CARBON TRUST

RESTRICTED – COMMERCIAL

Assessment Of Energy Saving Opportunities For Virgo Fidelis School

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Executive Summary

The Carbon Trust is grant funded by the Department for Environment, Food and Rural Affairs, the Department for Business, Enterprise and Regulatory Reform, the Scottish Executive, the Welsh Assembly Government and Invest Northern Ireland.

This report presents the results of an initial opportunities assessment of Virgo Fidelis School carried out by The Green Consultancy.

The agreed objectives of the Assessment were to identify and prioritise 10 opportunities for energy saving that can be taken by the site to save carbon.

The site is a large secondary school with 800 pupils aged 11-18. . The original buildings were completed in around 1850. Since then an extension to the main building (completed 1962) and sportshall has been added. The school has a gross internal area of around 5859 m^2. Building services are generally old, controlled with very simple systems and of average specification.

A summary of the 10 point Action Plan is presented in the table below.

If all the prioritised measures are implemented, the aggregated savings from the measures identified represent a 21% reduction in energy consumption and a 17% reduction in cost.

It is important to note that the savings from each measure are not directly cumulative unless they are derived from unrelated services (for example hot water and heating). This is because taking one measure may affect the amount of savings arising from another measure. For example, improving insulation will reduce energy consumption resulting in less energy savings being 'available' from also improving boiler efficiency. Consequently, if all measures are implemented actual savings will be less than cumulative savings identified here.

Action Plan

The recommendations listed below are prioritised, according to energy savings (£), with energy management the first priority

Priority	Recommendations These are expanded in section 4 below together with detailed actions and savings.	Estimated annual savings			Estimated cost (£)	Payback period (years)	Timescale for implementation and by whom	May be eligible for ECA*	May be eligible for loan*
		(£)	CO_2 (tonnes)	(kWh)					
1	Draft and implement an energy policy to improve energy management practices	955	6.571	26641	0	0	0 - 3 Months. Bursar, headmaster, site manager	No	No
2	Install Building Energy Management System	4753	30.490	164810	25800	5.4	6 - 12 Months. Site manager	yes	Yes
3	Install 2 variable temperature circuits to main plant room and heat only the administration area and support areas (basement) in the holiday periods	3761	24.129	130428	20000	5.4	6 - 12 Months. Site manager	yes	Yes
4	Fit thermostatic radiator valves (TRVs) to all radiators	2868	18.397	99444	5300	1.85	6 - 12 Months. Site manager	yes	Yes
5	Reset heating system times in main building plant room	2393	15.352	82984	0	0	0 - 3 Months. Site manager	no	No
6	Replace T8 switch start lighting (electromagnetic ballast) with electronic ballast T8 lighting.	1232	8.683	16170	19050	15	18 - 24 Months. Site manager	yes	Yes
7	Install radiator panels to all radiators mounted to external solid walls	563	3.611	19519	820	1.5	6 - 12 Months. Site manager	no	Yes
8	Install cavity wall insulation to St Edwards	559	3.790	20487	3542	6.3	6 - 12 Months. Site manager	yes	Yes
9	Install occupancy sensors to control lighting in staff room, assembly hall, dining hall, sportshall and 6th form common room	318	2.243	4176	1800	5.66	6 - 12 Months. Site manager	yes	Yes
10	Install timers to all photocopiers and printers bar hot wax printers	271	1.799	3351	300	1	0 - 3 Months. Site manager	no	Yes

Priority	Recommendations These are expanded in section 4 below together with detailed actions and savings.	Estimated annual savings			Estimated cost (£)	Payback period (years)	Timescale for implementation and by whom	May be eligible for ECA*	May be eligible for loan*
		(£)	CO_2 (tonnes)	(kWh)					
TOTAL		17673	115.065	568010	76612				

* Please refer to the Site Survey Publication for eligibility details or visit www.carbontrust.co.uk/loans and www.eca.gov.uk/etl

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1. Introduction

1.1. Objectives for the Visit

London Borough of Croydon wishes to reduce its carbon footprint and identify cost savings wherever possible. Consequently, it has requested the Carbon Trust to undertake 12 energy surveys of its secondary and primary schools including Virgo Fidelis.

The primary objective of this report is to identify a range of measures having the greatest energy saving potential at Virgo Fidelis School.

In addition to wider objectives of energy and carbon savings, those using the school need a comfortable environment in which to work and study. Correctly installed, maintained and controlled heating and other building services will ensure this and save energy at the same time.

The survey covers the following areas:

1. A general assessment of the building fabric
2. An assessment of normal and out of hours consumption
3. Boiler plant assessment including type and age of equipment, condition and operating efficiency
4. Heating system control assessment
5. Hot water system assessment
6. IT services assessment
7. Lighting installation assessment
8. Age, condition and control of kitchen equipment
9. Outline opportunities for renewables

Recommended measures in the action plan take account of budgetary constraints imposed by local authorities and the practicalities of installing measures in the school environment.

1.2. Site details

Virgo Fidelis School is a large girl's secondary school located in north Croydon. It has around 800 pupils. It occupies an area of around 5859 m^2 gross internal area (GIA). All heating and hot water services are provided by gas fired boilers. Heat is distributed using a wet system (radiators).

Blocks are arranged as follows:

- Main block. Completed in late 1840s. This block has 3 storeys and houses the administration function of the school on the ground floor plus most of the classrooms on the two floors above. It also has a large basement area housing support staff. It is served by two plantrooms serving the northern part of the main block (the Lodge) and the central and southern parts of the main block respectively. Walls are solid brick and up to 60cm thick in parts. Windows are single glazed. The roof is pitched, slate tiled and uninsulated.
- St Edwards wing. A 3 storey building constructed in 1962 with flat roof, brick walls with an unfilled cavity and single glazing. Heating and hot water provided by own plantroom.
- Sportshall. Completion date unknown but estimate 1980s. A single storey flat roofed building constructed of brick and block. Heating and hot water provided by dedicated boiler located in St Edwards plant room.

During term time the main buildings are occupied from around 7:30am till around 5:00 pm Monday to Friday. Revision classes are also run on Saturday mornings. On Sundays the main hall is used from 9 to 12. All buildings are heated and served with hot water through the holiday periods and over half term. Heating and hot water is not provided over the weekends.

All heating and hot water timing is manually controlled by seven day timeclocks in each plant room. Temperature control for central and southern parts of the main block is achieved using a single

thermostat located on the ground floor corridor of the main block on the eastern side of the building. Temperature control for the lodge is achieved using a VT circuit. Temperature control for St Edwards is also achieved through a VT circuit and through manually adjusting the flow temperature of the individual boiler serving this area.

Information on fuel consumption has been provided by Interserve, LB Croydon's contractor responsible for energy management in LB Croydon's corporate stock. Information on the operation of the school, building services and a floor plan was provided by the site manager, Mr Lesley and by the bursar, Mrs Ortego.

2. Energy Usage Profile

2.1. Site Energy Consumption and Spend

The site consumes approximately 2664147 kWh of energy per annum, costing a total of around £101050 including climate change levy but excluding VAT. All energy values are in terms of delivered energy.

This comprises

Utility	**Energy Consumption**		**Cost**		**Specific Energy Consumption**
	kWh/year	**%**	**£/year**	**%**	**kWh/m² GIA/annum**
Electricity	466686	18	37676	37	80
Gas	2197461	82	63375	63	375
Total Energy	2664147	100	101050	100	455

The unit costs for electricity and gas used in calculating savings are 8.073 and 2.884 p/kWh respectively. These values are average costs supplied by Interserve. These unit costs include the Climate Change Levy but exclude VAT and standing charges.

3. Energy Management Information

3.1. Benchmarks

Energy performance indicators give a measure of activity based energy use, which can be compared with equivalent benchmarks. Energy consumption benchmarks are published in Good Practice Guides for different buildings and some processes. For a particular site, the performance indices are modified to take into account building occupancy, size, activities, location and weather (degree days). The lower value indicates best practice.

Comparison of Site Energy Consumption with Benchmark Information.

	Virgo Fidelis	poor	typical	good
gas consumption (weather corrected) kWh/m2	467	207	160	117
electricity consumption (kWh/m2)	80	45	36	28

[Benchmarking data is drawn from GPG343 – Saving energy – a whole school approach. Figures for a secondary school with no swimming pool used]

The benchmarks indicate that the performance of Virgo Fidelis is extremely poor. This is a reflection of the age of the main buildings which have solid walls and single glazing and the old and inadequately controlled heating systems. The school's performance on electricity use is also very poor. This is in part due to the large computer server suite and ubiquitous use of older switch start light fittings.

The benchmarking suggests that there is great scope for measures to improve the energy efficiency of the site.

4. Carbon Reduction Opportunities

The key assumptions and detailed calculations supporting any figures in the following recommendations are included in Appendix 2.

Priority no. 1	Draft and implement an energy policy to improve energy management practices.			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
955	6.571	26641	0	0
Detail	Virgo Fidelis has no energy management policy or strategy. It is recommended that a staff member is identified on site who will have responsibility for drafting and overseeing the implementation of an energy management policy and associated strategy. The policy should address monitoring and targeting, energy awareness amongst staff and students and be integrated into any wider environmental policy. The structure of the policy should be as follows: • A statement of commitment • A number of clear objectives and targets • Achievement of each objective linked to specified resources and responsibilities • A summary of how the policy objectives are to be achieved in an action plan • Some mechanism for reviewing the progress of the policy In particular the energy policy for Virgo Fidelis should cover the following areas: 1. Regular monitoring and recording of energy use 2. Feedback on energy consumption presented to staff and pupils (display board, intranet etc) 3. Management of heating – correct settings of occupancy times for the various blocks 4. Management of water heating – appropriate settings for hot water in each block 5. Timetabling of use of classrooms in holiday periods – if possible cluster holiday usage in one building so that other buildings do not need to be heated unnecessarily 6. Management of IT (e.g switching off monitors at the end of the working day, correct set point for server room air conditioning) 7. Lighting – switching off lighting in unoccupied areas 8. Control of air conditioning equipment in the admin areas and IT suite – particularly use of set points and creation of a dead zone (see appendix 1) to ensure heating and cooling is not operating simultaneously. 9. Control of TRVs (assuming they are installed as a result of this report) Guidance on producing an energy policy is found in the publications listed at the end of this section.			
Rationale	An integrated energy policy with an individual responsible for overseeing its delivery is the cornerstone that ensures measures are implemented and a process of continual improvement is established. As well as influencing procurement and CAPEX decisions the policy and associated strategy should also seek to raise energy awareness amongst staff and pupils thereby instilling an energy management culture in the school.			

	This will invariably lead to an improvement in energy housekeeping. For example, as a result of implementing an energy management policy one should expect greater diligence in turning off unnecessary lighting, improvements in ensuring correct timeclock settings and in to reporting any observed energy wastage. For this reason there is a direct energy saving benefit from implementing a policy. The energy policy should also seek to draw educational value from improved energy management practice through involving pupils and through encouraging staff to integrate discussion of energy issues in lessons.
Risks	None
Next Step	The headteacher should convene a small group of individuals to develop the policy and steer its implementation. It is recommended that the group should consist of the headteacher, the site manager or caretaker and the bursar.
Relevant Publications	GPG343 Saving energy – a whole school approach. Energy Consumption Guide 73 - Saving Energy in Schools CTG001 Management Guide – Creating an awareness campaign

Priority no. 2	Install Building Energy Management System			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
4753	30.490	164810	25800	5.4
Detail	A BMS system should be installed in the Lodge, main block and St Edwards block plantrooms. At a minimum the BMS should have the capacity to: • set heating times for each day through the week and for special days • optimise heating start and stop times. • control flow temperature in the heating circuit • set temperatures in different zones The BMS replace existing control systems, allowing precise temperature settings for each day of the week, optimal start and stop and zone control. A BMS will also allow logging of energy performance data and provide an easier interface (PC) for the site manager to oversee control of the heating and hot water systems.			
Rationale	At present heating to the main block, St Edwards and the sportshall is controlled using manually adjusted 7 day timeclocks. Even when used diligently, these timeclocks provide only a very limited degree of control in comparison to a BMS. Consequently installation of a BMS will generate very significant energy savings. In contrast to the existing method of control a BMS will offer the following features resulting in much more efficient control: • Heating times for each day of the week. The seven day timeclocks currently used only allow one set of settings for heating times. These timings can then be simply set to operate or not using a switch for each day of the week. As a result, it is not possible to set different heating times for each day of the week. This results in settings which do not reflect occupancy. For example, if the heating must be extended for one day of the week it must also be extended for all other days – or overridden. This is evidently a wasteful practice. A BMS allows specific settings for each day of the week. • Optimal start and stop. A BMS will turn the heating system on at the latest time possible whilst ensuring that the occupied space reaches the desired temperature at the beginning of occupancy. Similarly, the BMS will calculate the optimal time to turn off the heating at the end of the day whilst achieving set temperatures for particular occupancy times. Current controls do not have this function. Any changes to the heating times prompted by ambient temperatures must be made by the site manager overriding the timeclocks. Invariably, even the most diligent of site managers cannot achieve the same degree of control as an automatically optimised heating system. • Weather compensation. A BMS can accurately modulate flow temperature in the heating circuit based on mean internal and external temperature. This stabilises internal temperatures and prevent the boiler firing unnecessarily. The lodge and St Edwards already have weather compensation controlled by a three port valve, however a BMS will provide more accurate temperature sensing. • At present the buildings are only zoned by virtue of which plant room/boiler serves that space. However, there are some areas served by the same plantroom which have different occupancy and heating needs and which consequently should be zoned separately. For example, the administration			

	area has different occupancy to the classrooms. Both areas are served by the main plant room. A BMS can accurately control the heating requirements of different zones. It is recommended that a BMS having this functionality is installed in each plant room.
Risks	No risks
Next Step	Obtain quotes from qualified heating engineer
Relevant Publications	CTG002 Heating control

Priority no. 3	Install 2 variable temperature circuits to main plant room and heat only the administration area and support areas (basement) in the holiday periods			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
3761	24.129	130428	20000	5.4
Detail	At present heating for main block is unzoned and heating is distributed as a constant temperature circuit. It is recommended that two variable temperature circuits are installed serving two zones. Zone 1 should serve the admin and support areas. Zone 2 should serve the classrooms. This will require installing new pipework, pumps and valves to independently connect the existing radiator circuits to the plant room. A full feasibility study should be conducted first.			
Rationale	The main block has no zoning of its heat distribution. Consequently the entire building must be heated in the holidays to provide heating to the administration and support staff areas which are occupied in the holidays. These areas occupy only around 1/5 of the total floor area of the main block. Consequently, this practice wastes a very significant amount of energy. Heating to the main block is also provided by a constant temperature circuit. A variable temperature circuit which modulates the temperature of water through the radiators in response to external and internal temperatures will provide more stable internal temperatures and prevent the boiler firing unnecessarily. Consequently it is recommended that the admin and support staff areas on the ground floor and basement should be served with an independent variable temperature circuit. This will require the creation of two independent heating circuits which are arranged as variable temperature circuits. This will require new pipework and installation of new pumps and valves in the main plant room. The resulting system should be controlled by the BMS proposed in recommendation 2. By zoning admin and support areas separately the school will be able to heat only this area as necessary. This will save a significant amount of energy and provide greater comfort to those staff working in the admin areas through the holiday periods.			
Risks	None			
Next Step	Check occupancy times for each zone and commission feasibility study for creating new zones and VT circuits for the admin area to be heated from existing plant room.			
Relevant Publications	CTG002 Heating control			

Priority no. 4	Fit thermostatic radiator valves (TRVs) to all radiators			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
2868	18.397	99444	5300	1.85
Detail	It is recommended that TRVs with tamper proof shields are installed to all radiators in the blocks bar those areas where sensors and thermostats are sited.			
Rationale	At present most of the valves controlling flow into the radiators in the main block either cannot be adjusted or are of the conventional hand operated variety. Thermostatic radiator valves automatically adjust the heat emitted from the radiator based on ambient air temperature. TRVs allow occupants to fine tune their heating requirements based on the local conditions applying in each heated space. For example, where there is more solar gain on the southerly aspect of a building TRVs would be able to reduce heating in these areas. Installation of tamper proof TRVs would generate substantial energy savings and improve occupant comfort.			
Risks	TRVs should be installed which have a tamper proof cap. This will prevent staff and students using them as an on-off switch. TRVs are relatively vulnerable to vandalism and accidental breakage in the context of a school. They are particularly vulnerable in communal areas – corridors etc Guidance should be sought on previous experience of TRVs used in the school context. If they are considered impractical an alternative method of localised control can be gained by use of thermostatically controlled motorised valves regulating flow to different zones – for example a group of radiators in a room. Effective use of motorised valves will depend on the arrangement of existing pipework in each area of the school. TRVs or thermostatically controlled motorised valves must not be installed in areas where the sensors are located controlling the variable temperature flow around the circuit.			
Next Step	It is recommended that quotes are sought from a heating engineer to either install TRVs or motorised valves to the radiator circuit in the main block.			
Relevant Publications	CTG002 Heating control			

