

Appendix R Renewables Report

Bilston Leisure Centre (Plot A)

**Interim Renewable Energy Options
Assessment**

B2094800

Date: November 2008

Document control sheet Form IP180/B



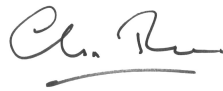
Client: Wolverhampton City Council
 Project: Bilston Leisure Centre
 Title: Interim Renewable Energy Report

Job No: B2094800

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1.1 Introduction

As part of the wider Bilston Urban Village (BUV) development, the leisure centre will be a prominent gateway building. It therefore provides an ideal opportunity to champion the principles of sustainable design and construction.

A number of studies on renewable and low carbon technologies have been undertaken during the development of the Plot A and wider BUV proposals.

The findings of the study show that the existing reports provide a good generic overview of a range of technologies and planning policy however specific information relevant to the leisure development is limited. Due to the fact that energy prices have risen rapidly over the past two years the cost estimates and payback periods for the technologies are out of date.

Jacobs have been commissioned to produce a revised renewable energy strategy which considers the leisure centre in isolation.

1.2 Aims & Objectives

The proposed Bilston Leisure Centre needs to comply with a range of environmental targets including local and regional planning policy, BREEAM and current Building Regulations.

This report aims to explore the renewable and low zero carbon technologies available for implementation on the leisure centre development to ensure the required environmental targets are met successfully.

The outcome of this initial study is to determine the most appropriate energy strategy for the leisure centre project. Following an initial review of the available options a more detailed study will be undertaken.

1.7 Methodology

An initial assessment of the feasibility of a range of renewable technologies is presented with the advantages and disadvantages of each technology being reviewed. This includes estimates on annual energy production, spatial impact and impact on building design, operational viability, estimated cost and CO₂ reduction potential.

This will highlight the different energy strategy options available for the Leisure Centre. A high-level assessment will be conducted for the various options, providing guidance on the different technologies involved and the initial design and cost implications of a specific strategy.

This allows a conclusion to be formed on the most viable technology, or combination of technologies, which would be appropriate to achieve the environmental targets for the development.

Several energy options are put forward for consideration which will be analysed further, following discussion with all parties.

Following the identification of a preferred strategy the second stage of the report will follow. This will build on the conclusions drawn in the initial interim report and provide a detailed analysis of the preferred strategy. It will assess the different technologies involved in more detail including energy performance, CO₂ emission savings, basic financial savings and more detail on technical issues and constraints.

2 Planning Policy Overview

The planning requirements regarding the energy and associated CO₂ emissions for the Bilston Plot A development are determined by three different requirements which are outlined below:

2.1 BREEAM 2006 Requirements

The Bilston leisure centre development will achieve a BREEAM 'Very Good' (under Bespoke 2006) rating and beyond this the design will seek to maximise sustainability benefits, particularly in relation to operational performance.

There are two criteria related to energy under BREEAM 2006 which are:

E1: Reduction of CO₂ emissions (up to 15 credits)

| Credits | Percentage improvement over building regulations (New Buildings) |
|---------|--|
| 1 | +1% |
| 2 | +2% |
| 3 | +4% |
| 4 | +6% |
| 5 | +8% |
| 6 | +10% |
| 7 | +12% |
| 8 | +14% |
| 9 | +18% |
| 10 | +22% |
| 11 | +30% |
| 12 | +40% |
| 13 | +50% |
| 14 | +60% |
| 15 | ≥70% |

In order to achieve a 'Very Good' rating the Bilston leisure centre project will need to achieve at least 5 credits based on the scale above.

P11: Renewable & low emission energy (3 credits)

1. One credit is awarded where evidence provided demonstrates that a feasibility study considering renewable and low emission energy has been carried out and results implemented.
2. Second credit is awarded where evidence provided demonstrates that 10% of total energy demand for the building/development is supplied from local renewable or low emission energy sources.
3. Third credit requires 15% of total energy demand to be met.

2.2 Advantage West Midlands (AWM) Sustainability Checklist

Good practice - "meeting 10% of total site energy demand will be produced from an on-site renewable scheme."

2.3 "Plot A" Development BRIEF

The development brief requires: "A 15% improvement on relevant Building Regulation requirements should be achieved in the building fabric performance of the building."

