buildings etc.

A building mounted wind turbine unit is fixed to a mast that is in turn fixed to the building structure. This type of application has the benefit of raising the wind turbine to a greater height above the ground where the wind speeds shall be higher. It shall also raise the wind turbine above the majority of the local obstructions such as trees or buildings.

However the design of a building mounted wind turbine is very complex and must be fully coordinated into the structure of the building not only to provide sufficient structural support for a the weight and turning moment forces of the turbine unit assembly but also to ensure that the vibration from the operational turbine is not transferred into the structure but is fully isolated at the source. As a result of this it is very difficult to successfully accommodate a wind turbine onto the structure of an existing building.

The location of a wind turbine on top of a building also causes additional problems with regard to access for maintenance of the unit and the need for specialist access platforms.

Advantages

- Wind turbines can provide a meaningful energy contribution to the site;
- Wind turbines can be used as a good visible public relations statement.

Disadvantages

- Wind turbines will require planning consent and potentially consent from Civil Aviation Authority if close to airports or flight paths.
- Wind turbines can raise local resident complaints and objections.
- Wind turbines do create a level of operational noise that must be considered.
- Wind turbines are a relatively expensive sustainable energy option.

In general, the site is not considered as being suitable for a wind turbine installation due to the close proximity of the local properties and potentially restricted wind patterns from the surrounding trees and buildings.

Rainwater Recycling

Grey water is defined as the waste water produced from baths, showers, clothes washers, and wash-hand basins. The wastewater generated by toilets is called blackwater. Wastewater from kitchen sinks and dish-washers is often considered to be blackwater as well, due to the higher organic content. As its name implies, greywater is of lesser quality than potable water, but of higher quality than black water. Rainwater is water collected from surface run off from buildings such as from roofs. In general, the main collection systems utilised in buildings are from rain or grey water sources.

A water recycling system collects this water (rain or grey) and stores it within tanks and then resupplies it back to the building where it is used to supply the non-potable water consuming appliances, such as the toilets and watering plants. In this way, the overall water consumption of the building is reduced.

Advantages

- Water consumption on the site can be dramatically reduced as the prime water usage is via the toilets;

- The grey water recycling tank can double up as the site drainage attenuation tank.

Disadvantages

- The grey water storage tank can be large and requires space either within the building or outside;
- Pipework arrangements must be routed so as to allow for the collection of the water and also the redistribution of the grey water back to the appliances. Therefore the system requires additional pipework;
- Pipework arrangements need to be considered to ensure avoidance of dead legs and the associated legionella risks.

Grey water quality is problematic in its reuse. Rain water systems have a higher water quality and are therefore more suitable and can be accommodated within almost any building provided the space for the tanks and plant can be accommodated and the internal plumbing can be organised for the additional pipework connections.

Night Time Cooling

The ability to adequately naturally ventilate a building is a major contributor to reducing on site carbon emissions by the avoidance of operating electrically driven ventilation fans. The feasibility of a room to be adequately naturally ventilated relies on a number of factors including ventilation opening, height of room, depth of room from window/vent opening, height of the stack above the room, level of internal heat gains and level of solar heat gains.

With the provision of natural ventilation to the building, the potential use of night cooling to pre cool the building overnight can be implemented. This is best achieved by motorised ventilators providing a controlled ingress of cool night air into the building. The effectiveness of night cooling is dependent on the ability of the building fabric to store the temperature overnight so that it is slowly released during the following day, however, even with low thermal mass buildings, night cooling can be beneficial. Any night cooling scheme will need to consider security of the building accommodate this.

Natural ventilation via manual opening windows is considered to be possible for the consulting room areas.

Conclusion

Following the report the table below now shows the technologies that can be considered over those suitable at the initial outset. Generally PV and Air Source Heat Pumps would be favourable, however during the design stage other technologies can be introduced to produce the same results.

Sustainable Design Option	Suitability	Systems Proposed
Bio Mass Boiler	No	No
Air Source Heat Pump	Yes	Yes
Ground Source Heat Pump	Yes depending on ground conditions	No
Solar Voltaic Panels	Yes	Yes
Solar Hot Water	Yes	Yes
Combined Heat & Power	No	No
Wind Turbine	No	No
Rain Water Recycling	Yes	No
Night Time Cooling	Yes	Yes

Whilst the detailed design stage has yet to be commenced, it is possible to make estimates of the likely energy usage of the development using data collected from various other projects that have been designed to meet the current Building Regulations Part L2A energy criteria.

The table below shows these predicted figures.

Item	Proposed Project
Floor Area	968.7m^2
Predicted Thermal Energy	27,048 kWh
Predicted electricity Consumption annually	66,001 kWh
Predicted CO^2 production assume gas	5,354 kGCO^2
Predicted CO^2 production from electricity	34,123 kGCO^2
Total CO^2 production per year	39,478 kGCO^2
Predicted CO^2 production per year m^2	40.65 kgCO^2 per m^2
Target of energy from renewable technologies	**9304 kWh**