Priority no. 5	Reset heating system times in main building plant room			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
2393	15.352	82984	0	0
Detail	The timeclock controlling heating to the main block is currently set to heat between 4:30 am and 19:25 Monday to Friday. It is recommended that the switch off time is brought forward to 18:00			
Rationale	During term time the main buildings are occupied from around 7:30am till around 17:00 pm Monday to Friday. Therefore heating until 19:25 is unnecessary. It is recommended that the heating system is turned off at 18:00 pm to better reflect occupancy. Savings reported above are based on a 18:00 switch off time. The very early start time (4:30 am) is presumably required because of the high thermal mass of the main school buildings however it may be possible to start the system later and turn off the heating even earlier in which case further savings will result. A BMS will automatically calculate the optimum start and stop times given programmed occupancy times.			
Risks	None			
Next Step	Check occupancy times for the main building. Reset heating times. Log temperatures in different parts of the building to ensure desired comfort conditions are achieved.			
Relevant Publications	CTG002 Heating control			

Priority no. 6	Replace T8 switch start lighting (electromagnetic ballast) with electronic ballast T8 lighting.			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
1232	8.683	16170	19050	15
Detail	Lighting throughout the school is provided by T8 fluorescent tubes in switch start (electromagnetic) ballasts (fittings). These fittings should be replaced by more efficient high frequency electronic light fittings. Costs of replacement can be reduced by doing the work when the spaces are undergoing refurbishment.			
Rationale	High frequency electronic fittings for fluorescent tubes use around 15% less energy than older switch start light fittings. In addition, electronic fittings will cause fluorescent tubes to flicker less, lamps to last longer and permit the use of dimming controls. Consequently, wherever existing switch start fittings fail or as part of refurbishment or for rooms where replacing lighting is a significant maintenance issue required, the older switch start fittings should be replaced with modern electronic fittings. These recommendations will result in energy savings, better quality lighting and lower maintenance costs. Replacement fittings should also use reflective louvres rather than the box type diffuser system. This will result in greater light intensity from each tube meaning that that less tubes may be necessary. In this instance, T8 lighting is recommended over T5 alternatives as T8 tubes and fittings are significantly cheaper than T5s and there is virtually no difference in efficiency of a high frequency T8 plus ballast compared with a T5 plus ballast at standard ambient temperatures (25 degrees C). If costs are not a significant issue then T5 lighting should be considered. T5 lighting is marginally more efficient than T8s at higher ambient temperatures (35 degrees) and also renders colours slightly better than T8.			
Risks	Fittings should be replaced by a qualified lighting installer.			
Next Step	Quotes from 3 installers should be obtained			
Relevant Publications	CTV021 ‘ Lighting – Bright ideas for more efficient illumination’			

Priority no. 7	Install radiator panels to all radiators mounted to external solid walls			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
563	3.611	19519	820	1.5
Detail	Louvered and reflective radiator panels should be installed behind all radiators which are attached to an external solid wall. The survey estimated that there were around 140 suitable radiators at the site.			
Rationale	Most of the wall area at Virgo Fidelis is constructed of solid brick. Consequently heat transfer through walls is relatively high. Where there is a high difference in temperature such as between the wall immediately behind a radiator and the external environment, heat transfer will be more rapid. Reflective, louvered radiator panels reduce convective and radiative heat loss from the radiator to the wall behind. They are particularly appropriate for solid walls such as found at St Josephs and, in aggregate, can save a significant quantity of energy. The panels can be quickly and cheaply installed. Therefore they have a quick payback.			
Risks	None			
Next Step	The panels are simple to install. On site staff should be able to easily do the work. However a specialist contractor can also be used. The costs above assume a contractor is used (2 days labour).			
Relevant Publications	CTV014 Building Fabric. Energy saving techniques to improve the efficiency of building structures			

Priority no. 8	Install cavity wall insulation to St Edwards			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
559	3.790	20487	3542	6.3
Detail	Install cavity wall insulation to St Edwards block			
Rationale	Although appearance of the brickwork of the St Edwards block suggests a solid wall it is very likely, given the date of construction, that there is a cavity. The brickwork has been arranged as it has (to resemble a solid wall) so that it is similar in appearance to the original 1850s building with which it directly connects. The site manager has also suggested that the building has cavity walls. Given the date of construction (1962) it is unlikely that these cavities were filled at the time of construction. Examination of the walls suggests that that there has been no retrospective insulation since construction therefore it is recommended that a contractor is asked to assess whether the cavities have been partially filled and, if not, to install blown urea formaldehyde (UF) cavity wall insulation to the building. This will reduce heat loss and create significant energy savings when applied in conjunction with an effective heating control system.			
Risks	When applying insulation measures it is vital that control systems are able modulate boilers and distribution systems to reduce the heat delivered to the space. Where this is not the case the space overheats and no energy savings are realised. Local control using thermostatic radiator valves would encourage savings from insulation measures.			
Next Step	Obtain quotes for cavity wall insulation to St Edwards block.			
Relevant Publications	CTV014 Building Fabric. Energy saving techniques to improve the efficiency of building structures			

Priority no. 9	Install occupancy sensors to control lighting in staff room, assembly hall, dining hall, sportshall and 6th form common room			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
318	2.243	4176	1800	5.66
Detail	Lighting in a number of well lit but intermittently occupied rooms is currently controlled by manual switches at the room entrances. As these spaces are only occupied intermittently they will routinely have the lights left on unnecessarily with manual switching. Therefore it is recommended that Passive Infrared (PIR) occupancy sensors are fitted to switch off lighting when it is not required in these rooms. These controls can also be linked to ambient light level so that they dim and switch off lights completely when there is sufficient daylight. Specialised electronic lighting ballasts (fittings) are required if photosensitive control is required. Photosensitive dimming is particularly appropriate for use in the sportshall which is well lit with skylights at present. Sensors should be fitted to each entrance to the room.			
Rationale	Lights are often unnecessarily left on in intermittently occupied spaces such as the staff room, changing rooms and the hall. These are large, well lit spaces. Consequently, energy wastage from this practice will be high. Occupancy sensors will provide assurance the lights are only switched on only when necessary. This will result in substantial energy savings. Occupancy sensors providing an auto-on function (lights come on automatically when presence detected) will also have an awareness raising effect. Occupancy sensing control is generally quite cheaply installed therefore payback times are reasonable. If the installation is judged a success then further PIR controlled lighting should be considered for other intermittently occupied space such as the toilets.			
Risks	Incorrectly set controls or positioned sensors can result in lights switching off when the space is still occupied. Care should be taken to set the delay appropriately and to use a reputable installer. However, most lighting contractors will be able to supply and install this control system.			
Next Step	Obtain quotes from 3 lighting installation contractors for the work.			
Relevant Publications	CTV021 'Lighting- bright ideas for illumination'			

Priority no. 10	Install timers to all photocopiers and printers bar hot wax printers			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
271	1.799	3351	300	1
Detail	The school has 5 large photocopiers and around 25 printers. This equipment is currently left running 24/7 throughout the year. Timers should be fitted to this equipment to ensure that is it turned off completely when not required.			
Rationale	Most printers and photocopiers can be safely turned off when not requires. At present they are allowed to operate in standby mode 24/7 throughout the year. Even in standby mode energy consumption can be quite significant. Fitting timers will ensure that equipment is not consuming power unnecessarily. This will also reduce the air conditioning load in the admin area.			
Risks	No risks			
Next Step	Research most appropriate timing device.			
Relevant Publications	GPG 118 Managing energy use. Minimising running costs of office equipment and related air conditioning.			

In addition the following measures are recommended for further investigation by the site, but are not graded as a priority for action at the present time:

Item No	Description of Recommendation
1	Draft proof external doors
2	The home economics classrooms of the southfacing side of the St Edwards wing suffers from overheating. They are not air conditioned so there is little scope for energy saving however comfort may be improved through reducing unwanted solar gain into a space is through installation of external louvered shading.
3.	Wind turbine. It is known that the school is interested in renewables. The school already has a small (estimate 1kWpeak) PV array on the roof of the St Edwards wing. A further renewable technology which is more visible and will generate significant amount of energy (in a windy site) is a wind turbine. In terms of wind energy the site benefits from being on a hillside in a fairly open setting. Consequently, wind speeds are higher than in more densely built up areas. The average windspeed at this site at 3 different heights above ground level is shown in the table below. Great Britain Wind Speed Map Grid Reference TQ 33 71 OS 533 171 Wind Speed N 6.30 6.40 6.40 6.60 6.70 6.50 6.80 6.80 6.40 m/s at 45m above ground level 5.80 5.90 6.00 6.20 6.30 6.10 6.40 6.50 5.90 m/s at 25m above ground level 5.00 5.10 5.20 5.40 5.60 5.30 5.70 5.80 5.10 m/s at 10m above ground level Zero values indicate areas at sea Figure 1: average windspeeds at the site Source: BERR windspeed database found at: http://www.berr.gov.uk/cgi-bin/nre/noabl1.pl Windspeeds of 5.6 m/s at 10 metres above ground level suggests a viable wind resource. At 25 metres above ground level windspeed increase to 6.3 m/s. Small increases in windspeed result in large increases in the power of the wind as the power in the wind is determined by the cube of the windspeed. Windspeed is highly site specific – especially near buildings. It would be highly advisable to monitor windspeeds in selected sites for at least 6 months prior to

progressing a wind turbine installation project.

A turbine mounted to a 13 metre mast positioned in the north eastern part of the playing fields would have a large fetch and catch prevailing south westerly winds.

Figure 2: Suggested site for a wind turbine

It is recommended that an installer accredited by the government's Low Carbon Building Program should advise on suitable locations and supply a quote for the work. To give a general idea of the savings that are possible the following scenario has been developed:

Installation of a 2.5 kW Proven turbine on a 13 metre tower secured to the ground at average windspeeds of 5.6 m/s should generate around 4000 kWh/annum. At 8 pence per kWh electricity avoided, savings are around £324/annum are generated. Larger turbines are available would generate greater significantly greater quantities of energy.

Figure 3: Proven wind turbine

In addition to direct savings from displacing grid electricity the generator will also be able to claim renewable obligation certificates. These can be sold to energy suppliers for

	around 4.5 pence per KWh. Consequently, sale of ROCs provides additional revenue of around £180/annum. Therefore total financial benefit of the ground based system is around £505/annum. Cost of an in installed 2.5 kw Proven wind turbine with 10 metre tower and balance of systems is estimated at £10000. Consequently payback for this system is around 20 years. However, 50% of the cost of the installation should be supplied from the Government's Low Carbon buildings Program. The remainder can often be sourced through grant from 'Green Tariffs' run by the energy suppliers.

5. Next Steps after Your Survey

As part of the survey delivery process you will receive a supplement containing additional generic information. This is intended to complement your survey report and provide further information to enable you to implement the opportunities identified.

The supplement is divided into four sections;

- The Survey Process
- Implementation: Advice and Support
- Implementation: Financial Support
- Further Offering from External Organisations

Please contact your account manager if you do not receive your site survey supplement.

Appendices

Appendix Supplementary Site Information

The table below summarises the systems and

IMPORTANT NOTICE

Nothing in this report is intended to be or should be interpreted as an endorsement of, or recommendation for, any supplier, service or product.

Whilst reasonable steps have been taken to ensure that the information contained within this report is correct, you should be aware that the information contained within it may be incomplete, inaccurate or may have become out of date. Accordingly, The Green consultancy, the Carbon Trust, its agents, contractors and sub-contractors and the Government make no warranties or representations of any kind as to the content of this report or its accuracy and, to the maximum extent permitted by law, accept no liability whatsoever for the same including without limit, for direct, indirect or consequential loss, business interruption, loss of profits, production, contracts, goodwill or anticipated savings. Any person making use of this report does so at their own risk.

services assessed at the site.

Element	Assessment and general condition	Age and date for next upgrade	Recommendation
Building fabric			
External doors	All external doors are constructed of pine or other solid timber. Most had very little draftproofing	Age: 20-100 years Upgrades:	Draft proof external doors
Walls	Main block – solid brick up to 2 feet thick. No internal or external insulation. Good condition. Figure 4: Main block walls are constructed of solid brick up to 2 feet thick St Edwards – double skin of brick constructed with cavity. Cavity is presumed to be unfilled (no evidence of retrospective cavity fill). Good condition.	Age: 160 years for main building, 46 years for St Edwards wing. Estimate 20 years for sportshall. No upgrade date.	Install cavity wall insulation to St Edwards wing walls

Figure 5: St Edwards walls are constructed with a cavity

Sportshall – brick and block. Assumed that cavities have been filled at time of construction. Good condition.

Figure 6: Sportshall walls are constructed of brick and block

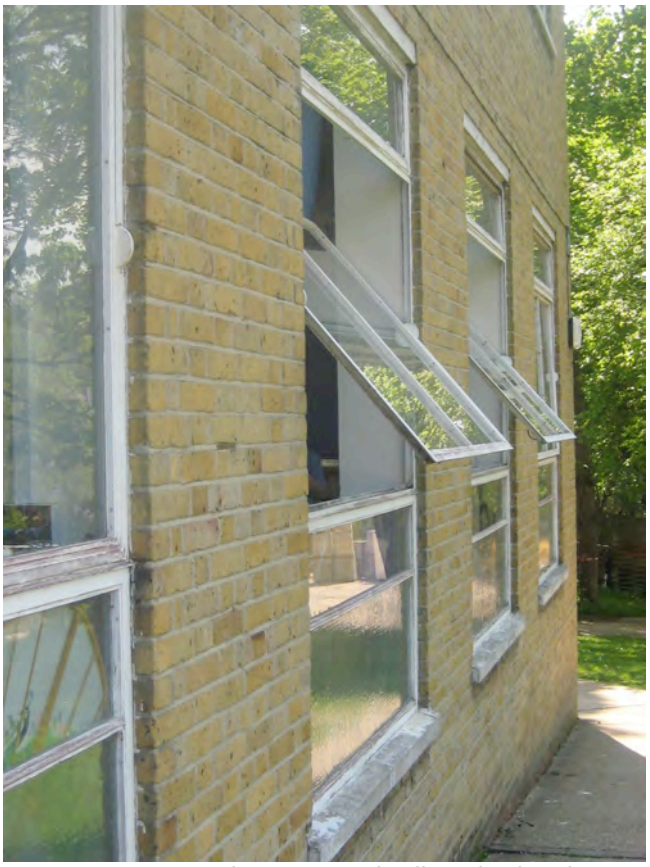
Windows	All windows on site bar those in the modern dining room are single glazed in metal or wooden frames and in poor or average condition. Closure is poor or average. The school has secured finance to replace all glazing with double glazed units.  Figure 7: Windows are nearly all single glazed	Age: 20 – 50 years. Upgrade: imminent	Ensure that the specified glazing has good thermal properties. Glazing on the south side of the St Edwards wing should be soft coated Low e to minimise unwanted solar gain in the summer months causing overheating.
Roof and ceilings	The main block has an uninsulated pitched roof tiled with slate. Figure 8: Main block roof The roof space in the main building is uninsulated.	Age: as per date of construction. No upgrade time.	As the suspended ceilings are insulated with 100 mm of mineral wool, additional insulation to the relatively small areas of accessible roof space is unlikely to be economically viable.

	 Figure 9: Uninsulated main block roof space Original ceilings in the main block are constructed of lath and plaster. Suspended ceilings have been installed beneath these to reduce the heated volume of the space. This has been done throughout the site. Suspended ceilings have a 100mm mineral wool insulated backing.		

Boilers, water heaters and control	The site has 3 plant rooms as follows: **Plantroom 1: Main plant room, main block** This plant room serves radiator circuits in the western and southern parts of the main block – i.e. the main block other than the Lodge. Heating plant: Ideal concord super series 3 modular boiler with 8 modules. These are rated at 85% efficient GCV. Total output power is 400 kW. This boiler is estimated at around 12 years old. Figure 10: modular boiler in the main plant room Distribution: Constant temperature circuit to radiators	Age of boiler Plantroom 1: boilers 12 years Upgrade: 2016	Conduct feasibility study to create 2 or 3 new heating zones: Zone 1 to serve the admin area. Zone 2 to serve the classrooms. Zone 3 to serve the dining hall, assembly hall and library. Each zone to be served by a variable temperature circuit. Install building energy management system to control timings and temperature in the zones. In the meantime turn off heating at 6:00 pm during the week.

