Lensbury ltd.

Lensbury family restaurant

Energy strategy

Low and zero carbon feasibility study
July 2013

Prepared for:

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Revision Schedule

Low and zero carbon feasibility study
July 2013

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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1 Introduction

Terms of reference

1.1.1 Planning for Sustainability has been instructed to undertake an initial energy study to identify the potential for improvement of the energy performance of the proposed new family restaurant on the Lensbury Hotel estate in Richmond-on-Thames.

1.1.2 The report is to be used to inform the agreement of a BREEAM target and to address the requirement of a low and zero carbon feasibility study in the BREEAM requirements.

1.1.3 The report is based upon the RIBA stage B design drawings and information and as such only indicative information is available.

Proposed development

1.1.4 The proposed new family restaurant would be located within the boundary of the Lensbury Hotel in Teddington, Richmond-on-Thames. The restaurant comprises a dining area for 100 covers with a play area for children of various age groups (see figure 1). In addition the restaurant includes ancillary facilities appropriate for a restaurant such a kitchen and serving areas and sanitary facilities.

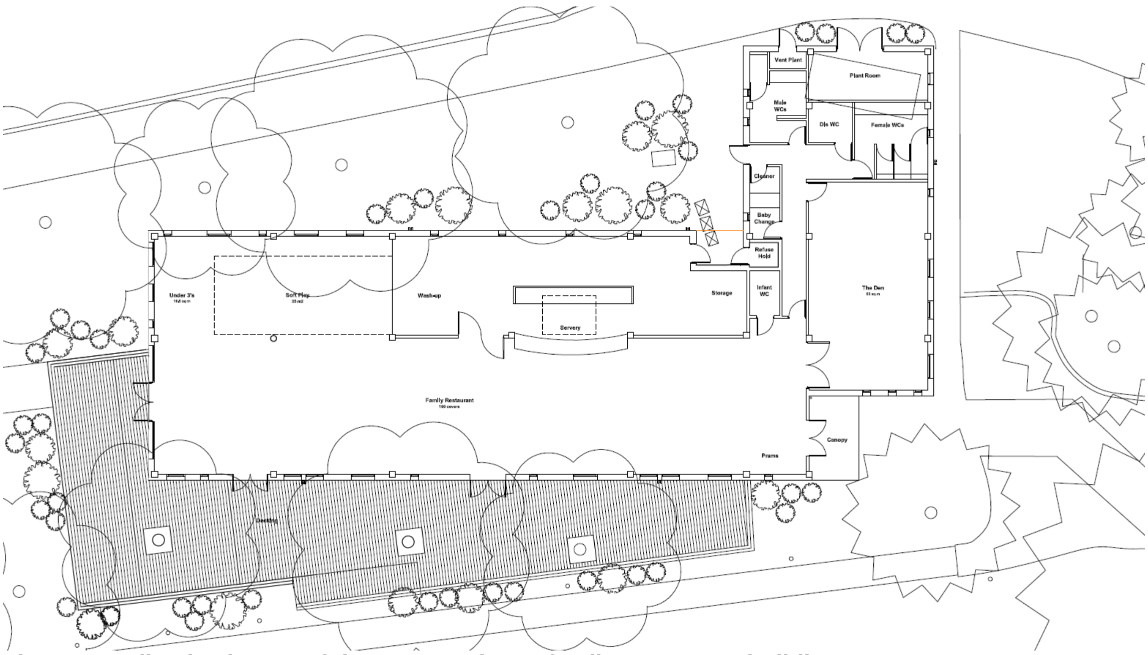

Figure 1. Indicative layout of the proposed new family restaurant building

1.1.5 The immediate setting of the proposed building is dominated by a number of mature trees.

BREEAM requirements

1.1.6 The local planning authority has expressed that the building should achieve the BREEAM certification level of “excellent”. There are a number of minimum standards with regard to the energy performance of a building that need to be achieved in order to achieve a certification level of “excellent”.