10% of the building's annual heat demand or electricity consumption should be supplied from a local renewable energy source.

2.4 Clarification of Requirements

Discussion with Rosemary Coyne the Sustainable Design and Construction Policy Manager at AWM was undertaken to clarify the specific planning requirements in the design brief. It was confirmed that a 10% CO₂ reduction from on site LZC technologies would be accepted as meeting the renewable energy target.

However, it would be dependant on supporting evidence that demonstrates the use of LZC technologies would achieve more CO₂ savings than an energy strategy involving renewables only.

Evidence should demonstrate that detailed studies have been undertaken and prove that CHP would provide an optimal solution to the energy needs of the development.

3 Low and Zero Carbon (LZC) Technologies

This section provides a general overview of the low and zero carbon technologies available. It should be noted that carbon emissions associated with the manufacturing of the renewable technologies have not been accounted for when calculating carbon savings within this project.

Key factors that need to be addressed when determining the feasibility and choice of renewable and low carbon technologies for this development include:

- Energy Production Potential – technologies must produce a useful and consistent amount of energy.
- Spatial Impact - ability to provide renewable energy on a site wide basis without impacting on the surrounding development.
- Impact on Building Design - site-specific considerations and any planning issues.
- Operational Viability - ability for the technology to be easily managed by the owner, or through a low cost contractual arrangement.
- Estimated Cost - capital and installation costs for the renewable energy provided – value for money.
- CO₂ emission savings: can the technology be utilised to meet the required savings target.

Each renewable energy technology has been assessed to ascertain whether it is feasible to integrate it into the Bilston Leisure Centre development.

3.1 Natural Gas Fuelled Combined Heat and Power (CHP)

Combined Heat & Power (CHP) is an efficient way of producing usable heat and generating electricity simultaneously at the point of use from a single fuel. CHP offers an economic and environmentally friendly alternative to meeting thermal and electrical demands in many applications.

The heat from the engine block, oil cooler and exhaust, which would normally be wasted, is absorbed by coolant water through a high efficiency heat exchanger. This energy is stored as hot water and is then usable directly for central heating, hot domestic water, or indirectly for air conditioning.

Gas-fired CHP has the potential, in the right circumstances, to offer overall reductions in energy costs and associated CO₂ emissions, due to the value of the heat produced and utilised within a building rather than wasted to the atmosphere. It is this ability that enables CHP to act as a carbon mitigation technology and allows it to be considered as part of a programme aimed at minimising carbon emissions.

Gas fired CHP is not classed as a renewable technology so it does not count towards any renewable energy targets. However, it can significantly reduce the overall CO₂ emissions for the development.

A CHP unit could be introduced to supply low carbon electricity and heat to the leisure centre. The CHP unit would need to operate in conjunction with conventional gas boilers which would provide an additional heat source during periods of high demand.

The leisure centre has a swimming pool and therefore has a constant thermal base load throughout the year. This thermal base load makes it suitable for CHP as the unit would achieve the required annual running hours of 4,000. This is essential for CHP schemes to be cost effective and environmentally beneficial.

Due to the proposed ongoing development on the wider Bilston Urban Village site it would be feasible to implement a district CHP scheme. This would involve a central energy centre and a district heating main which other developments could connect into when complete. The use of a district scheme has various benefits including increased system efficiency, cost savings and CO₂ savings.

The main issues limiting the potential for a district CHP system is the phasing of the construction and commitment from potential future developers. If a district scheme is to be selected then it would require significant investment and additional infrastructure.

Due to the time scales involved with the leisure centre development it may not be feasible to agree and finance the infrastructure costs at this time. It may be more practical to design the system specifically for the leisure centre now and leave potential for expansion in the system when more plots are developed.

CHP has been selected as a suitable technology for further consideration on the development.

3.2 Biomass CHP

Biomass CHP works in the same way as conventional CHP except the fuel source is biomass. Biomass CHP systems require considerably more space than a conventional system due to the additional plant, equipment and fuel store requirements.

The available space within the leisure centre is already limited so the only option would be to locate the plant, equipment and fuel store externally.