Control and timings:
Heating controlled by thermostat sited in main corridor of the main block. Timing controlled by manually adjusted 7 day timer. No weather compensation or optimisation controls. Frost stat. Heating times were as follows:

	on	off	on	off
Mon	4.30	13:00	13.30	19.45
Tues	4.30	13:00	13.30	19.45
Weds	4.30	13:00	13.30	19.45
Thurs	4.30	13:00	13.30	19.45
Fri	4.30	13:00	13.30	19.45
Sat	off	off	off	off
Sun	off	off	off	off

Water heating plant: Domestic hot water was heated in a large calorifier by a dedicated Ideal Concord standard boiler. The calorifier provides hot water to the main building including the kitchens and the sportshall.

Control and timings for HWS:
Timings for hot water were controlled by a 7 day manual timeclock. Settings were as follows:

Hot water settings		
	on	off
Mon	5.30	21:15
Tues	5.30	21:15
Weds	5.30	21:15
Thurs	5.30	21:15
Fri	5.30	21:15
Sat	5.30	21:15
Sun	5.30	21:15

The sportshall is used between 8 and 10 pm on Wednesdays and until 7pm during the week. Therefore these settings do not reflect occupancy and should be adjusted.

Change hot water occupancy settings in main plant room to more accurately reflect actual occupancy

Plantroom 2: Lodge
This plant room serves radiator circuits in the lodge block only.

Heating plant: 3 floor standing Ideal concord CX boilers. Not possible to ascertain actual output power. Boilers are rated at 80% GCV efficient and to be 13-14 years old. Distribution: One variable temperature circuit to radiators.

Control and timings:
Heating times controlled by seven day timeclock. Weather compensation through a variable temperature circuit. No optimiser. Timeclock settings were as follows

Lodge settings				
	on	off	on	off
Mon	6:00	12:30	14:00	19:30
Tues	6:00	12:30	14:00	19:30
Weds	6:00	12:30	14:00	19:30
Thurs	6:00	12:30	14:00	19:30
Fri	6:00	12:30	14:00	19:30
Sat	Off	Off	Off	Off
Sun	Off	Off	Off	Off

Plant room 2 boilers 13-14 years old. Should be upgraded within the next 5-6 years

Change boilers in 5-6 years.

Install building energy management system

The lodge is occupied from 7:30 to around 18:00 Monday to Friday therefore these settings do not reflect actual occupancy and should be adjusted.

Water heating plant: none

Plantroom 3: St Edwards wing
This plant room houses boilers serving radiator circuits in the Saint Edwards wing and in the sportshall

Heating plant Saint Edwards: Ideal Concord CXi boiler. This boiler estimated at 15-20 years old. Rated efficiency is 80% GCV

Distribution: Variable temperature circuit serving radiator circuit. No local control.

Control and timings:
VT circuit. No optimiser. Heating timings controlled by seven day timeclock.

St Edwards settings				
	on	off	on	off
Mon	7:00	11:30	16:00	19:00
Tues	7:00	11:30	16:00	19:00
Weds	7:00	11:30	16:00	19:00
Thurs	7:00	11:30	16:00	19:00
Fri	7:00	11:30	16:00	19:00
Sat	Off	Off	Off	Off
Sun	Off	Off	Off	Off

These settings for the radiator circuit do not reflect occupancy. Start time could be reset to 7:30 am and heating turned off at 6pm.

Heating plant sportshall: Ideal Harrier G.T.E (GT300/11) boiler. This boiler rated at 84% efficient and around 8-10 years old.

Distribution: Constant temperature circuit serving sportshall radiator circuit. No local control

Control and timings:
Heating timings controlled by seven day timeclock. Settings were as follows:

sportshall				
	on	off	on	off
Mon	6:30	13:30	14:00	18:30
Tues	6:30	13:30	14:00	18:30
Weds	6:30	13:30	14:00	18:30
Thurs	6:30	13:30	14:00	18:30
Fri	6:30	13:30	14:00	18:30
Sat	Off	Off	Off	Off
Sun	Off	Off	Off	Off

These timings do not reflect occupancy and should be adjusted.

Age: St Edwards's boiler is estimated at 15 years old. Should be upgraded in next 5 years

Change timeclock settings

Install building energy management system

Plantroom pipework and pumps	Plantroom 1 – Adequately insulated - some pipework was uninsulated. 3 speed circulation pumps Plantroom 2 –. Adequately insulated. 3 speed circulation pumps. Plantroom 3 – Adequately insulated. 3 speed circulation pumps.		Insulated uninsulated pipework in plant room 1

Distribution	Cast iron and some pressed steel radiators throughout the site. No TRVS Figure 11: The site has a mix of pressed steel and cast iron radiators. None have TRVs		Install tamper proof TRVs. If these prove inappropriate due to vandalism or accidental damage install, if pipework is suitable, thermostatically controlled motorised valves to control heating to each room or grouping of radiators to achieve similar result as TRVs.
Cooling	The school has recently installed air conditioning to the admin offices on the ground floor. There is also some ac in one of the IT suites and cooling the server room.	Age: estimate ac between 1 and 5 years	New glazing should reduce ac load in the admin area. No recommendation
Server room	The server room is located in the basement of the main block. It comprises 12 dedicated servers. The server room is cooled by a split ac unit. The set point is set to 18 degrees. This is considered cooler than necessary.	-	First consult manufacturers of server units and, if appropriate reset ac set point to 23 degrees.
PCs and monitors	The school has around 250 reasonably new pcs. 50 % have LCD monitors. A network shutdown is in operation however this does not turn off the monitors. These must be manually switched off at the end of the working day. However they are routinely left running 24/7 (in standby). Standby functions on the PCs are disabled so that lessons using computers which generally require pupils to log in can start promptly. It is also considered that coming out of standby can occasionally cause problems. Consequently, hard disks are set to run continuously.	<4 years	Include turning off of monitors in energy management policy
Printing and photocopying	There are around 25 printers in the school. None are hot wax. All are left on 24/7. The school has five large photocopiers which are reasonably new and have factory default power saving settings in operation but which are not routinely switched off at the end of the working day.	<5 years	No recommendation for replacement. Ensure new machines have best practice energy saving features. Fix timeclocks to printers and photocopiers.
Other	There are interactive whiteboards in most of the classrooms	<3 years	No recommendation

<table>
<tr>
<td>Luminaires</td>
<td>Lighting in the school is mostly by T8 triphosphor fluorescent tubes in switch start fittings with either reflective louvres or box diffusers.

A lighting inventory taken during the site visit is shown below with assumed circuit wattage for each luminaire type and corresponding estimate of annual energy consumption based on assumed light operation time:

<table>
<tr><th></th><th>numbers of luminaires</th><th>circuit wattage per luminaire</th><th>estimated annual energy consumption (kWh)</th></tr>
<tr><td>2" T8 in a luminaire with 4 bulbs (electronic)</td><td>0</td><td>76</td><td>0</td></tr>
<tr><td>2" T8 switch start in a 4 lamp luminaire</td><td>30</td><td>90</td><td>4918</td></tr>
<tr><td>4" T8 switch start (single)</td><td>0</td><td>45</td><td>0</td></tr>
<tr><td>5" T8 switch start (single)</td><td>165</td><td>70</td><td>21038</td></tr>
<tr><td>5" T8 switch start (double)</td><td>146</td><td>140</td><td>37230</td></tr>
<tr><td>5" T8 electronic (single)</td><td>0</td><td>112</td><td>0</td></tr>
<tr><td>5" T8 (electronic) double</td><td>0</td><td>58</td><td>0</td></tr>
<tr><td>5" T5 electronic (double)</td><td>0</td><td>80</td><td>0</td></tr>
<tr><td>6" T8 switch start (single)</td><td>49</td><td>82</td><td>7319</td></tr>
<tr><td>6" T8 switch start (double)</td><td>7</td><td>164</td><td>2091</td></tr>
<tr><td>6" T8 switch start (quadruple)</td><td>0</td><td>328</td><td>0</td></tr>
<tr><td>6" T8 electronic (single)</td><td>10</td><td>70</td><td>1275</td></tr>
<tr><td>6" T8 electronic (double)</td><td>32</td><td>140</td><td>8160</td></tr>
<tr><td>6" T12 switch start (single)</td><td>17</td><td>93.71429</td><td>2902</td></tr>
<tr><td>8 " T12 switch start (double)</td><td>40</td><td>234.2857</td><td>8535</td></tr>
<tr><td>cfl (=2X18 watt sick in single luminaire)</td><td>0</td><td>36</td><td>0</td></tr>
<tr><td>2d</td><td>69</td><td>38</td><td>4776</td></tr>
<tr><td>Total</td><td></td><td></td><td>98242</td></tr>
</table>
</td>
<td>New fittings are < 5 years. Old fittings are 10years+</td>
<td>Replace switch start fittings with electronic ballast fittings.</td>
</tr>
<tr>
<td>Lighting control</td>
<td>100% manual switching. Banked switching in halls. Good condition.</td>
<td>Manual switching is 30 years +</td>
<td>Install occupancy sensors in staff room, common rooms, main hall, sports hall and dining hall

Consider further installation of occupancy sensors/dimming controls in toilets and other classrooms</td>
</tr>
<tr>
<td>Kitchen equipment</td>
<td>Equipment in the kitchen consists of:

• 1 larder fridge
• 1 chest freezer
• 1 double door larder fridge</td>
<td>5+ years</td>
<td>No recommendation</td>
</tr>
</table>

	• 2 electric servers • 1 deep fat fryer • 4 gas ovens • 1 gas hob • 1 deep fat fryer • 1 extraction fan • 1 microwave • 1 chilled merchandising cabinet fitted with screen • 1 beverage cooler • 1 smoothie maker Kitchen equipment was considered to be appropriately sited and in good condition. Energy housekeeping by kitchen staff was also good. The merchandising cabinet was emptied and shutoff at the end of each day. Stock was run down in preparation for the holidays and unnecessary appliances turned off over the holiday periods.		

Appendix 2 Detail of Carbon Reduction Opportunities: Assumptions and Calculations

2.1 Consumption, emissions and unit cost assumptions

	Annual usage (kWh)	Average cost per unit (pence inc CCL ex VAT)	Emissions factor (kg CO_2 per kWh)
Electricity	466686	8.073	0.537
Gas	2197461	2.884	0.185

2.2 Calculations

Measure	Calculation	Saving (kWh)
1. Draft and implement an energy policy to improve energy management practices	Savings assumed to be 1% of annual gas and electricity use. Electricity (kwh): 466686*1% = 4667 kwh Gas (kwh): 2197461*1% = 21975 kWh	4667 21975
2 Install Building Energy Management System	Total gas consumption = 2197461 Estimated savings from BMS = 7.5% (ref GPG 312 Invest to Save). Therefore estimated savings = 2197461*7.5% = 164810 kWh	164810
3. Install 2 variable temperature circuits to main plant room and heat only the administration area and support areas (basement) in the holiday periods	Calculate average gas consumption for heating of main block and admin plus basement per annum based on floor area. Calculate number of heated days per annum (assuming no weekend heating= 156 days). Calculate energy consumption per heated day in each area. Whole block = 6436 kWh/day Admin and basement = 1323 kWh/day Number of heated days in the holidays = 26 Therefore: Heating consumption of main block in holidays = 26*6436 = 164186 kWh Heating consumption admin and basement = 26*1323 = 33759 Savings from separate zoning of admin and heating only this area in the holiday periods (and not entire block) = 164186 – 33759 = 130428 kwh/annum	130428 kWh
4. Fit thermostatic radiator valves (TRVs) to all radiators	Total heating consumption =1988876 kWh Assumption that TRVs save 5% of energy use (ref: GPG312 Invest to save) Savings = 5%*1988876 = 99444 Assume cost per TRV installed = £25 Estimate number of TRVS required: 212	99444
5. Reset heating system times in main building plant room	Calculate average gas consumption for heating of main block based on floor area = 1005477kWh. Calculate kWh / day based on number of heated days per year	82984

	= 1005477/ 156 = 6436 kWh/day (z) Calculate current hours of operation for each day of the week (a). Calculates new hours of operation for each day of the week (b). Calculate factor for each day of the week based on reset occupancy to apply to average daily consumption of main block on each day of the week (a/b)*z. From this calculate new consumption per day and consequent savings.	
6. Replace T8 switch start lighting (electromagnetic ballast) with electronic ballast T8 lighting.	Savings based on calculation of existing consumption of lighting system based on lighting inventory taken at time of site visit. Circuit wattage for replacement lighting providing equivalent lighting (lux) using electronic ballast taken from best practice guidance (Lighting guide 007 Carbon Trust). Lighting inventory shown in the appendix Assumed cost to replace single fitting= £35 Assumes cost to replace double fitting = £45	16170
7. Install radiator panels to all radiators mounted to external solid walls	Assumptions based on technical guidance for Energy Efficiency Commitment (EEC) approved measures (2002-2007) Typical savings per m^2 of panel for a radiator mounted to a solid external wall (kwh/annum) = 93 Assume size of typical radiator = $1.5m^2$ Therefore savings per radiator = 1.5*93 = 140 kwh/annum Estimate number of suitable radiators external solid walls = 140 Savings = suitable radiators * savings per radiator = 140*140 = 19519 kWh/annum	19519
8. Install cavity wall insulation to St Edwards	Calculate area of external wall in the buildings after accounting for glazing: 354 m^2 Calculate average heat loss per annum (kWh) based on existing wall U value of 1.66 and 20 year average degree days for south east = 2029 = area*degree days*24*U value/1000 = 28702 kWh Calculate heat loss of insulated wall based on U value of 0.714 and 2029 degree days = 12313 kWh Assume boiler efficiency of 80% to calculate delivered kWh. energy loss existing wall = 28701*(1/0.8) = 35878 energy loss insulated wall = 12313*(1/0.8) = 15391 Savings = 35878-15391 = 20487	20487
9. Install occupancy sensors to control lighting in staff room, assembly hall, dining hall, sportshall and 6th form common room	Calculate lighting demand in sportshall, assembly hall, staff room and common room based on installed lighting in each room (from lighting inventory taken during site visit) and assumption that lights are switched off 50% of the potential maximum time under existing practice (= lights on in these spaces 914 hrs per annum) Assume occupancy sensors will save 35% of existing lighting demand in these spaces. Ref: GPG 312 Invest to Save Therefore savings = 35%*914 hours*lighting load in each room. Assume cost of each sensor installed = £300 Require one senor for each entrance to each room.	4176

<table>
<tr>
<td>10. Install timers to all photocopiers and printers bar hot wax printers</td>
<td>Assume following power demand in standby and operational modes for printers and photocopiers:
<table>
<tr><td>timeclocks on photocopiers etc</td><td>power consumption in use</td><td>hours in use per day</td><td>power consumption in standby</td><td>hours in standby</td></tr>
<tr><td>consumption per photocopier</td><td>560</td><td>1.5</td><td>30</td><td>22.5</td></tr>
<tr><td>consumption per printer</td><td>110</td><td>1.5</td><td>20</td><td>22.5</td></tr>
</table>
Reference GPG 118 managing energy use, minimising running costs of office equipment and related air conditioning.

Estimated savings on this consumption = 40%
Reference GPG312 Invest to Save

Numbers of printers and photocopiers are known therefore calculation of annual energy consumption is possible</td>
<td></td>
</tr>
</table>

Appendix 3 Summary of Areas Covered

Main area	Sub topics	Key area?	Yes, covered	Not covered	Reason for exclusion (e.g. customer already familiar, not relevant at this site, etc.)
Energy Management and Reporting System					
	Policy and Strategy	YES	Yes		
	Energy Management responsibility	YES	Yes		
	Use of meters	YES	Yes		
	Data collection and analysis	YES	Yes		
	Publicising Energy Performance		Yes		
	Workforce engagement	YES	Yes		
	Use of the Standards for Managing Energy		Yes		
	Buildings Energy Management Systems		Yes		
Energy Performance					
	Space Heating	YES	Yes		
	Boiler house/ plant room/ boilers	YES	Yes		
	HVAC systems and plant	YES	Yes		
	Compressed Air	YES		yes	No compressed air on site
	Combustion processes	YES		yes	Not relevant
	Lighting	YES	Yes		
	Motors and drives	YES	yes		
	Building Fabric	YES	Yes		
	Refrigeration/ Cooling Systems	YES	Yes		
	Hot water systems		Yes		
	Steam distribution			Yes	
	Heat recovery			Yes	

Main area	Sub topics	Key area?	Yes, covered	Not covered	Reason for exclusion (e.g. customer already familiar, not relevant at this site, etc.)
	Process	YES		Yes	Not relevant
	Pumps and fans			Yes	Not significant
Energy Supply	Opportunities for Renewables		Yes		
	Opportunities for CHP			yes	Not appropriate

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creative environmental networks

Sustainable Energy Report for Cypress Junior School

Study completed by CEN

12/8/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your building. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	28,930	1,013	0	0
Switch Off Equipment	5,649	480	0	0
Control of Lighting	4,080	350	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Roof Insulation	30140	1,055	4,130	3.9
TOTAL[1]	**68,799**	**2,900**	**4,130**	**1.4**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 68799kWh
- ✔ Achieve financial savings of £2900 per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures could be as low as £4,130. This would imply a simple pay back of only 1.4 years. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp installed)	110	80	5,800	52

- 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies.
We offer free follow-up support and advice, helping you to implement the recommendations.
We will support you in engaging building occupants and developing an Energy Plan, setting out actions & targets
CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your organisation is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable.