1.1.7 ENE01 deals with the energy performance of the building in comparison with the minimum requirements that are set-out in the building regulations. The minimum requirement is that the buildings carbon emissions are at least 25% better that the target emissions as defined by the building regulations. In addition the BREEAM standard uses a specific metric, the Energy Performance Ratio New Buildings (EPR_{nb}). The “excellent” level requires this ratio to be 0.36 or higher.

1.1.8 ENE04 deals with the provision of low or zero carbon technologies. In order to gain BREEAM excellent there is a minimum requirement that a feasibility study is carried out and that the recommendations of the feasibility study are implemented.

Energy assessor

1.1.9 The energy analysis and the feasibility study were carried out by Ondrej Gajdos. Mr Gajdos has considerable experience with assessing the energy performance of buildings similar to the family restaurant. He is accredited by CIBSE as a low carbon energy assessor and a low carbon consultant.

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2 Fabric thermal performance

U-values

2.1.1 The building regulations include a range of minimum values to the insulating properties of the main building elements. These are provided in table 1 below.

Table 1 Minimum Standards for new thermal elements

Element	Standard (W/M^2K)
Wall	0.35
Roof	0.25
Floors	0.25
Personnel doors	2.2
Vehicle access doors	1.5
Windows	2.2

2.1.2 As the project is for a new building we propose significant improvements on the "standard" thermal performance are made. The proposed u-values are set out in table 2 below.

Table 2 Proposed u values for thermal elements

Element	Standard (W/m^2K)[2]
Walls	0.20
Roofs	0.15
Floors	0.15
Personnel doors	1.4
Windows	1.4

Air tightness

2.1.3 The building should be made air-tight so that air and heat losses are managed. This will require a knowledgeable and experienced builder. The architect will need to carefully consider buildability in this respect.

2.1.4 We advise aiming at improving the air tightness to a value of less than 4 $m^3/(h\ m^2)$. This is 60% better than the minimum requirement of 10 $m^3/(h\ m^2)$ for new buildings.

3 Baseline energy consumption

3.1.1 A baseline for energy consumption and CO_2 emissions was determined using the SBEM calculations as required by the building regulations. A standard gas fired solution for heating and hot water was selected to inform the baseline energy consumption. The U-values as described in the previous section were assumed as were the following additional elements:

- Average lighting energy: 3 W/m2.100lux
- Photoelectric controls in the family restaurant
- Occupancy sensors in toilet and baby changing rooms
- Separate metering of lighting energy with "out of range" alarm
- Natural ventilation with mechanical extracts in toilets and showers
- Heating with variable speed pumps, separate provision for energy metering with "out of range" alarms, weather compensator

3.1.2 Table 3 shows the predicted baseline energy consumption for the main end uses and the associated carbon emissions. The carbon emissions are calculated using the standard carbon emission factors. Figure 2 gives an overview of the contribution to the total carbon emissions of each of the main end uses.

Table 3.Baseline Energy consumption and CO_2 emissions by end use

End Use	Energy (kWh/annum)	Fuel	Emissions ($kgCO_2$/annum)	Energy Cost (£/a)
Heating	36,375	Gas	7,202	1,128
Hot Water	49,016	Gas	9,705	1,519
Auxiliary	1,595	Electricity	824	183
Lighting	22,386	Electricity	11,574	2,565
Total:	**109,372**		**29,306**	**5,395**

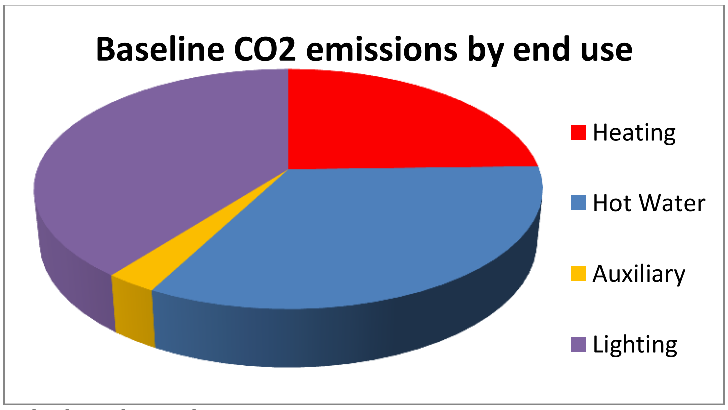

Figure 2. Baseline CO_2 emissions by end use

4 Technology options

4.1 Gas-fired conventional boiler

4.1.1 This would include the provision of a highly efficient gas boiler. There is gas available on the site. Current technology enables very efficient operation. The boiler would be located within a plant room and serve the heating system, which would consist of radiators.