The cost of the Biomass CHP plant and equipment would considerably more than a conventional gas CHP system. Other considerations include the availability of biomass fuel at the required quality (i.e. moisture content), the ongoing cost of fuel, availability of equipment and increased maintenance requirements. Biomass CHP systems are considerably more complicated than gas fired CHP systems and also have a lower life expectancy.

The use of biomass CHP has not been considered further due to the high capital cost and reduced operational life of the units.

3.3 Wind

The Bilston Leisure Centre development will have limited scope for free standing wind turbines which would require masts from around 15m to 50m in height.

Building mounted micro wind turbines are easier to integrate into an urban setting. However, micro turbines are in their infancy and could only be attached to certain points on the leisure centre development, therefore limiting the number of turbines that could be installed.

The amount of electricity generated by these turbines is relatively small due to their small size and lower urban wind speeds. Therefore a significant number of turbines would be required in order to provide a useful amount of electricity.

It is likely that the wind speeds on site may not be sufficient to generate useful amounts of electricity. Therefore it would not be feasible to integrate them due to the low output potential.

Although a large scale wind turbine could potentially provide significant CO₂ savings it would need to be located at least 300m from the nearest dwelling. Due to the location of the site the development could not achieve this requirement.

Wind turbines have not been considered as a suitable technology for the development.

3.4 Solar Thermal

Solar thermal systems rely on a solar collector connected to a hot water cylinder. For solar thermal systems to work on the leisure centre development they would need to be located on a southerly facing roof area.

Solar thermal systems could provide a proportion of the domestic hot water requirements for the leisure centre facilities and pool heating. However, their contribution would be minimal compared to the considerable thermal load of the leisure centre.

The compatibility of solar thermal systems with CHP also needs to be considered. The use of a solar thermal system for heating the pool water and other domestic hot water uses would in effect reduce the thermal load that could be met by the CHP plant therefore reducing the operational hours of the system.

CHP plant works most effectively when its annual running hours are maximised. Therefore, the use of a solar thermal system would affect the efficiency and viability of a CHP system.

If CHP is not used on the development then the use of solar thermal systems would become viable. However the potential energy and cost savings would be significantly lower than compared to other technology options.

Solar thermal has not been selected as a suitable technology for further consideration as it would provide lower CO₂ reductions than other technology options.

3.5 Solar Photovoltaic (PV)

Solar PV works on the basis that daylight is converted into electricity and mainly comes in the form of panels. This enables it to be easily integrated into buildings.

The main design consideration, which effects overall output, is the orientation of the panels. The optimum orientation is due south at an angle of between 20 and 40 degrees.

Solar PV can provide significant reductions in CO₂ emissions and can be easily integrated onto a building. The main consideration with the use of PV is the associated cost implications.

Solar PV could be used as part of a mix of other low or zero carbon technologies however it would not be used in isolation.

3.6 Biomass Boilers

Although biomass boilers can offer high CO₂ savings the required infrastructure would be costly for this development. To provide the annual heat demand for the leisure centre a large amount of biomass fuel would be required.

Although not all of this fuel would be stored on site a considerable fuel store would be necessary. A large amount of space would also be required for the associated plant and equipment.

Other considerations for the use of biomass include the availability of biomass fuel at the required quality (i.e. moisture content), the ongoing cost of fuel, availability and cost of plant and equipment and increased maintenance requirements.

Biomass boilers would provide a heat source and therefore would reduce the load on any CHP system use. As discussed previously the viability of a CHP system is dependant on the annual running hours and maximum base thermal load.

If CHP is not selected as a preferred technology on the development then the use of biomass boilers may become a feasible option. However, if CHP is selected biomass boilers would not be viable.

Biomass boilers are a feasible technology for the development but only if CHP is not used.

3.7 Ground Source Heat Pumps (GSHP)

The ground temperature at a depth of approximately 2m is around 10°C consistently throughout the year. This energy source can be utilised to provide a heating through the use of a heat pump. The heat pump has the ability to upgrade the heat from 10°C to around 40°C.

GSHP can use horizontal loop collectors which are located a few metres below the ground and take up large areas. An alternative is to use vertical boreholes, which can be up to 150m deep.




Heat produced through a GSHP system is low-grade heat which would not be suitable for many uses in the leisure centre.

The use of a GSHP system on the site would not be feasible due to on site contaminated land issues and ground conditions.