2.2 An Overview of the Site

The building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data. From the nature of the organisation (including size) benchmark data has been used within this report to assess energy performance against sector standards.

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report.

Your organisation currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the organisation and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.1 Energy Consumption

The current annual gas consumption of the site is 235,441 kWh pa and the current electricity consumption is 75,326 kWh. This equates to costs of £8,240 and £6,400 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	75,326	24	6,400	44	32,390	42
Gas	235,441	76	8,240	56	44,730	58

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

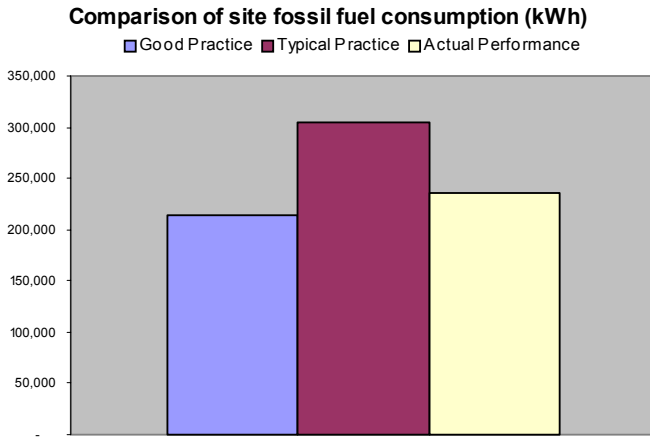


Chart 1-1 Current Energy Performance

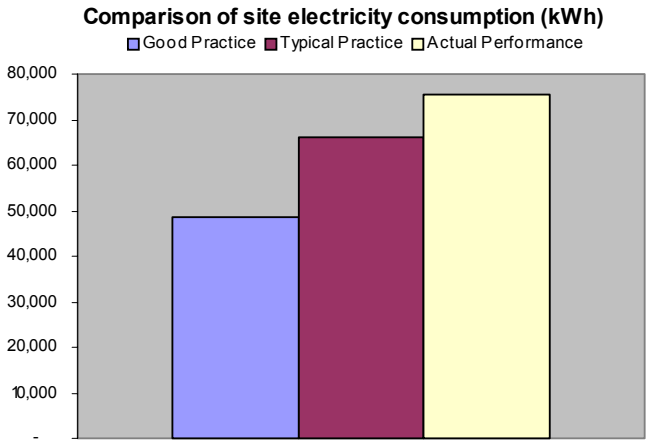


Chart 1-2 Energy Saving Opportunities

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.

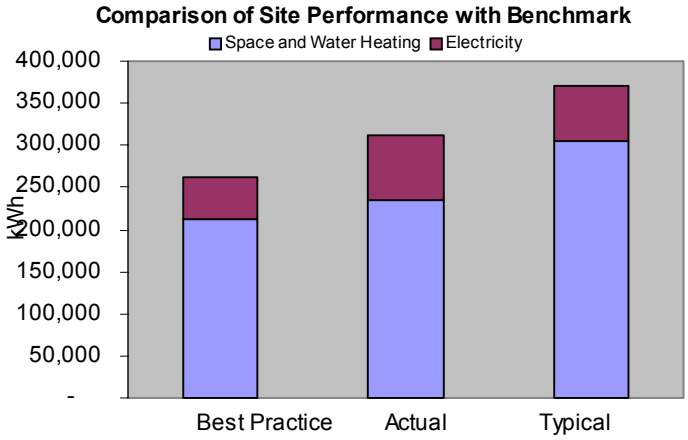


Chart 2-1 Heat consumption against benchmark, benchmark

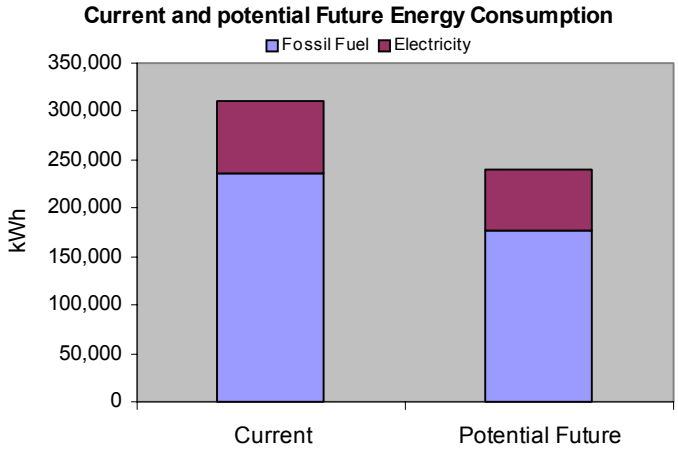


Chart 2-2 Electricity consumption against

Fuel prices vary across the country, and often change quickly. Your energy costs were not available and have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

2.2.4 Summary of Energy Performance Compared with Benchmark

The site could potentially improve its electricity consumption levels as they are currently above typical consumption levels for your sector. The profiling is likely to be due to the partial use of electric heating which would increase the electricity usage and reduce the space heating usage in comparison to benchmark data, and the use of an electric immersion heater to provide hot water for catering. Particular areas of this report to consider include lighting and machinery, and ensuring that equipment is turned off when not in use, and power is not wasted.

2.2.5 Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don’t measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation. We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better control & reducing your internal temperature could deliver a £1,013 saving pa with no investment. Ensure that timers on individual electric radiators are set for suitable times to refelect changing uses of classrooms. Staff should be trained on how to use TRVs and broken TRVs should be replaced. Locks can be placed over TRVs to make them child proof.

Figure 1 TRV set high

Figure 2 Timer on electric radiator

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity.

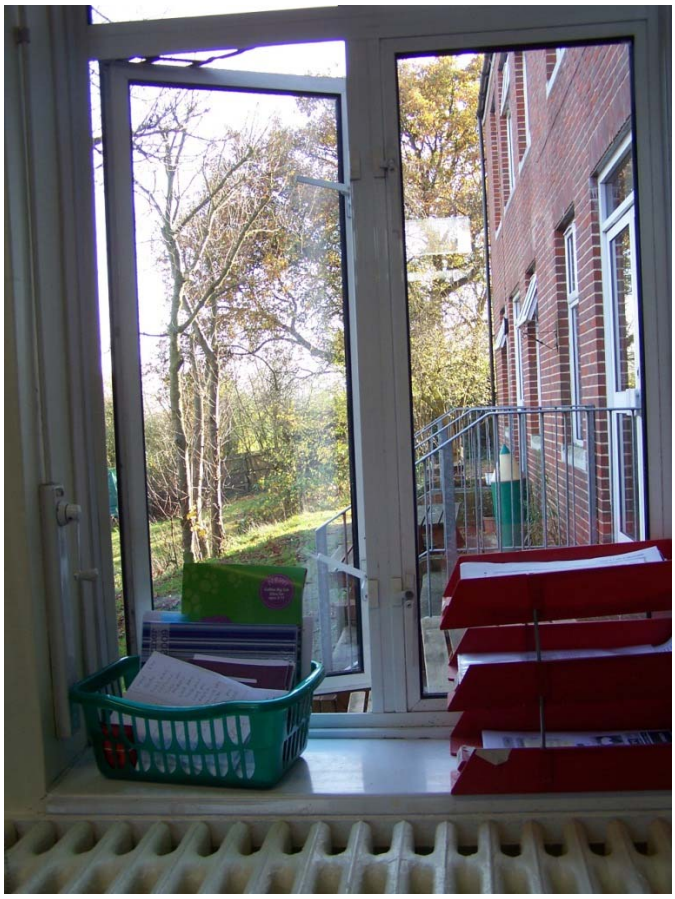


Figure 3 TRV set to maximum in classroom with window open

The current temperature settings for the building have been estimated, as there are individual thermostats. Boiler control settings are linked to TREND and not controlled by site staff. It would be beneficial if site staff could control the set temperature for the heating system, as this would not need to interfere with the boiler controls. Based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 21degrees. If you reduce your building temperature by 2 Degrees, you could save around 28,930 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Insulating your pipe work can reduce heat losses through the pipes. Pipe insulation comes in a variety of materials and is cheap to buy. Smaller pipes can be insulated by the site manager, however, larger pipes may require an installer. installed pipe insulation has a payback period of between 0.5 - 2 years depending on the operating hours of the heating system.

The insulation jacket on one of the hot water cylinders is disintegrating and should be replaced. This measure has a very short payback time and is strongly recommended.

Figure 4 Hot water cylinder with incomplete insulation

Zoning

Zoning of the heating system could be possible within your building, meaning that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This would reduce overheating which is currently overcome by staff opening windows. There are two boiler rooms which effectively mean that there are two zones, but these are not linked to occupancy, orientation or building fabric to allow a lower heat input to achieve the same set temperature. It was not established how room thermostats interacted with only two zones. This is suggested as an area of investigation.

Figure 5 Windows open to reduce internal temperature

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall. Insulation type, cost and efficiency will vary greatly according to the type of building structure your organisation currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

Insulation Savings	Saving (kWh)	Cost Saving (£)	Installation Cost (£)	Payback (Years)
Roof Insulation	30,140	1,055	4,126	3.9

Your building currently has roof insulation, but this was installed approximately ten years ago and is therefore likely to be 200mm. Current Building Regulations demand 270mm of loft insulation and it is recommended that insulation is topped up to this level. Please note costs and savings are estimated as access to the loft was not provided. There is loft access at height and it is recommended that this is done when equipment for working at height is erected for changing lights.

Figure 6 Access to roof space

We identified several draught areas within the building around doors. Draught proofing is a simple and low cost measure, which can usually be fitted by the facilities/premises/site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. The Loft access hatches should be checked for draught proofing as this can help minimise heat escaping to the loft cavity. Therefore this is recommended as a priority measure for the building.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Control of Lighting	4080	350	0	0
Conversion to higher efficiency tubes	1959	167	0	0

Figure 7 Blackout blinds drawn blocking out natural lights and artificial lights on

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

By switching off unnecessary lights, you could potentially save 4,080kWh or £350.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. This should include opening blinds whenever glare issues can be overcome, if blinds are closed to use Interactive Whiteboards, they should be opened as soon as possible to maximise natural light. Lights are zoned so that banks of lights closest to the window can be turned off when natural light is sufficient, whilst maintaining an even level of light throughout classrooms.

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

Figure 8 Blinds drawn and obstructions over window reducing natural light

When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers. Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

3.4 Equipment

Individual pieces of equipment within your School will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Figure 9 Computer screens on, displaying screensaver when not in use

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 5,649kWh or £480 through switching off computers and other common office equipment. If your School is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Figure 10 No timer on immersion heater

Hot water is provided to to the kitchen from an electric immersion cylinder. This is an expensive and carbon intensive way to heat water and should be carefull monitored. It is recommended that a timer is fitted so that water is only heated as and when required as it is thought that water is constantly kept at 60°, regardless of requirement.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artificial and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your School can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste. This is particularly important as no consumption data was submitted to the Display Energy Certificate assessor, resulting in the worst buidling efficiency rating.

3.6 Teachers and Pupil Awareness and School Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among building occupants
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other building occupants are aware of their environmental impacts and any environmental policy which your organisation may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this Energy Check, you have indicated that you are interested in saving energy and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600.

3.7 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Water

Water consumption can make up a significant part of any organisation's utility bills and reducing consumption is becoming increasingly important in today's changing climate.

4.1 Behavioural changes

A large part of your water use can be saved by altering the way that building users use water. These small changes can soon add up to a large reduction in water use. It was identified that there were no stickers or labels near taps and water appliances encouraging people to save water and turn off taps. Small stickers could be designed in-house and will not only encourage water saving in your organisation but may effect your building users' behaviour when they are in the wider community.

4.2 Water saving measures

4.2.1 Taps

It was identified that you have some tap aerators. Tap aerators are simple devises that fit into existing tap nozzles and mix air with water under pressure as it emerges from the tap. The apparent flow rate is not affected. Water savings of up to 10 litres per minute may be achieved. They are a low cost measure (around £5 each), do not require specialist fitting and the remaining taps should be fitted with aerators as part of your water saving project.

4.2.2 Toilets

We identified the potential to install up to 15 water saving devices in toilet cisterns around your organisation. Each water saving device can save between 1-2.5litres for every flush. There are two types of water saving device which can be used in your cisterns; a hippo and a save-a-flush. Both can be easily installed by a member of staff and up to 50 of each can be sent to you for free by Thames Water if you are in their supply area. Check their website for further details.

4.3 Harvesting Rainwater

Approximately 3.6 million litres of water falls onto a typical 4,000 square meter roof each year. Most of this water runs into the sewage main and is lost. Your organisation has plants or vegetables that are watered from the mains supply costing your organisation money. You should consider installing water butts on down pipes to harvest rainwater and use this water instead. Depending on the amount of watering that you require, you could save up to 5,000 litres of water each year per water butt. Water butts usually cost around £25 to £35 each and are easily installed.

4.4 Monitoring, measuring and billing

The water meter is not read and recorded frequently. Reading your meter frequently not only helps you to be billed accurately by your supplier but can also help you to identify leaks and measure reductions in consumption.
Consumption figures or meter readings can be plotted into a simple graph and displayed so that building users can see how much they are consuming and the reduction in consumption when they try to save water. Readings should be recorded at regular intervals into a simple chart on a weekly or fortnightly basis. This can be done by your site manager at the same time each week as part of the opening or closing procedure.

5 Energy Management Plan

5.1 Summary of recommendations:

Cypress Junior School can reduce energy costs by a minimum of £2,900 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

5.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.
Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.
Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.
Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.
Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

5.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

5.4 Develop an Action Plan

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:
• The efficiency and consumption of plant (eg; boilers and lighting).

• The running cost of energy consuming plant and equipment.
• The suitability and efficiency of installed plant and equipment.
• The cost of plant running over weekends and lights left on unnecessarily.

5.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

5.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

5.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:
Renewable Energy Appraisal

6 Executive Summary Renewable Energy

6.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• No year round demand
Wood-fuel heating	Thermal	✗	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✗	• No available ground area • Incompatible heating system

Summary of feasible technologies

6.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC02/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Hall roof							
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,252	1,399	228	25,200	12,600	721 (360)	111 (55)
Option 2. Year 3 roof							
Solar PV Sanyo Hybrid 9.45 kWp (56.4 m2)	7,318	3,147	512	47,250	23,625	601 (300)	92 (46)

The sustainable energy options

Options 1 and 2
Both options 1 and 2 represent individual installations of the technologies. The larger of the installation, Option 2 (the Year 3 roof) offers the greatest carbon saving.