4.1.2 Benefits are that the installations would be compact and require little space. It could also be coupled easily with other heating sources and thereby act for either standby or peak lopping if required. This option would be the easiest to install and operate and requires the lowest capital investment.

4.1.3 This system can be made to comply with the relevant regulations, but would not be classed as a "low carbon" option.

- Indicative BER: 56.1 kgCO2/m2.a
- Indicative BER/TER: 15.9%
- Indicative % renewable: 0%

Summary table

Item	Description	Comment
A	Energy generated from LZC	None.
B	Payback	Not applicable.
C	Land use	None.
D	Local planning requirements	None that we are aware of.
E	Noise	Minimal.
F	Feasibility of export heat/electricity	Not applicable.
G	Life cycle cost of potential specification	Replacement in 15 years – cost will be less than £3,500
H	Any grants available	No, although certain highly efficient boilers Attract Enhanced Capital Allowances.
I	All technologies appropriate to the site and energy demand	Yes.
J	Reasons for excluding technologies	Not excluded.

4.1.4 Selected as potentially appropriate in combination with other technologies.

4.2 Combined heat power

4.2.1 Combined Heat and Power provides heat and electricity from a single unit. Heat is used to provide hot water in both high grade and low grade forms. The engine is connected to a generator, the electricity used is fed from the electrical system either serving a based load or exported to the grid.

4.2.2 All CHP units rely on a continuously running engine, and appropriate silencing. The key factor with such a system is that electricity is offset from the grid which has an inherently poor carbon performance due to inefficiencies and the current UK energy mix.

4.2.3 A crucial requirement for CHP is that there is a year round thermal demand. Micro CHP with heat output of up to 16 kW can be considered for this building, e.g. Baxi DACHS. Such CHP with a suitably sized buffer vessel could provide all DHW and approximately 50% of space heating if it runs for approximately 4200 hours per year.

- Indicative BER: 38.1 kgCO2/m2.a
- Indicative BER/TER: 42.9%
- Indicative % renewable: 0%

Summary table

Item	Description	Comment
A	Energy generated from LZC	Dependent on the size and type of the system.
B	Payback	Dependent on the size and type of the system.
C	Land use	No.
D	Local planning requirements	No.
E	Noise	Yes – although correct specification can reduce engine noise.
F	Feasibility of export heat/electricity	Export of electricity to grid is possible.
G	Life cycle cost of potential specification	Regular servicing and maintenance (like a gas boiler) and cleaning will be necessary annually and replacement of in say 10 years depending on specification and manufacturer.
H	Any grants available	Enhanced Capital Allowances.
I	All technologies appropriate to the site and energy demand	The building is likely to be suitable for a micro CHP installation.
J	Reasons for excluding technologies	Not excluded.

4.2.4 Selected as potentially appropriate subject to further considerations.

4.3 Biomass fired conventional boiler

4.3.1 In general biomass boilers operate on wood or waste fuel. Current technology enables extremely efficient operation using wood chip, pellets or waste streams. The high temperature output possible from the boiler allows the client a choice of either radiators or under-floor heating.

4.3.2 Using waste streams as fuel is generally only suitable if a specifically high and uniform waste stream is readily available and a high energy demand is present. As neither of these two factors applies for this proposed development a wood based system in the form of pellets or woodchip would be the most suitable biomass application on this site. Running costs depend on fuel type, with woodchip being cheaper than wood pellets.