Ground source heating systems have not been considered for this development due to ground conditions.

4 Technologies Overview


The following section summarises the considerations made for each technology:

| | | Feasibility Assessment Summary | | | | | |
|----------------------------|---|--|---|---|--|---|---|
| Renewable Technology | Annual Energy Production | Spatial Impact | Impact on Building Design | Operational Viability | Estimated Cost | CO ₂ Reduction Potential | Overall Suitability for Bilston Development |
| Natural Gas Fuelled CHP | A CHP system has the potential to provide significant amount of heating, hot water and power requirements. | The use of a gas CHP system would have minimal spatial impact on the development. | Additional plant room space would be required for the plant and associated equipment. | The use of a gas CHP system on this development would be feasible due to the consistent thermal load provided by the swimming pool. | Capital cost of units is high. However, energy cost savings are considerable and commercial options are available for purchasing the system. | High due to waste heat being utilised within the development and on site electricity generation. |  |
| Biomass Fuelled CHP | A CHP system has the potential to provide significant amount of heating, hot water and power requirements. | The use of a biomass CHP system would require considerably more space than a gas CHP system. It would also require frequent fuel deliveries. | Additional plant room space would be required for the plant, associated equipment and fuel store. | The development has a consistent heat load provided by the swimming pool. However, frequent fuel deliveries would be required. | Capital cost of units are high and the associated infrastructure would require significant capital costs. | High due to zero carbon fuel source |  |
| Wind Turbine (Small Scale) | Depends on the wind speed and local topography but the overall production is limited and unpredictable due to the smaller size. | The spatial and visual impact is a moderate factor for the selection of small scale wind turbines | Requires a small footprint however needs to be clear of obstructions for a good wind resource. | Wind monitoring should take place to determine the feasibility and estimated electricity generation. | A relatively low capital cost would be required for a suitable small scale wind installation | Offsets grid electricity but annual emission reductions are low especially from small wind turbines |  |

Feasibility Assessment Summary

| Renewable Technology | Annual Energy Production | Spatial Impact | Impact on Building Design | Operational Viability | Estimated Cost | CO ₂ Reduction Potential | Overall Suitability for Bilston Development |
|------------------------------------|---|--|--|---|--|--|---|
| Wind Turbine (Large Scale) | Depends on the wind speed and local topography but a large turbine could generate significant electricity | The spatial impact is a significant factor for the selection of large wind turbines | Requires a medium footprint however needs to be clear of obstructions for a good wind resource and at least ~ 300m from the nearest dwelling | Planning approval required with extensive consultation. Detailed wind monitoring should take place to determine the feasibility and estimated electricity generation. | A medium capital cost would be required for a suitable large scale wind installation with potential good environmental and financial returns | Offsets grid electricity with annual emission reductions being potentially high | <input type="checkbox"/> |
| Solar Photovoltaics (PV) | Has the potential to provide consistent amounts of electricity each year | Negligible | Added to roof areas and can be on a flat roof or pitched roof as long as a southerly orientation is achieved. | No apparent issues as long as the systems are designed correctly | Higher capital costs compared to other technologies. 1kWp system may cost approximately £5,000 | Offsets grid electricity with annual emission reductions being consistent year on year | <input checked="" type="checkbox"/> |
| Solar Thermal Water Heating | Can potentially produce a significant amount of thermal energy. | Panels would be located on the roof with a large thermal store within the building. | Added to roof areas and can be on a flat roof or pitched roof as long as a southerly orientation is achieved. | System doesn't integrate well with CHP as it reduced the base heating load. | Low cost compared to other renewable systems, approximate cost of a typical 4m ² system is ~ £3,000 | Offsets natural gas and size of installations will often be small | <input checked="" type="checkbox"/> |
| Biomass Boilers | Can meet the annual heating and hot water demands with the benefit that the fuel is carbon neutral | Biomass boilers are larger than normal and require a fuel store and regular fuel deliveries. | Biomass boilers require a fuel store and considerable additional space. | Large deliveries of fuel and regular ash removal and disposal are required. Biomass boilers require more maintenance than conventional systems. | Capital cost higher than conventional systems and maintenance costs would be more. Fuel costs would be slightly higher when compared to natural gas. | High due to zero carbon fuel source | <input checked="" type="checkbox"/> |