6.3 Methodology

The approach that has been taken in this study is as follows:

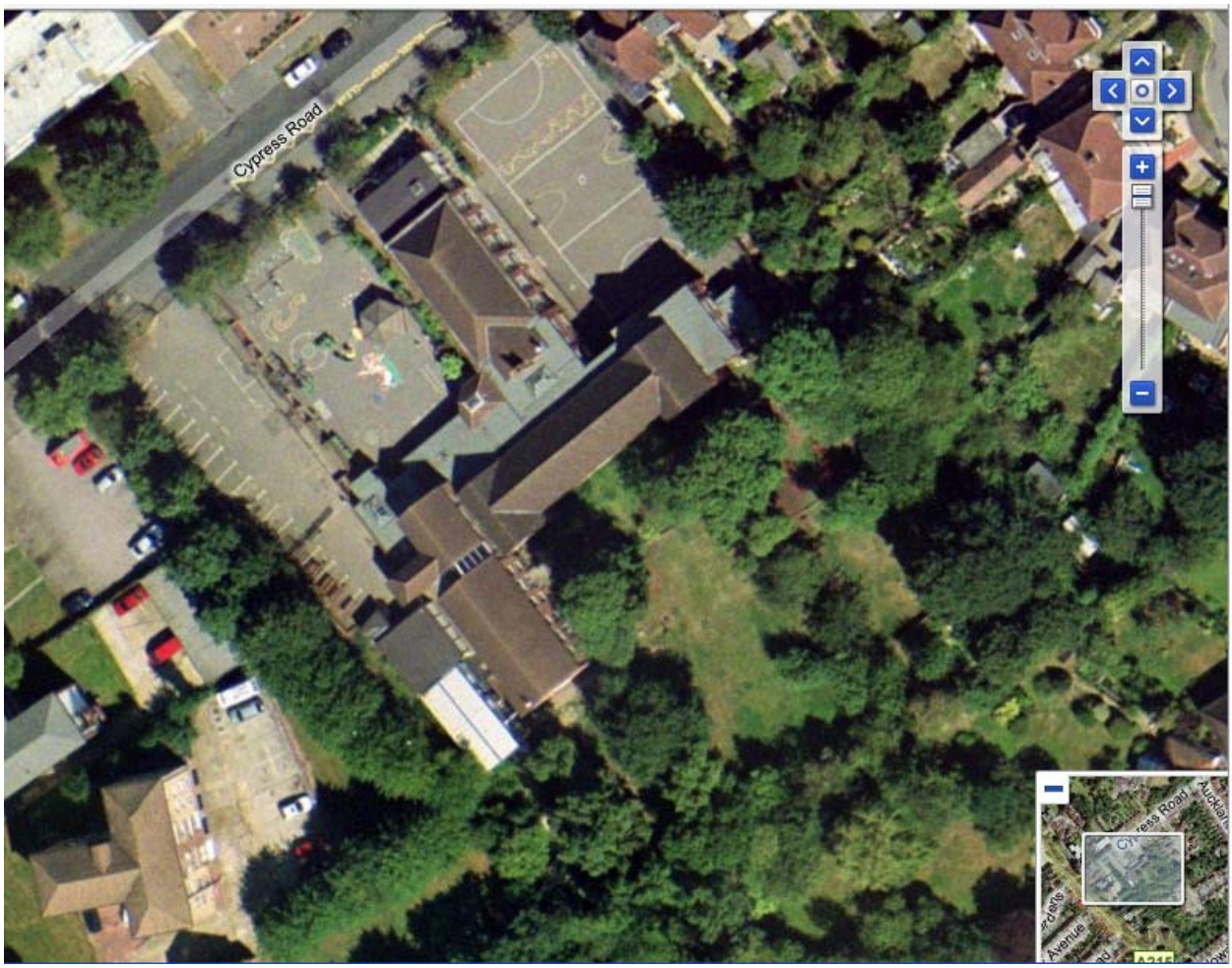
1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and

operational information.

3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Cypress Junior School with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.



7 Roof and ground areas

7.1 Roof

There are two areas of suitable south west facing roof space above the Year 3 classrooms and Hall pitched at an estimated 40° angle. This relates to approximately 32m^2 and 76m^2 of available roof space respectively. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

7.2 Ground Area

There is 275m^2 of external ground area free from trees. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

8 Feasibility study of the technologies

8.1 List of feasibility criteria per technology

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Fuel supply chain	Has the existence of an established fuel supply chain been verified?	✓
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	×
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	×
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

[3] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

In this section, the technical viability of the following renewable technologies has been assessed for the Cypress Junior School site in order to rule out unfeasible options.

Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Cypress Junior School would still wish to consider this technology as an option.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

9 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

9.1 Solar photovoltaics

9.1.1 Site Information

There is approximately 32m^2 of unshaded roof space above the Hall and 76m^2 above Year 3. There is a narrow walk way between the Year 3 classroom and the nearest building which may have repercussions for the erection of scaffolding to access the roof.

9.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

9.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,252	1,399	228	25,200	12,600	721 (360)	111 (55)
Solar PV Sanyo Hybrid 9.45 kWp (56.4 m2)	7,318	3,147	512	47,250	23,625	601 (300)	92 (46)

Table 6-1: Examples of carbon savings and costs for PV panels

<u>Assumptions:</u>

These outputs have been calculated assuming that the roof is pitched at 40 degrees from horizontal and the panels would be oriented towards south-west (corresponding to a 95% relative output).

9.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

10 Summary of options

10.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Installation and operational issues
Option 1. Hall roof						
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,252	1,399	25,200	12,600	721 (360)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. Year 3 roof						
Solar PV Sanyo Hybrid 9.45 kW (56.4 m2)	7,318	3,147	47,250	23,625	601 (300)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions for the Cypress Juniors site

Options 1 and 2
Both options 1 and 2 represent individual installations of the technologies. The larger of the installation, Option 2 (the Year 3 roof) offers the greatest carbon saving.

11 Conclusion

The aim of this study is to provide Cypress Junior School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

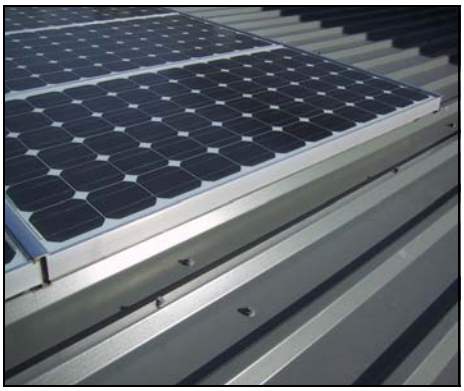
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Obstructions around the Year 3 classrooms –** there is a narrow walk way between the Year 3 classroom and the nearest building which may limit scaffolding erection.

12 Annexes

12.1 Solar Photovoltaics (PV)

Solar photovoltaics

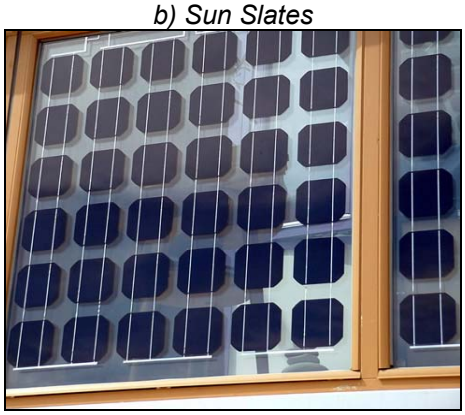
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgC/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

[4] Cost includes supply and installation for >20kWp. Price per kWp will increase as system size decreases (by up to 20%). Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Solar photovoltaics

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

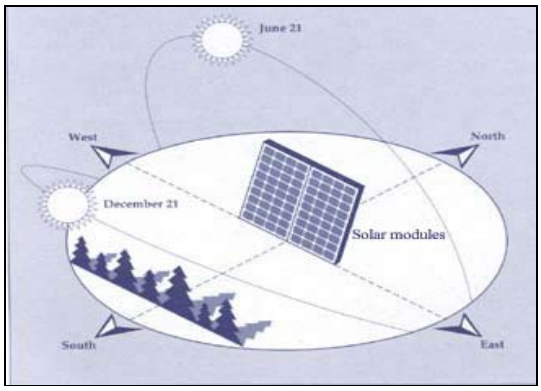
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

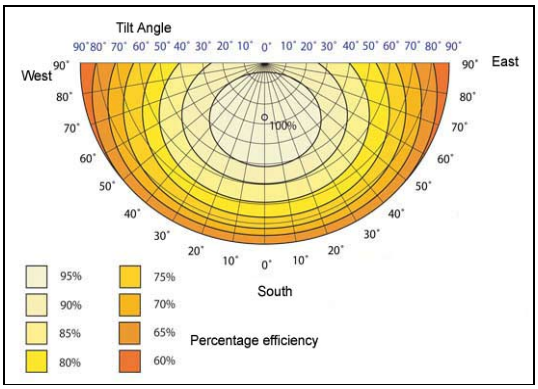
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

12.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Financing low and zero carbon solutions

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of ‘small generators’ in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Forestdale Primary School

Study completed by CEN

11/6/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	14,460	804	0	0
Control of Lighting	6,459	550	0	0
Switch Off Equipment	4,844	412	0	0
TOTAL[1]	**25,763**	**1,770**	**0**	**0**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Achieve financial savings of £1770 per year, and protect against future fuel price increases.
- ✔ Deliver environmental benefit with an energy saving of 25,763kWh

Our initial analysis suggests the cost of implementing these measures could be free. This would imply there would be no payback period. The specific measures recommended, financial information and technical details are of course included in the attached report.

1.2 Renewable Energy Options

The following table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	Cost per ton CO_2[£/t]
Solar PV (per kWp)	7264	2027	99225	546

- ✔ 7,264 kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Forestdale Primary School has 230 building occupants, and the building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data.

2.1 Aerial Photo of the site (Microsoft ™)

From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and lighting.

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

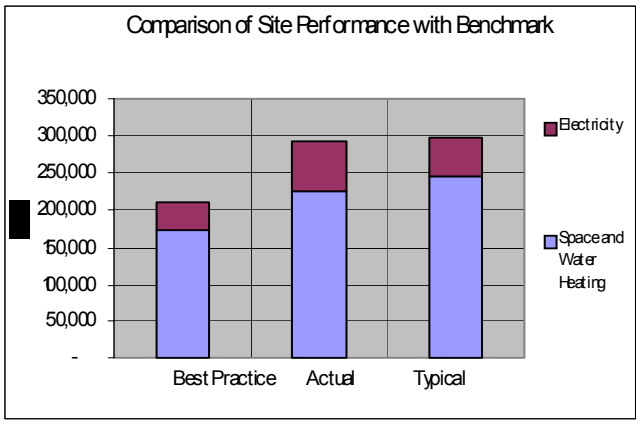
2.2.1 Energy Consumption

The current annual fossil fuel consumption of the site is 135,560 kWh pa and the current electricity consumption is 64,590 kWh. This equates to costs of £12,559 and £5,490 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	64,590	22	5,490	30%	27,260	33
Gas	70,970	24	2,484	14%	13,770	17
Oil	155,000	53	10,075	56%	40,920	50

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:



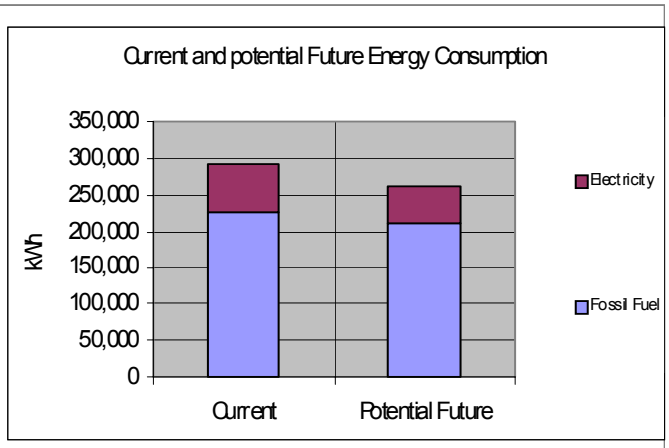
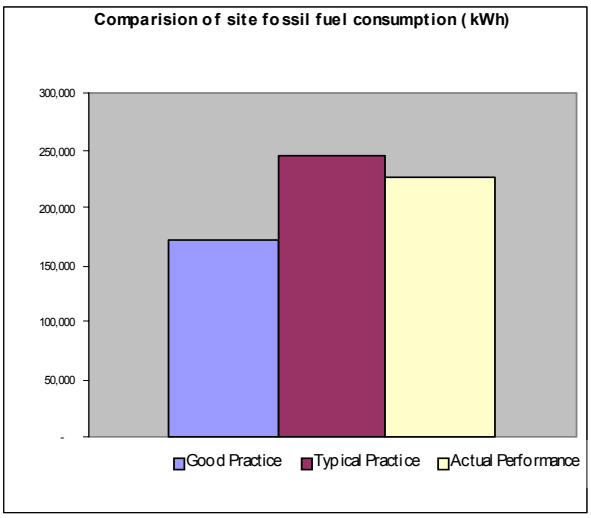


Chart 1-1 Current Energy Performance *Chart 1-2 Energy Saving Opportunities*

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



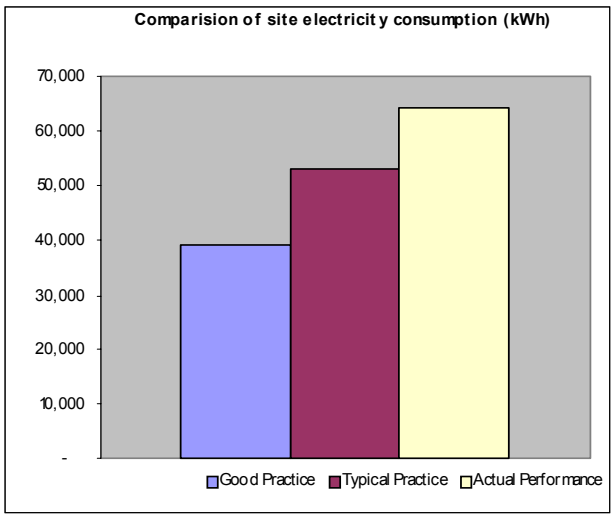


Chart 2-1 Heat consumption against benchmark, *Chart 2-2 Electricity consumption against benchmark*

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

2.2.4 Summary of Energy Performance Compared with Benchmark

The site could potentially improve its electricity consumption levels as they are currently above typical consumption levels for your sector. Particular areas of this report to consider include lighting and machinery, and ensuring that equipment is turned off when not in use, and power is not wasted.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better control & reducing your internal temperature could deliver a £804 saving pa with no investment

• It was noted that there are locks on the Thermostactic Radiator Values (TRV's), for child safety, that can only be changed by the site manager. Teacher training on how to change the temperature on the TVR's will save energy, as it will encourage the teachers to reduce the temperature rather than open windows.

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

• During the site survey it was noted that some of the radiators present within the school had equiment stored onto and next to them, shown in fig 3.2 below.

Fig 3-2 Radiator obstructed by equipment

Removing this equipment will increase the efficiency of your radiator. This is because air needs to circulate underneath the radiator.

•The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade.

This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity.

The current temperature settings for the school have been estimated, as there was no access to the boiler control settings at the school. However, based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 20 degrees. If you reduce your building temperature by 1 Degrees, you could save around 14,460 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall. It was noted that your school had has resent updated both the wall and the roof insulation. This investment will change the heating levels required for the school as more of the generated heat will be keep inside the building. Check with the staff that the heat is at a expectable level and reduce the thermostat if possible.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Control of Lighting	6459	550	0	0
T12 to T8 Conversion	3373	287	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building or room unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting. This would a potentially be relativity easy for your school as you have zone lighting present in all the rooms. This zoned lighting in the building would enable, when daylight is sufficient, lights nearest the windows should be switched off whilst those deeper in eth room can be left on to create an even light throughout the room. Another low/no cost measure is to swirch of lights that are on in rooms with skylights present during day light hours.

By switching off unnecessary lights, you could potentially save 6,458 kWh or £550.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

Your school currently uses lighting sensors in some rooms. It is important to check that these are correctly placed and maintained, to ensure their efficiency.

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy.

Fig 3-3 Monitors left on even though computer is off

Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Screensavers can be set to display a “turn me off” message if this would help staff. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Monitors were not set to hibernate mode which would automatically power computers down. This can be

done to a variety of levels and require different re-start times to suit the level of use of a computer.

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 4844 kWh or £411.8 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

It was noted that the IT suite had a air conditioning unit present. Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

You have identified that high energy using equipment within your school includes a IT suite and interactive white board. Therefore this equipment should be carefully monitored to ensure maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

3.6 Teachers and pupils awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.

Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

3.7 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Energy Management Plan

4.1 Summary of recommendations:

Forestdale Primary School can reduce energy costs by a minimum of £1,770 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.

Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating. Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.

Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:

Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Local residents situated to close
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• No year round demand for hot water
Wood-fuel heating	Thermal	✗	• No available space for fuel storage
Ground source heating	Thermal	✗	• Incompatible heating system

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Flat Roof							
Solar PV Sanyo Hybrid 9.45 kWp (56.4 m2)	7,100	3,053	852	47,250	23,625	619 (310)	55 (28)
Option 2. Flat Roof small installation							
Solar PV Sanyo Hybrid 5.04 kWp (30.1 m2)	3,861	1,660	463	30,240	15,120	729 (364)	65 (33)

The sustainable energy options

Options 1

Option 1 shows the only technology that is feasible for your school. There was only one identifiable roof that could be used for PV as the remainder has a significant amount of shadowing during the day from trees around the school. Using the full roof space has been assumed to incur 5% loss of efficiency from some overshadowing.