4.3.3 It is necessary to have the space to store the fuel. The size of the storage facility would depend on the fuel need and the frequency of delivery of fuel that is considered optimal. Autofeed systems exist that reduce the handling time of refilling the boiler reservoir. Easy vehicular access would be required to the hopper/storage space to enable deliveries.

4.3.4 Biomass offers significant CO_2 reductions and is often classed as “carbon neutral”. Biomass is one of the most carbon efficient ways of energy provision available for this site.

4.3.5 There are some drawbacks to a biomass system. As mentioned above it requires additional space for fuel storage and it requires fuel deliveries. It also needs regular maintenance and monitoring in the form of ash emptying and checking of the fuel reserves. In addition to the additional handling and space issues, biomass boilers can contribute to local air quality pollution, although for the smaller devices relatively clean technologies exist. The entire borough is designated air quality management area and even for smokeless system further consent from the local authority would be required.

- Indicative BER: 26.1 $kgCO_2/m^2.a$
- Indicative BER/TER: 12.4%
- Indicative % renewable: 53.5% reduction in regulated CO_2 emissions against baseline

Summary table

Item	Description	Comment
A	Energy generated from LZC	100% of the heat demand.
B	Payback	Not applicable, similar considerations as for gas fired boiler.
C	Land use	Large storage space required, depending on frequency of delivery.
D	Local planning requirements	Concern regarding effect on air quality
E	Noise	Minimal.
F	Feasibility of export heat/electricity	Not applicable.
G	Life cycle cost of potential specification	Replacement in 15 years – cost likely to be around £ 7,500.
H	Any grants available	No grants but Renewable Heat Incentive would apply and attracts Enhanced Capital Allowances.
I	All technologies appropriate to the site and energy demand	Possibly, depending on discussion with local authority regarding air quality. There may be limitation to storage and delivery of the fuel.
J	Reasons for excluding technologies	Not excluded, subject to further considerations.

4.3.6 Selected as potentially appropriate subject to further considerations.

4.4 Ground source heat pump

4.4.1 Heat pump technology is not new – it operates on the same principles as a domestic refrigerator or air conditioning. The system effectively "pulls" heat in from a sink of heat and "pumps" this heat into a heat store or across a heat exchanger.

4.4.2 Ground source heat pumps (GSHP) use a buried ground loop which transfers heat from the ground into the building through a heating distribution system. GSHP technology can be used both for heating and cooling. Two main types of GSHP are available:

- Horizontal loop is suitable for applications where sufficient area is available to accommodate horizontally buried pipes.
- Vertical loop system can be used where ground space is limited, but will require boreholes typically 15-150m deep, and is consequently more expensive to install than horizontal systems.

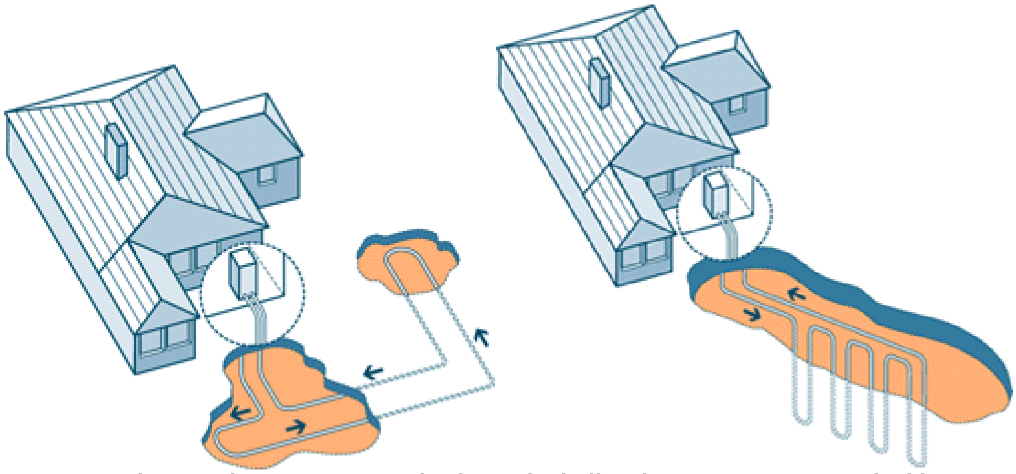

Figure 3.Groundsource heat systems. A horizontal, shallow loop system, B. Vertical loop system

4.4.3 The GSHP boiler can realistically provide heat up to a maximum of 55°C. This temperature is slightly too low for optimum operation with radiators or efficient space heating. If they are used then they would need to be very large.