Feasibility Assessment Summary

| Renewable Technology | Annual Energy Production | Spatial Impact | Impact on Building Design | Operational Viability | Estimated Cost | CO₂ Reduction Potential | Overall Suitability for Bilston Development |
|---------------------------------|--|---|---|---|--|---|---|
| Ground Source Heat Pumps | System can provide a proportion of space heating and hot water requirements. However heat pumps do require some electricity to generate the heat output. | Ground conditions are a factor and systems require a large space for the collector loops. Due to unsuitable ground conditions GSHP would not be suitable on this development. | Can affect building design although early consideration can limit problems associated with design and installation. | GSHP system outputs are generally low temperature so would not be useful for many uses within the leisure centre. | Capital costs are higher than conventional heating systems, and the associated installation costs are higher due to drilling bore holes. | Requires electricity to produce heat, which therefore reduces overall available emission reductions |  |

5.1 Option 1 - CHP Led with Renewables

Option 1 would be a CHP led option supported by the use of renewables. This would mean that renewable technologies selected would need to be compatible with a CHP system.

Positive (+)

- Good practice design
- Contributes to all relevant targets
- Back up power capability

Negative (-)

- Full investment required by WCC
- The use of CHP limits the options available to achieve the renewable energy targets if they are compulsory under the planning requirements.
- Discounts the use of feasible renewables including solar thermal and biomass boilers.

5.2 Option 2 – Renewables Led without CHP

Option 2 would be an energy strategy led by renewables not including CHP. This would allow the use of renewable technologies that are not compatible with CHP.

The technologies considered suitable for this development which are not compatible with CHP include solar thermal and biomass boilers.

Positive (+)

- Target would be achieved using only renewable energy technologies.
- Reduced dependence on fossil fuels.

Negative (-)

- Full investment required by WCC.
- Cost of compliance would exceed a CHP led option.
- Reduced CO₂ savings compared to CHP led option.
- Not good practice design for a leisure centre development

5.3 Option 3 – CHP (ESCO) Led with Renewables

Option 3 would be similar to option 1 except the CHP system would be provided by an Energy Services Company (ESCO).

Positive (+)

- Lower levels of investment required by WCC.
- ESCO provider responsible for capital and maintenance costs.
- Potentially lower unit prices compared to grid tariffs.
- Would reduce the overall CO₂ footprint of the leisure centre development.

Negative (-)

- Additional investment required for renewable energy technologies.
- Long term contract required.
- Potential penalties if the agreed amount of energy is not consumed.
- Equipment is not under the ownership of the council.

5.4 Option 4 – CHP (ESCO) Led without Renewables

Option 4 would involve a CHP system serving the leisure centre only without the use of renewable technologies.

Positive (+)

- No investment into renewable energy technologies required.
- Lower levels of investment required by WCC.
- ESCO provider responsible for capital and maintenance costs.
- Would reduce the overall CO₂ footprint of the leisure centre development.

Negative (-)

- Long term contract required.
- Potential penalties if the agreed amount of energy is not consumed.
- Equipment is not under the ownership of the council.

5.5 Option 5 – District CHP (ESCO) Led with Renewables

Option 5 would involve a district CHP system providing heat and power to the wider urban village development, including renewable technologies supplying the leisure centre. This would only be feasible when the other plots on the development are completed.

Positive (+)

- Lower levels of investment required by WCC.
- ESCO provider responsible for capital and maintenance costs.
- ESCO would connect up to wider development achieving improved efficiency and greater CO₂ savings.
- Would include a proportion of renewable energy to go towards the local / regional targets.
- Would reduce the overall CO₂ footprint of the leisure centre development.

Negative (-)

- Separate energy centre would be required.
- Commitment and buy in from other parties would be required at an early stage.
- Increased cost of required system infrastructure.

The report outlines several options for implementation on the proposed Bilston Leisure Centre Development. At this stage the options have been considered at a strategic level and will require more detailed analysis when more decisions have been made on the overall energy strategy.

Following feedback on the proposed options a more detailed strategy can be formed, including detailed cost estimates and more accurate CO₂ savings.

Based on the analysis undertaken gas fired CHP is the most viable option for the development. However, the estimated cost, installation and running options need further investigation.