Options 2

Shows a smaller instalment on the same roof this PV installation covers a 30.1 m^2 area.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Forestdale with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has mainly a flat roofs with two pitched roof found on the west section. Most roofs are found south-easterly direction. A central flat roof elevated higher than surrounding roofs has a total roof area of 132m^2. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies.

6.2 Ground Area

There is available ground area however the local residents are in close proximity to the school boundaries. The area of this available ground area is 14,960 m^2.

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for Forestdale Primary School in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Forestdale Primary School would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	✓
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✓
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✓
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓ *
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	×
Fuel supply chain	Is there an established fuel supply chain?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	×

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

[3] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

7.2 Additional feasibility elements

7.2.1 Photovoltaic's

The roof will be overshadowed for a proportion of the day. This shadowing will limit the available roof area. Overshadowing on the flat roof if using all of the area will be approximately 5%. Photovoltaics will be assessed for further feasibility in section 6.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaics

8.1.1 Site Information

There is a lot of open space on the roof of the buildings. However, there is a significant amount of roof that will be overshadowed by the surrounding vegetation. This shadowing has limited the available roof space to place PV on and there will still be some reduction of performance related to these buildings (up to 5%)

8.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 9.45 kWp (56.4 m2)	7,100	3,053	852	47,250	23,625	619 (310)	55 (28)
Solar PV Sanyo Hybrid 5.04 kWp (30.1 m2)	3,861	1,660	463	30,240	15,120	729 (364)	65 (33)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:

These outputs have been calculated assuming that the flat roofs would be have the panels mounted on an A-frame pitched at 40 degrees from horizontal and that they would be oriented towards south-east (corresponding to a 95% relative output). Shadowing of the panels would further reduce the efficiency of the panels by approximately 5%

8.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

Summary of options

8.2 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP	Installation and operational issues
Option 1. Flat Roof all available space						
Solar PV Sanyo Hybrid 9.45 kWp (56.4 m2)	7,100	3,053	47,250	23,625	619 (310)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 1. Flat Roof small installation						
Solar PV Sanyo Hybrid 5.04 kWp (30.1 m2)	3,861	1,660	30,240	15,120	729 (364)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions for the Forestdale site

Option 1

Option 1 shows the only technology that is feasible for your school. There was only one identifiable roof that could be used for PV as the remainder has a significant amount of shadowing during the day from trees around the school. Using the full roof space has been assumed to incur 5% loss of efficiency from some overshadowing.

Option 2
Shows a smaller instalment on the same roof this PV installation covering a 30.1 m^2 area.

9 Conclusion

9.1 Going forward

The aim of this study is to provide Forestdale Primary School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

1 **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.

2 **Overshadowing** – tress around the site create complex shading and further modelling would be required to accurately gauge the impact on solar panel performance.

10 Annexes

10.1 Solar Photovoltaics (PV)

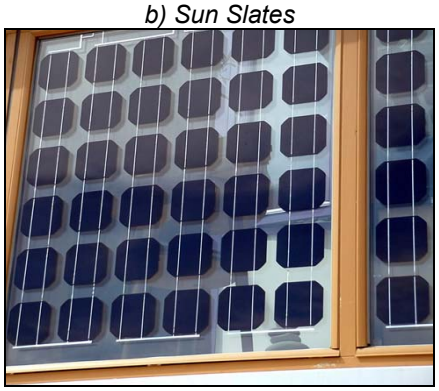
Solar photovoltaics

Product information

a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO2/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

[4] Cost includes supply and installation for >20kWp. Price per kWp will increase as system size decreases (by up to 20%). Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year (see **Error! Reference source not found.** and Annex Figure 3 for more details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Solar photovoltaics

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

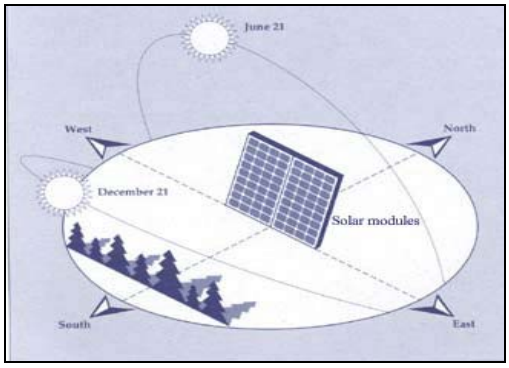
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

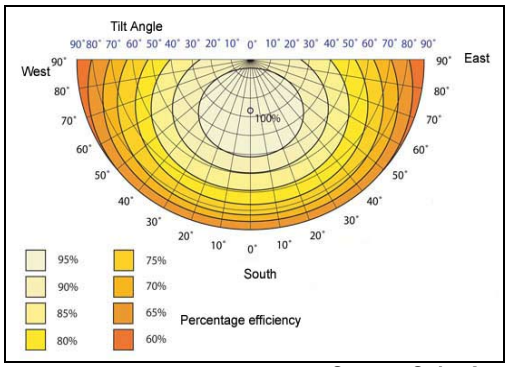
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 2: Solar variations throughout the year



Source: Solar Access

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

10.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Heavers Farm Primary

Study completed by CEN

11/25/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your building. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	77200	2702	0	0
Switch Off Equipment	11045	939	0	0
Energy Efiicient Lighting	3900	332	144	0
TOTAL[1]	**92145**	**3970**	**140**	**0**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 92145kWh
- ✔ Achieve financial savings of £3970 per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures could be as low as £144. This would imply a simple pay back of under a year. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	50

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies.
We offer free follow-up support and advice, helping you to implement the recommendations.
We will support you in engaging building occupants and developing an Energy Plan, setting out actions & targets
CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas of interest to your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

The building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data.From the nature of the organisation (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is neither very new, nor old, you can expect that certain energy efficient considerations have been incorporated, but there are also many improvements which you can currently make. These are outlined within this report, and we will work with you on how best to implement these measures, particularly given the unique design of the building which incorporates a large area of external glass.

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.1 Energy Consumption

The current annual gas consumption of the site is 436010 kWh pa and the current electricity consumption is 147260 kWh. This equates to costs of £15,260 and £12,520 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	147260	25	£12,520	45	62140	42
Gas	436010	75	£15,260	55	84590	58

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

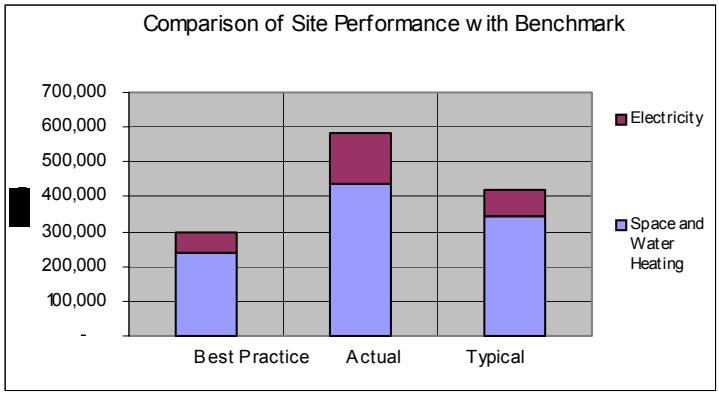


Chart 1-1 Current Energy Performance

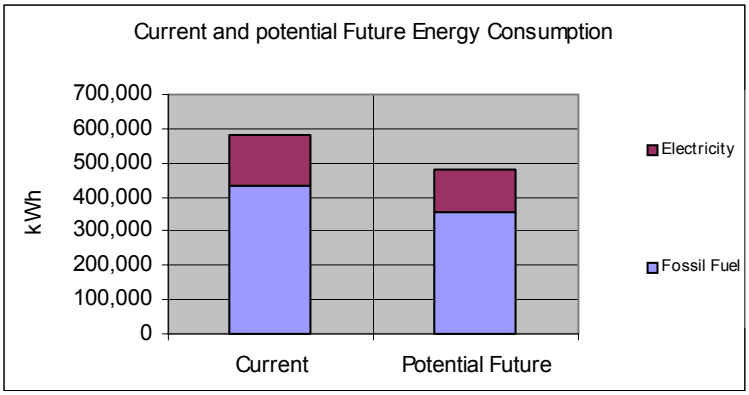
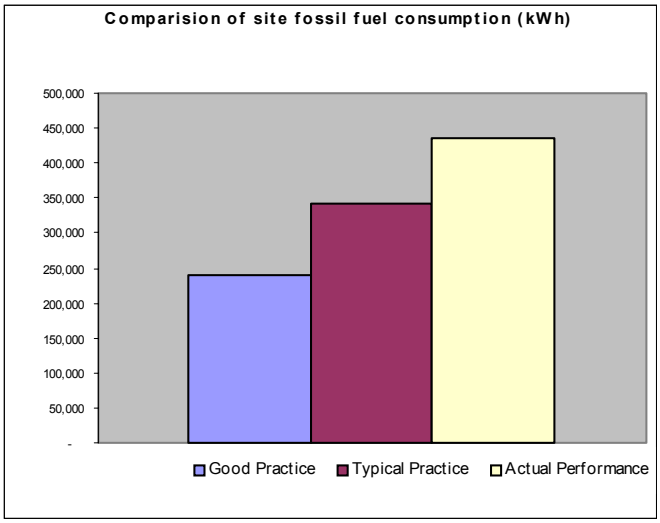


Chart 1-2 Energy Saving Opportunities

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



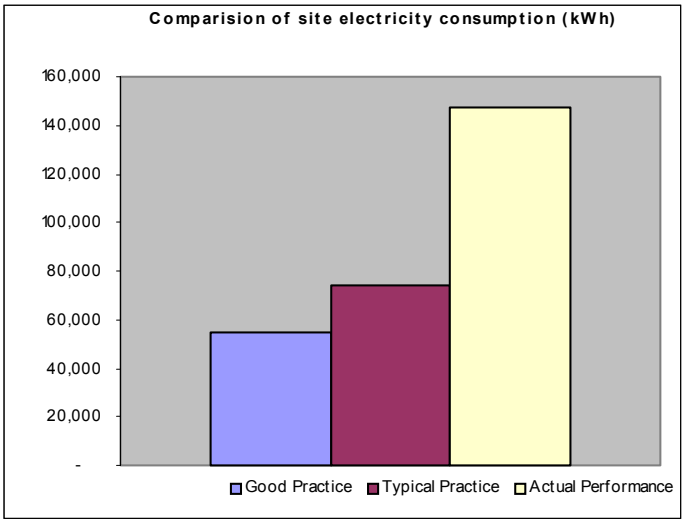


Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark
Your site is not reaching best or typical practice consumption levels for either gas or electricity. This may be due to unforeseen/unusual circumstances (for example equipment utilised by your organisation which is not typical of the sector), but is a clear warning to closely monitor your energy consumption. These high energy consumption figures are likely to be from the low insulating value of the glass construction and the inefficient zoning of the heating system. There are large potential savings to be made at this site, by reducing consumption to be more inline with benchmarks. Specific measures to achieve this reduction are outlined later in the report. In addition, please call CEN on 020 8683 6600 for more information.

Monitoring and Continuous Improvement
A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation. We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better control & reducing your internal temperature could deliver a £2,702 saving pa with no investment. This includes a review of the temperature set points for the heating zones.

• Blinds should be open whenever glare issues allow to increase solar gain.

Figure 1 Blinds should be open to maximise solar gain and natural light

• Training staff to use TRVs (Thermostatic Radiator Valves) could deliver £122. This should ensure that windows are not opened to cool rooms that are being heated.

Figure 2 Window open while heating is on

• It was observed that your boiler and pipework are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system.

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity. The current temperature settings for the school have been estimated, as there was no access to the boiler control settings at the school. However, based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 22degrees. If you reduce your building temperature by 3 Degrees, you could save around 77200 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. This high temperature has been set to overcome under-heating problems and this issue should be considered by the heating engineers together with zoning improvements.

Zoning

Your school currently has zoning within the heating system. However, it is vital to monitor how the different zones work together, and if there are undesired variations between the zone temperature. There with eth zoning at the moment. There are problems with the six separate heating zones. Currently, while the end zones reach a suitable temperature, the central zones overheat and the skylights are opened to reduce the temperature. This is highly wasteful for gas consumption and the

problem should be addressed with the heating engineers.

Figure 3 Skylights open during heating season

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your organisation currently occupies. It is difficult to improve insulation at Heavers Farm as the external building material is glass. This material conducts heat very well and will lead to high heat losses, making it particularly important to ensure that the hating system is working efficiently. Some areas of glass near ground level, have been blocked in. It is suggested that if this is done elsewhere that insulating board is considered as a material. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	CO_2 Savings (Kg pa)[3]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Energy Efficient Lighting	3900	332	144	0
Control of Lighting	3520	300	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

By switching off unnecessary lights, you could potentially save 3520kWh or £300. This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. All areas have automatic lighting sensors, but in many rooms this are broken, it is recommended that these are repaired. In the meantime, staff should be trained in how to use the oned lighting that llows banks of lihhts

[3] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

Your school has fitted all the existing tungsten light fittings with energy efficient light bulbs. We recommend that you continue to replace your old bulbs with energy efficiency light bulbs, and this will provide continuous savings. Energy efficient light bulbs commonly last up to eight times longer than traditional bulbs, and are therefore a good investment in the long term as well as saving you money now.

In several open plan communal areas, very high wattage spotlight bulbs are used. It is receommended that the lower wattage fluorescent tube lighting is used in these areas.

Figure 4 High wattage spotlight in upper right, low wattage tubes not in use to the left

As wattage data has not been provided, we have estimated that your tungsten lights are currently using 70Watt bulbs. If this is different within your building, the savings will vary accordingly.

Standard tunsgsten lights and fluorescent lights are not the only bulbs which can be replaced by more energy efficient lighting. Further savings can be achieved through considering the other sources of light within your building. F Lamps and circular lamps can also be replaced by compact fluorescent lamps, and the most efficient types of metal halide, mercury, halogen or sodium lights should also be purchased when replacing old bulbs. Most bulbs were found to be energy efficient versions.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 11045kWh or £939 through switching off computers and other common office equipment. The ventilation system is running copnstantly which is not necessary. It is suggested that the school invests in a timer switch so that the ventilation system only runs when the building is occupied. It is thought this will cost in the region of £200.

You have identified that high energy using equipment within your school includes a waste compactor and ventilation system. Therefore this equipment should be carefully monitored to ensure maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated). Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

3.6 Teachers and pupils Awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among building occupants
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other building occupants are aware of their environmental impacts and any environmental policy which your organisation may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this Energy Check, you have indicated that you are interested in saving energy and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600.

4 Energy Management Plan

4.1 Summary of recommendations:

Heavers Farm Primary can reduce energy costs by a minimum of £3,970 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.
Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.
Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.
Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.
Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:
• The efficiency and consumption of plant (eg; boilers and lighting).
• The running cost of energy consuming plant and equipment.
• The suitability and efficiency of installed plant and equipment.
• The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

4.8 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	×	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	• No year round demand
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	×	• No available ground area • Incompatible heating system

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. PV large installation							
Solar PV Sanyo Hybrid 65.1 kWp (388.4 m2)	51,485	22,138	3,604	292,950	146,475	529 (265)	81 (41)
Option 2. PV small installation							
Solar PV Sanyo Hybrid 8.4 kWp (50.1 m2)	6,643	2,857	465	42,000	21,000	588 (294)	90 (45)

The sustainable energy options

Options 1 and 2
Both options 1 and 2 represent individual installations of the technologies. The larger of the installation, Option 1 (all suitable roof space used) offers the greatest carbon saving.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Heavers Farm Primary School with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has a corrugated metal pitched roofs at an angle of approximately 20° facing southwest. Overshadowing from the hall and kitchen annex limits the available roof space to approximately 400m^2. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is 6045m^2 of available external ground area. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for Heavers Farm Primary in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Heavers Farm Primary would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[4]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Fuel supply chain	Has the existence of an established fuel supply chain been verified?	✓
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	✓
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

* Assuming that the design is defined to meet these criteria

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

[4] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

7.2 Solar photovoltaics

7.2.1 Site Information

The building has a corrugated metal pitched roofs at an angle of approximately 20° facing southwest. Overshadowing from the hall and kitchen annex limits the available roof space to approximately 400m^2.