4.4.4 A GSHP based system can offer good CO_2 performance, as long as the building is excellently insulated and airtight. Because the GSHP runs on electricity this does mean that it is using fairly inefficiently produced electrical energy (due to gas, coal and oil being the predominant UK energy mix). But if correctly installed on a highly insulated and air tight property there is the possibility of good CO_2 reductions. With such an installation there is a real possibility of overall reduction of fuels bills as opposed to gas,

4.4.5 Ground source heat pumps are also more efficient for space heating than they are for the provision of hot water. This is mainly due to the higher temperature requirements for hot water. Considering the high hot water demand of the proposed development ground source heat pumps are not as effective here than they can be in other development proposals.

4.4.6 The major disadvantage of such a system is the cost of having the boreholes drilled and probable running costs over and above other systems with better returns or even efficient gas based systems.

- Indicative BER: 46.3 $kgCO_2/m^2.a$
- Indicative BER/TER: 22.7%
- Indicative % renewable: 17.5% reduction in regulated CO_2 emissions against baseline

Summary table

Item	Description	Comment
A	Energy generated from LZC	Full output.
B	Payback	Negative payback, as the efficiency of the system is reduced due to the high hot water demand. The higher electricity price makes the running cost for this solution higher than a gas based system.
C	Land use	Land is required for the installation of the underground loop system. The nearby rugby pitch would be suitable.
D	Local planning requirements	None.
E	Noise	Minimal.
F	Feasibility of export heat/electricity	Not applicable, output would meet demand.
G	Life cycle cost of potential specification	Replacement of boilers in 20 years – cost likely to be around £ 20,000.
H	Any grants available	No grants but Renewable Heat Incentive would apply and attracts Enhanced Capital Allowances.
I	All technologies appropriate to the site and energy demand	Technology would be appropriate in combination with more effective solutions for hot water.
J	Reasons for excluding technologies	Excluded due to the additional running cost and increased capital investment compared to other systems.

4.4.7 Ground source heat pumps are not selected for further consideration.

4.5 Air source heat pumps

4.5.1 Air source heat pumps (ASHP) operate on the same principles described above for GHSP. Instead of a ground loop, heat is recovered from ambient air. An externally mounted unit, with a fan and fins (looking very similar to a typical air conditioning external unit) is utilised.The heat pump can operate at external temperatures down to -10°C and even lower, although the lower the temperature the lower the performance. An accumulator would be needed and both the ASHP boiler and accumulator could be installed in a plant room.

4.5.2 Despite being electrical in operation, an ASHP based system can offer very good CO_2 performance. Thermal performance of the building as detailed earlier is essential if the ASHP system were to function correctly and efficiently. ASHP technology is very much less costly than GSHP due to no boreholes being necessary. Slightly poorer performance (depending on supplier) is offset by the lower installation costs.

4.5.3 Conventional ASHP heating is best coupled with an under-floor heating system, as the temperature outputs which would be needed for maximum efficiency are less suitable for a heat delivery system based on radiators. As is the case with GSHP, the higher temperature requirements for the hot water demand reduce the efficiency of ASHPs. This makes an ASHP for all the heat requirements in this building less attractive. However when ASHP is combined with another system, such as for instance a gas-fired boiler, servicing the hot water demand the efficiency will be improved.