7.2.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

7.2.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	CO_2 Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 65.1 kWp (388.4 m2)	51,485	22,138	3,604	292,950	146,475	529 (265)	81 (41)
Solar PV Sanyo Hybrid 8.4 kWp (50.1 m2)	6,643	2,857	465	42,000	21,000	588 (294)	90 (45)

Table 6-1: Examples of carbon savings and costs for PV panels

<u>Assumptions:</u>
These outputs have been calculated assuming that The roof is pitched at 20° from horizontal and the panels would be oriented towards south-west (corresponding to a 96% relative output).

7.2.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

8 Summary of options

8.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per KG carbon saved	Installation and operational issues
Option 1. Large PV Installation						
Solar PV Sanyo Hybrid 65.1 kWp (388.4 m2)	51,485	22,138	292,950	146,475	529 (265)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. Small PV Installation						
Solar PV Sanyo Hybrid 8.4 kWp (50.1 m2)	6,643	2,857	42,000	21,000	588 (294)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions for the Heavers Farm Primary School site

8.2 Options 1 and 2

Both options 1 and 2 represent individual installations of the technologies. The larger of the installation, Option 1 (all suitable roof space used) offers the greatest carbon saving.

9 Conclusion

9.1 Going forward

The aim of this study is to provide Heavers Farm Primary School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Roof integrity –** Further structural investigation would be required to ascertain whether the roof and building structure has sufficient structural integrity for a PV installation.

10 Annexes

10.1 Solar Photovoltaics (PV)

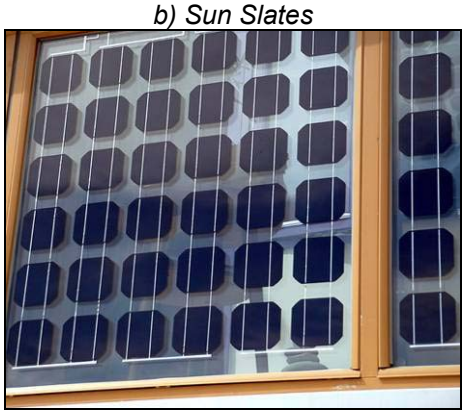
Solar photovoltaics

Product information

a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO2/kWp/yr]	Guideline cost[5] [£/kWp]	Guideline cost[5] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Solar photovoltaics

Annex Table 1: Outputs of solar photovoltaic products

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year (see **Error! Reference source not found.** and Annex Figure 3 for more details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Solar photovoltaics

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

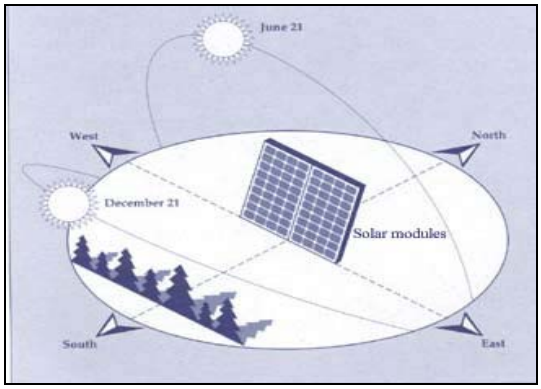
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

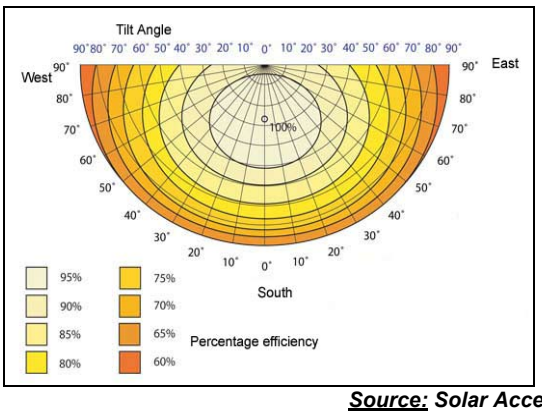
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

10.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more

Financing low and zero carbon solutions

compelling.

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of ‘small generators’ in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Howard Primary School

Study completed by CEN

12/5/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your building. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Switch Off Equipment	8601	731	0	0
Reduce Internal Temperature	13480	472	0	0
Control of Lighting	5130	440	0	0
TOTAL1	27211	1640	0	0

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 27,211kWh
- ✔ Achieve financial savings of £1,640 per year, and protect against future fuel price increases.

Our initial analysis suggests that there is no initial cost to implementing these measures. The specific measures recommended, financial information and technical details are of course included in the attached report.

1 Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO2
Solar PV (per kWp)	110	80	5800	52

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies.

We offer free follow-up support and advice, helping you to implement the recommendations.

We will support you in engaging building occupants and developing an Energy Plan, setting out actions & targets
CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

2 Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas of interest with regard to this project is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable.

2.2 An Overview of the Site

The building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data. From the nature of the organisation (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment.

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, behavioural changes regarding electrical equipment, lighting and heating could provide significant energy savings. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report

Your organisation currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the organisation and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins. In support of your application for renewable technology funding, please keep any evidence of behavioural changes that you make.

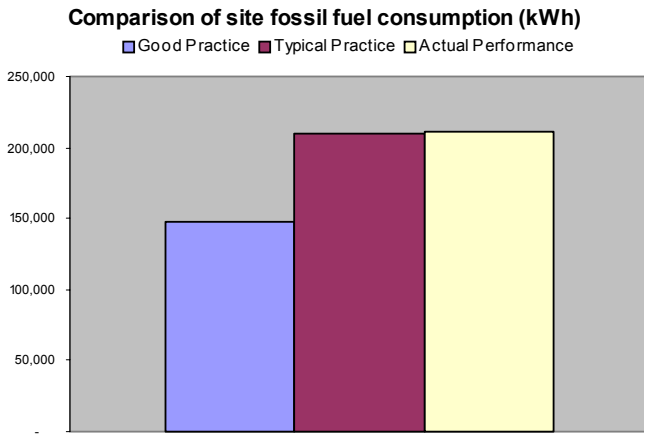
2.2.1 Energy Consumption

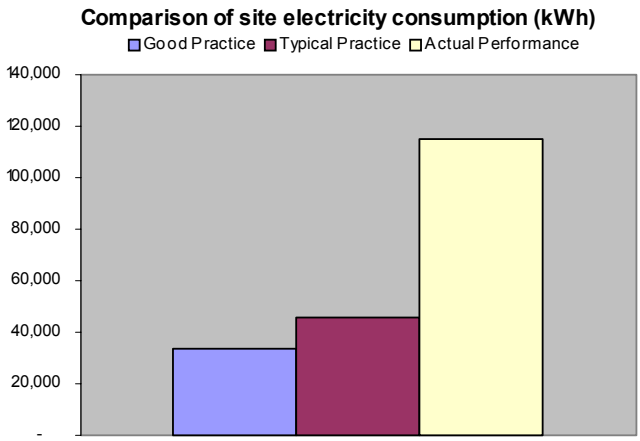
The current annual gas consumption of the site is 210571 kWh pa and the current electricity consumption is 114677 kWh. This equates to costs of £7,369 and £9,750 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	kWh	%	£	%	$kgCO_2$	%
Electricity	114677	35	9,750	57.0	49	55
Gas	210571	65	7,369	43.0	40	45

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark





data:

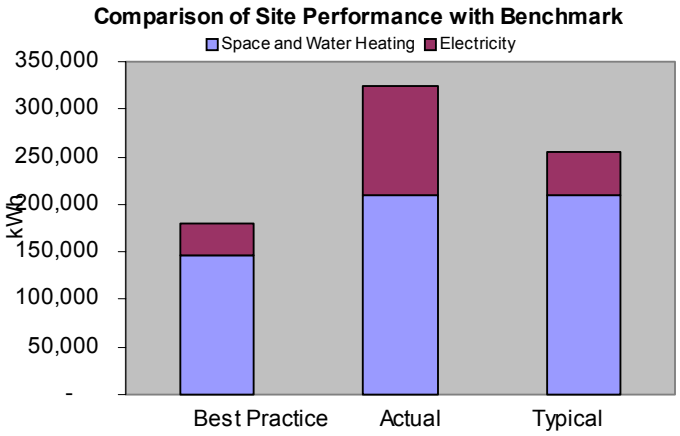
Chart 1-1 Current Energy Performance

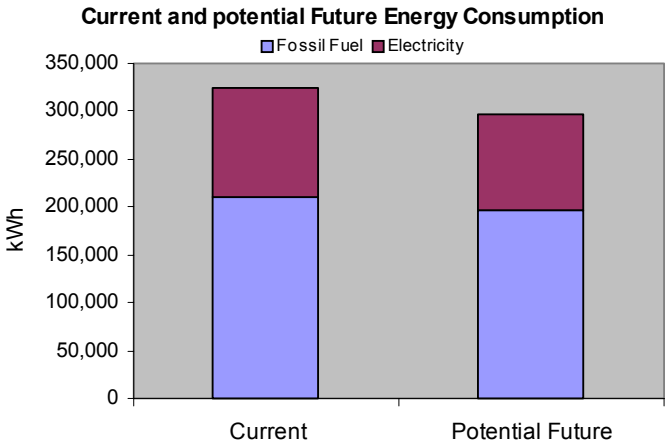
Chart 1-2 Energy Saving Opportunities

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.

Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark





Fuel prices vary across the country, and often change quickly. As your energy costs were not available, they have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark
The site could potentially improve its electricity consumption levels as they are currently above typical consumption levels for your sector. Particular areas of this report to consider include lighting and machinery, and ensuring that equipment is turned off when not in use, and power is not wasted.

Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

Figure 1 Window open when heating is on

• Training staff on how to use TRVs (Thermostatic Radiator Valves) to control room temperature rather than opening windows could deliver £590 of savings per annum. TRVS should be turned down in rooms that are used infrequently.

• Better control & reducing your internal temperature could deliver a £472 saving pa with no investment. Primarily this should be reducing the running temperature of the heating system. The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity. The current temperature settings for the building have been estimated, as there was no access to the boiler control settings. However, based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 21°. If you reduce your building temperature by 1 Degrees, you could save around 13480 kWh each year. This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been

set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Insulating your pipe work can reduce heat losses through the pipes. Pipe insulation comes in a variety of materials and is cheap to buy. Smaller pipes can be insulated by the site manager, however, larger pipes may require an installer. installed pipe insulation has a payback period of between 0.5 - 2 years depending on the operating hours of the heating system.

Zoning

Your organisation currently has zoning within the heating system. However, it is vital to monitor how the different zones work together, and if there are undesired variations between the zone temperature. This could lead to additional further savings

Isolating your boilers could save money

It would appear that you would not need to take action in terms of isolating your boiler

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your organisation currently occupies. Howard Primary has solid walls so cannot easily install wall insulation. Loft insulation was installed in 2006 and should be sufficient, although loft access was not possible to confirm this.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Control of Lighting	5130	440	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

By switching off unnecessary lights, you could potentially save 5130kWh or £440.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. Whenever possible blinds andcurtains should be opne to maximise natural light and reduce the need for artificial lighting.

Figure 2 Curtains drawn reducing natural light

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Your School currently uses lighting sensors, although many of these were not working. It is important to check that these are correctly placed and maintained, to ensure their efficiency. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers. Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30%

on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Howard Primary School is working to replace redundant sensors.

3.4 Equipment

Individual pieces of equipment within your School will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Figure 3 Computers and screens left on when not in use

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 8601kWh or £731.3 through switching off computers and other common office equipment. If your School is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artificial and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your School can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated). Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

3.6 Teachers and Pupil Awareness and School Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among building occupants
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other building occupants are aware of their environmental impacts and any environmental policy which your organisation may have.

Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this Energy Check, you have indicated that you are interested in saving energy and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600.

4 Water

Water consumption can make up a significant part of any organisation's utility bills and reducing consumption is becoming increasingly important in today's changing climate.

4.1 Behavioural changes

A large part of your water use can be saved by altering the way that building users use water. These small changes can soon add up to a large reduction in water use.

It was identified that there were no stickers or labels near taps and water appliances encouraging people to save water and turn off taps. Small stickers could be designed in-house and will not only encourage water saving in your organisation but may effect your building users' behaviour when they are in the wider community.

4.2 Water saving measures

Taps
Water use from taps could account for up to 25% of your water use, with flow rates up to 20 litres per minute, depending on pressure.

It was identified that you have tap aerators that reduces your flow rate to around 10 litres per minute. If you install more taps around your organisation in the future, remember to specify that they have aerators.

Toilets
We identified the potential to install up to 18 water saving devices in toilet cisterns around your organisation. Each water saving device can save between 1-2.5litres for every flush. There are two types of water saving device which can be used in your cisterns; a hippo and a save-a-flush. Both can be easily installed by a member of staff and up to 50 of each can be sent to you for free by Thames Water if you are in their supply area. Check their website for further details.

Harvesting Rainwater
Approximately 3.6 million litres of water falls onto a typical 4000 square meter roof each year. Most of this water runs into the sewage main and is lost.

Your organisation has plants or vegetables that are watered from the mains supply costing your organisation money. You should consider installing water butts on down pipes to harvest rainwater and use this water instead. Depending on the amount of watering that you require, you could save up to 5,000 litres of water each year per water butt. Water butts usually cost around £25 to £35 each and are easily installed.

4.3 Monitoring, measuring and billing

The water meter is not read and recorded frequently. Reading your meter frequently not only helps you to be billed accurately by your supplier but can also help you to identify leaks and measure reductions in consumption.

Consumption figures or meter readings can be plotted into a simple graph and displayed so that building users can see how much they are consuming and the reduction in consumption when they try to save water. Readings should be recorded at regular intervals into a simple chart on a weekly or fortnightly basis. This can be done by your site manager at the same time each week as part of the opening or closing procedure.

Your organisation currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the organisation and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

4.4 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

5 Energy Management Plan

5.1 Summary of recommendations:

Howard Primary School can reduce energy costs by a minimum of £1640 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

5.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.
Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.
Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.
Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.
Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

5.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

5.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

5.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating. Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

5.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

5.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

6 Executive Summary Renewable Energy

6.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	×	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	No year round demand
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	×	• No available ground area • Incompatible heating system

Summary of feasible technologies

6.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Hall Roof							
Solar PV Sanyo Hybrid 6.93 kWp (41.3 m2)	5,371	2,310	376	34,650	17,325	600 (300)	92 (46)
Option 2. Main Roof							
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,441	1,050	171	18,900	9,450	720 (360)	111 (55)
Option 3. West roof							
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,255	1,400	228	25,200	12,600	720 (360)	111 (55)
Option 4. All roof spaces used							
Solar PV Sanyo Hybrid 14.28 kWp (85.2 m2)	11,068	4,759	775	78,750	39,375	680 (340)	105 (52)

The sustainable energy options

Options 1, 2 and 3
Both options 1, 2 and 3 represent individual installations of the technologies.

Option 4.
Option 4 offers the maximum carbon savings, using all available roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings.

6.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Howard Primary School with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

7 Roof and ground areas

7.1 Roof

The building has three south east facing roof areas. There is 49m^2 over the hall (excluding an area of skylight), a total of 24m^2 on either side of the cross gable of the main roof and 28m^2 over the west roof of the main building. There is some minimal shading from distant trees and proximity of buildings amounting to approximately a 2% loss of output. All these roofs are at the rear of the building but there is good vehicle access that would allow for scaffolding and equipment to be delivered. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies.

7.2 Ground Area

There is no 1710m^2 of available external ground area adjacent to the privately rented nursery block. This information will be used to assess the feasibility of Ground Source Heat Pump Installations.

8 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the Howard Primary School site in order to rule out unfeasible options.

8.1 List of feasibility criteria per technology

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Fuel supply chain	Has the existence of an established fuel supply chain been verified?	✓
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	×
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

9 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

9.1 Solar photovoltaics

9.1.1 Site Information

Trees on the other side of the playground may cause some slight shadowing, estimated at about 2%. A cross gable roof and parapet limits the available roof area on the rear roof of the main building to two sections on the main roof, either side of the cross gable.

Fuseboards are being upgraded, the suitability of the electrics should be appropriate for a PV installation but this should be checked by installers at the time of quotation.