- Indicative BER: 50.7 $kgCO_2/m^2.a$
- Indicative BER/TER: 19.8 %
- Indicative % renewable: 9.5% reduction in regulated CO_2 emissions against baseline

Summary table

Item	Description	Comment
A	Energy generated from LZC	Full output
B	Payback	Due to the price for electricity being significantly higher than gas there are only minimum financial savings estimated for the proposed solution. The additional cost for the air source heat pump compared to gas boiler will not pay back during its lifespan.
C	Land use	External condenser location is required
D	Local planning requirements	None
E	Noise	Local from the external condenser – manufacturers are providing quieter units now. Consider locating away from residential units to shield any noise.
F	Feasibility of export heat/electricity	not applicable, output would meet demand
G	Life cycle cost of potential specification	Replacement of ASHP unit in 25 years – cost likely to be around £ 10,000.
H	Any grants available	No grants or Renewable Heat Incentive would apply and but attracts Enhanced Capital Allowances
I	all technologies appropriate to the site and energy demand	Technology would be appropriate in combination with more effective solutions for hot water.
J	Reasons for excluding technologies	Included for further consideration

4.5.4 Air source heat pumps are selected for further detailed consideration.

4.6 Wind power

4.6.1 There is a great variety in the size and subsequently the capacity to generate electricity among wind turbines. When considering the building on its own a small turbine or set of turbines would, under the right circumstances, be able to provide a significant amount of electricity to be attributed to the building's energy use.

4.6.2 The small turbines could be stand-alone or mounted on the roof top of the building. Because these turbines are usually at a limited height, the availability of wind is often not sufficient. The national wind database shows that the wind speed at 10 m above ground level in this area is 4.5 m/s. This wind speed is an approximate value in open field. In practice the many obstructing objects on the site will render the average wind speed even lower that the quoted value. This level of available wind is not sufficient to allow an effective small scale wind power generation on the site.

4.6.3 Larger scale wind turbines would produce considerably more energy than consumed within the proposed building. In theory this could be a site wide solution. However, there are significant planning considerations associated with larger wind turbines. These include noise and visual amenity considerations. In practice the Lensbury Hotel site is not considered a suitable location for a large wind turbine.

Summary table

Item	Description	Comment
A	Energy generated from LZC	Depending on the size of the system
B	Payback	At a suitable location wind turbines can have payback times from 9 years.
C	Land use	Some small scale systems can be roof mounted. Larger systems will be free standing and require land to be made available accordingly
D	Local planning requirements	Wind turbines can have impacts associated with the installation that will be material planning considerations in themselves.
E	Noise	Yes, although smaller turbines are less noisy
F	Feasibility of export heat/electricity	Yes, connection to grid
G	Life cycle cost of potential specification	Turbine maintenance and cleaning will be necessary annually and replacement of bearings needed in approximately 10 years depending on specification and manufacturer.
H	Any grants available	No, but Feed Inn Tariffs apply
I	All technologies appropriate to the site and energy demand	No, there is not sufficient wind for a small system and larger systems would have considerable visual amenity effects
J	Reasons for excluding technologies	Excluded, based on lack of technical feasibility, capital investment relative to size of the proposed development and potential adverse environmental effect in visual amenity.

4.6.4 Wind energy is not selected for further consideration.

4.7 Photovoltaic cells

4.7.1 This type of system converts sunlight to electrical energy using semiconductor arrays embedded within a glass panel. PV can be provided as "bolt on" panels or integrated in the building (such as PV roof tiles). In order to maximise generation, the system should be installed on a southerly facing aspect with no shading.

4.7.2 Output and hence potential generation depends on quality of panel and area and is adversely affected by overshadowing. Under ideal peak conditions the output of a PV array can be 1kW for each 7 m^2 of PV. Due to the way PV panels are connected to each other, one sub-optimal performing panel will reduce the efficiency of all other panels in the array. As a result PV is very sensitive to overshadowing.

4.7.3 In the direct vicinity of the building plot a number of mature trees are present. Due to the close proximity and the density of the canopy it is considered not feasible to harvest any solar energy from this location.

4.7.4 There may be small areas available that are less affected by shadow. There may be less sensitive uses for the roof space (see solar hot water).

Summary table

Item	Description	Comment
A	Energy generated from LZC	Not possible at this location.
B	Payback	At a suitable location photovoltaic cells can have payback times from 8 years.
C	Land use	None, although roof space would need to be made available.
D	Local planning requirements	None.
E	Noise	None.
F	Feasibility of export heat/electricity	Yes, connection to grid.
G	Life cycle cost of potential specification	Minimal – cleaning will be required and replacement is needed after 25 years.
H	Any grants available	No, but Feed Inn Tariffs and Enhanced Capital Allowance apply.
I	All technologies appropriate to the site and energy demand	Unlikely. The presence of mature tree in close proximity is likely to impair the performance of the PV array.
J	Reasons for excluding technologies	Excluded, based on reduced performance due to overshadowing trees.

4.7.5 Photovoltaic cells are not selected for further consideration.

4.8 Solar hot water

4.8.1 The use of sun energy to assist in the provision of hot water is commonplace and an installation on the roof could help to provide some of the annual hot water demand in the building (SHW). As with the photovoltaic cells, the location is not ideal for making use of the solar energy.

4.8.2 In the direct vicinity of the building plot a number of mature trees are present. Due to the close proximity and the density of the canopy it is considered not feasible to harvest any solar energy from this location.

Summary table

Item	Description	Comment
A	Energy generated from LZC	Not possible at this location.
B	Payback	At a suitable location solar hot water can have payback times from 8 years.
C	Land use	None, although roof space would need to be made available.
D	Local planning requirements	None.
E	Noise	None.
F	Feasibility of export heat/electricity	Not feasible.
G	Life cycle cost of potential specification	Minimal –replacement is needed after approximately 25 years.
H	Any grants available	No, but Renewable Heat Incentive and Enhanced Capital Allowance apply.
I	All technologies appropriate to the site and energy demand	The presence of mature tree in close proximity is likely to severely restrict the available solar energy.
J	Reasons for excluding technologies	Lack of available sunlight.

4.8.3 Solar hot water is not selected for further consideration.

5 Recommendations

5.1 Carbon emissions and regulatory performance

5.1.1 As set out in chapter 4 a number of potentially viable energy solutions have been identified. Table 4 gives an overview of the potentially viable solutions and their potential effect on the regulated performance and the performance compared to the baseline.

Table 4. Summary of potentially viable solutions

Option	TER	BER	Regulated improvement	Absolute improvement
Baseline	66.68	56.07	15.9%	
CHP	66.68	38.10	42.9%	32%
Biomass	29.82	26.10	12.5%	53%
ASHP and gas	63.20	50.75	19.7%	10%

5.1.2 In terms of regulatory performance the best results are achieved with the CHP option. The portion of energy supplied by the CHP is subject to a further assessment and detailed load profile calculation.

5.1.3 Clearly the biomass solution would lead to the lowest absolute carbon emissions. In terms of improvement over the building regulations it only represents a small improvement. There are also concerns about the operational issues. As the site is located in an Air Quality Management Area for NO_x and PM_{10}, a wood pellet boiler may not be accepted by the local authority.

5.1.4 In terms of regulatory performance the combination of ASHP for space heating and a gas fired boiler for domestic hot water performs better than the biomass boiler, based on the current set of assumptions. In terms of absolute CO_2 emissions, the performance is much less. The technology is relatively straightforward to install and maintain with little other issues associated with it. The cost is slightly higher than a straightforward gas-fired boiler. This option should be considered as a last resort option.

5.2 Breeam credits

5.2.1 In terms of ENE01 BREEAM credits the above solutions all score reasonably well and can achieve an EPR_{nc} rating of 0.42 and better. In terms of this specific metric the building would achieve the minimum requirements for BREEAM excellent. However, in order to achieve BREEAM excellent the building should also achieve at least 25% reduction of the BER over the relevant TER. This is achieved only by the CHP option.

5.3 Recommended next steps

5.3.1 We propose that as part of the M&E design the following steps will be taken:

- Carry out a detailed CHP feasibility check
- Alternatively a detailed option study into biomass as well as consultation with the local authority should be carried out.