9.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

9.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 6.93 kWp (41.3 m2)	5,371	2,310	376	34,650	17,325	600 (300)	92 (46)
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,441	1,050	171	18,900	9,450	720 (360)	111 (55)
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,255	1,400	228	25,200	12,600	720 (360)	111 (55)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the roofs are respectively pitched at 40° or 45° from horizontal and the panels would be oriented towards south-west (corresponding to a 95% relative output). Shadowing of the panels would further reduce the efficiency of the panels by approximately 2%

9.1.4 Life cycle cost implications
There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs.

Summary of options

9.2 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Installation and operational issues
Option 1. Hall Roof						
Solar PV Sanyo Hybrid 6.93 kWp (41.3 m2)	5,371	2,310	34,650	17,325	600 (300)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. Main Roof						
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,441	1,050	18,900	9,450	720 (360)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 3. West roof						
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,255	1,400	25,200	12,600	720 (360)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 4. All roof spaces used						
Solar PV Sanyo Hybrid 14.28 kWp (85.2 m2)	11,068	4,759	78,750	39,375	680 (340)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions

Options 1, 2 and 3
Both options 1, 2 and 3 represent individual installations of the technologies.

Option 4.
Option 4 offers the maximum carbon savings, using all available roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings.

10 Conclusion

The aim of this study is to provide Howard Primary School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

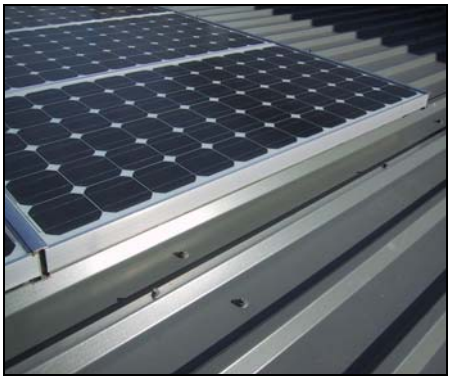
1 **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.

11 Annexes

11.1 Solar Photovoltaics (PV)

Solar photovoltaics

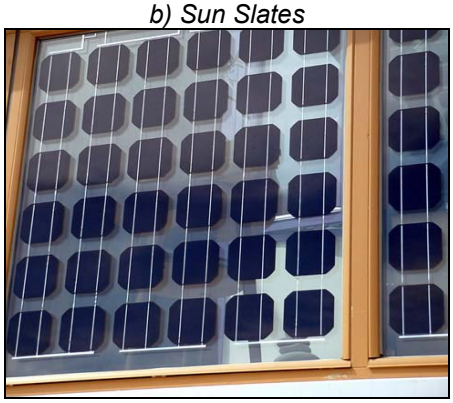
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

3 Cost includes supply and installation for >20kWp. Price per kWp will increase as system size decreases (by up to 20%). Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

Solar photovoltaics					
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year, although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Solar photovoltaics

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

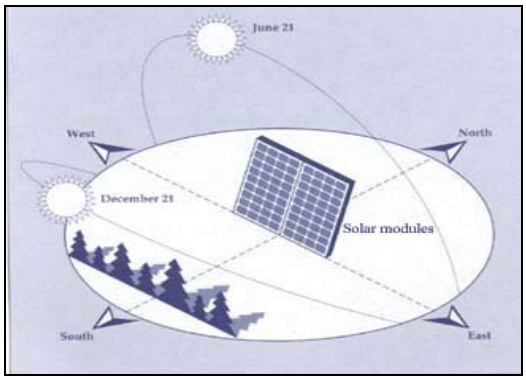
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

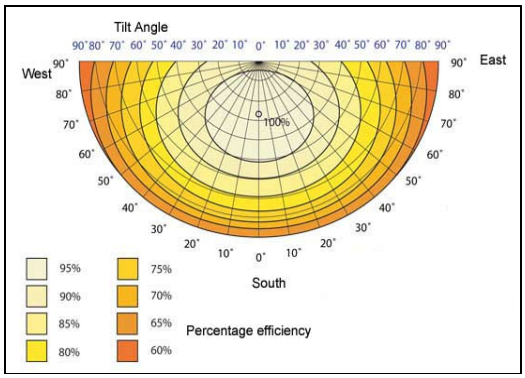
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

11.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions
Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Riddlesdown High School

Study completed by CEN

14/11/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce temperature and better control of heating	166,090	9,714	0	0
Control of Lighting	52009	4420	0	0
Conversion to energy efficient light	29249	2486	0	0
TOTAL[1]	**247,129**	**£16,600**	**0**	**0**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 247, 129kWh
- ✔ Achieve financial savings of £16,600 per year, and protect against future fuel price increases.

The specific measures recommended, financial information and technical details are of course included in the attached report. Please note that due to your projected decrease in energy costs due to the conversion from oil to gas, financial savings may not be as great as estimated.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Wind Turbine	5,819	2,502	20,000	200
Solar PV	149,193	64,153	837,900	546

- ✔ 5,819 kg of Carbon could be saved each year with the installation of a 2.5kW Wind Turbine system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Riddlesdown High School has approximately 2150 building occupants, and the building type has been classified as 'Education buildings Secondary' for the purposes of making comparisons with benchmark data.

2.1 Aerial Photo of the site (Microsoft ™)

From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards and also assess equipment and lighting.

During the audit it was noted that your school has recently replace the boiler system from an oil system to a gas system. This means that this energy audit has been based on the previous year's consumption.

2.2.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the heating controls and the way local temperatures are set would reduce energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report.

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

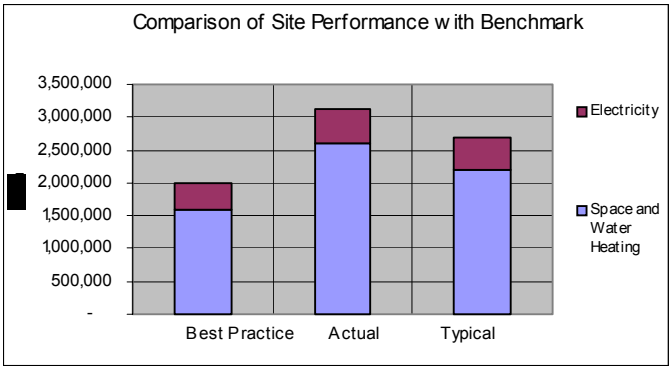
2.2.2 Energy Consumption

The current annual fossil fuel consumption of the site is 259,5190 kWh pa and the current electricity consumption is 520,090 kWh. This equates to costs of £151,778 and £44,210 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	520090	17	44,210	23	219480	25
Gas	563630	18	19,727	10	109340	13
Oil	2031560	65	132,051	67	536330	62

2.2.3 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:



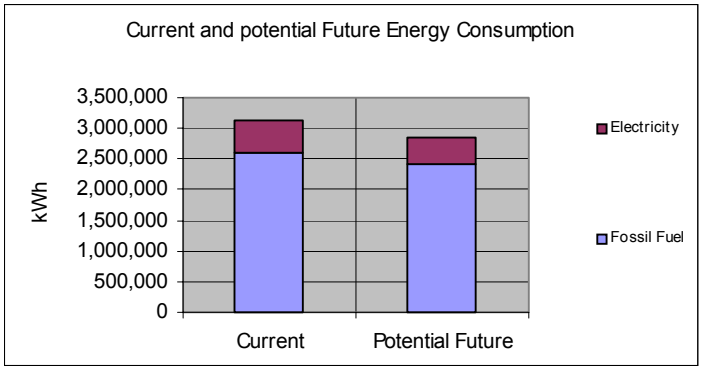
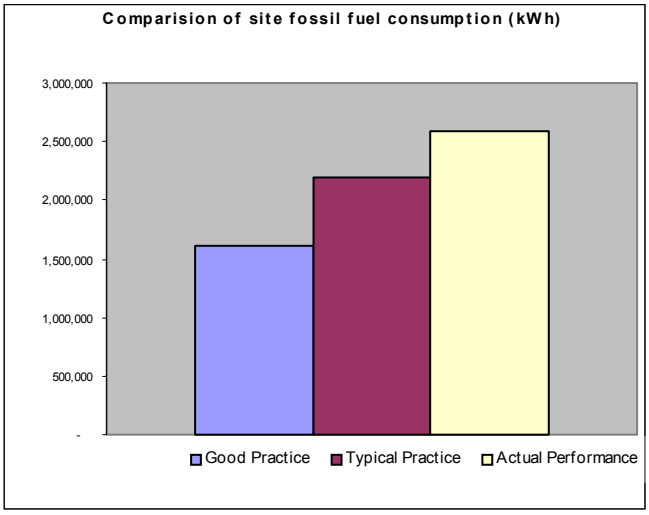


Chart 1-1 Current Energy Performance *Chart 1-2 Energy Saving Opportunities*

2.2.4 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



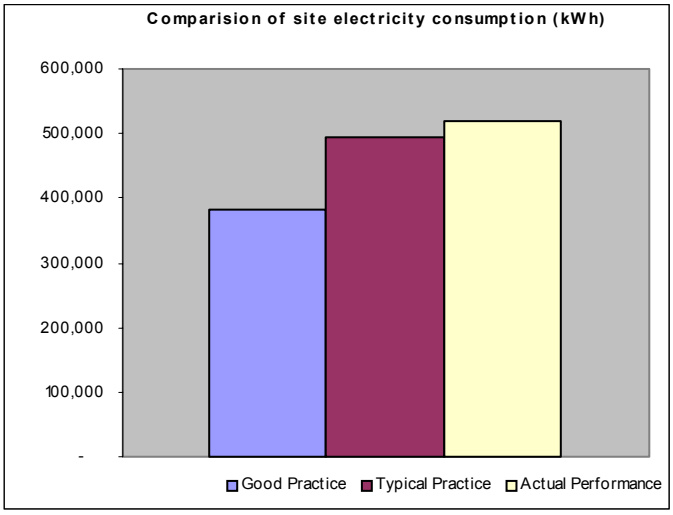


Chart 2-1 Heat consumption against benchmark, *Chart 2-2 Electricity consumption against benchmark*

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

2.2.5 Summary of Energy Performance Compared with Benchmark

Your site is not reaching best or typical practice consumption levels for either gas or electricity. There are large potential savings to be made at this site, by reducing consumption to be more inline with benchmarks. One of these has already been undertaken in the form of the changeover from inefficient, old oil boilers to new gas boilers. Specific measures to achieve this reduction are outlined later in the report. In addition, please call CEN on 020 8683 6600 for more information.

2.2.5 Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

As the school has just replaced the boiler system that controls a large proportion of the schools heat, the monitoring of the energy consumption is important. Have a monitoring system in place means that you can gauge the difference in your energy requirements when you are adjusting the heating level to find the optimal comfort for the staff and pupil. Another advantage of having this audit undertaken at now is that you can use the figure from this audit as a baseline to compare to next year's calculations.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system. Please note that cost and carbon projections are made using the previous year's consumption which was made up of a large proportion of oil, which is now no longer to be used as a fuel source.

• Better control & reducing your internal temperature could deliver a £9,714 saving pa with no investment.

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity.

Figure 1 Example of the windows being open

The current temperature settings for the school have been estimated, as there was no access to the boiler control settings at the school. However, based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 20 degrees. It was noted that with the new installation of the boiler that a comfortable temperature is yet to be reached. This is shown in figure 1 where almost all the windows are open despite it being November and the heating working in all the rooms. Where

overheating is an issue, staff should be trained to use TRVs (thermostatic Radiator Valves). It is noted that in high flow areas such as corridors TRVs are broken. In classrooms this is not an issue, but TRVs can be fitted with safety caps which staff are familiarised with.

Figure 2 Broken TRV

As classrooms are occupied all day, temperatures will increase in the afternoon, as such boiler run times should be reviewed to ensure that the building is starting to cool down towards the end of the day and boilers are shut down well before the building is closed.

If you reduce your building temperature by 3°, you could save around 166,090kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Zoning

Your school currently has zoning within the heating system. However, it is vital to monitor how the different zones work together, and if there are undesired variations between the zone temperature. This could lead to additional further savings and would address the problem of over and underheating experienced at the school.

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall. Most of the school has cavity walls which have been filled so no action needs to be taken on this measure.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Control of Lighting	52009	4420	0	0
T12 to T8 Conversion	29248	2486	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

By switching off unnecessary lights, you could potentially save 52009 kWh or £4420.This has been identified from our estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours.

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

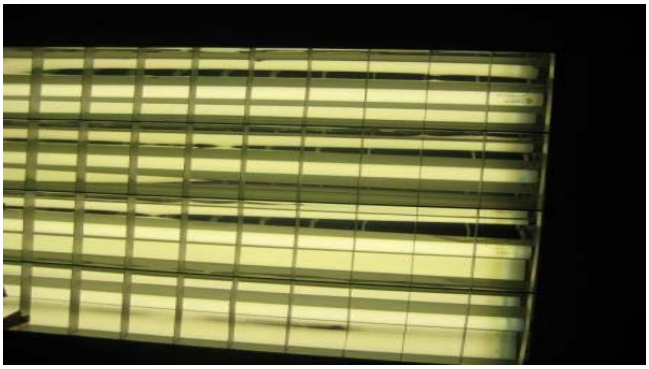
Standard tunsgsten lights and fluorescent lights are not the only bulbs which can be replaced by more energy efficient lighting. Further savings can be achieved through considering the other sources of light within your building. F Lamps and circular lamps can also be replaced by compact fluorescent lamps, and the most efficient types of metal halide, mercury, halogen or sodium lights should also be purchased when replacing old bulbs.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy

than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

2.3a A diffusers



2.3b A reflector

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Your school currently uses lighting sensors. It is important to check that these are correctly placed and maintained, to ensure their efficiency. Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Screensavers can be set to display a “turn me off” message if this would help staff. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Monitors were not set to hibernate mode which would automatically power computers down. This can be done to a variety of levels and require different re-start times to suit the level of use of a computer.

Figure 3 Monitors left on when computers not in use

Switching off equipment at night, such as television screens, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted

refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

You have identified that high energy using equipment within your school includes a IT Suite, Interactive white board. Therefore this equipment should be carefully monitored to ensure maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

3.6 Teachers and pupils awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.

Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

3.7 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy

saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Energy Management Plan

4.1 Summary of recommendations:

Riddlesdown High School can reduce energy costs by a minimum of £16,600 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.
Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.
Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.

Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced. Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.

Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)

Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.

Adopt better management of the heating and hot water systems to identify and reduce overheating. Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.

Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.

Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.

Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✓	• Sufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	• No year round hot water demand
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	×	• Incompatible heating system

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Pitched Roof							
Solar PV Sanyo Hybrid 6.3 kWp (37.6 m2)	5,086	2,187	610	31,500	15,750	576 (288)	52 (26)
Option 2. Wind turbine							
5kW Iskra	5,819	2,502	698	20,000	10,000	400 (200)	29 (14)
Option 3. All roof spaces used							
Solar PV Sanyo Hybrid 105.84 kWp (631.4 m2)	85,447	36,742	10,254	476,280	238,140	519 (259)	46 (23)

The sustainable energy options

Options 1 and 3

Both options 1 and 2 represent installation of solar PV. Option 1 demonstrates a single installation on the roof that is there easiest to access. Option 3 is the using all available roof space on the largest suitable roof area The larger of the installation, Option 3 (all roof space) offers the greatest carbon saving.

Option 2.

Option 2 shows the most viable option for a wind turbine. This system has the quickest payback time of all the wind turbines that are compatible with your site. It is recognised that the planning would be a greater issue as your school lies on a green belt, however this does not rule out the possibility of a successfully planning application.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Thornton Heath Early Years Centre with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has areas of both flat and pitched roofs. The flat roofs are largely overshadowed by the taller school buildings surrounding them. As the school is reasonably large in size there are numerous pitched roofs that are facing in a south-west direction. The pitch of these roof ranges from 20° to 35 °. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is available ground area situated at behind the main school buildings. This ground area is approximately 74 000 m^2. This information will be used to assess the feasibility of wind turbines and Ground Source Heat Pumps.

Feasibility study of the technologies
In this section, the technical viability of the following renewable technologies has been assessed for the Riddlesdown High School in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Riddlesdown High School would still wish to consider this technology as an option.

6.3 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	✓
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✓
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✓
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	✓
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓ *
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	×
Fuel supply chain	Is there an established fuel supply chain?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	✓
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×

Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

6.4 Additional feasibility elements

6.4.1 Photovoltaics

The roof will be overshadowed for a proportion of the day during the winter. This shadowing will limit the available roof area. Photovoltaics will be assessed for further feasibility in section 6.

6.4.2 Wind Turbines

The School is situated on a 'green belt'. This means that the planning application of the turbine will have to be adjusted to address this fact.

Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

7 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

7.1 Solar photovoltaics

7.1.1 Site Information

There is a lot of open space on the roof of the buildings. However, there is a proportion of the roof that is overshadowed by other building surrounding school buildings. This shadowing has limited the available roof space to place PV on and there will still be some reduction of performance related to these buildings (up to 5%)

7.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

7.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [$kgCO_2$/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 12.6 kWp (75.2 m2)	10,172	4,374	1,221	63,000	31,500	576 (288)	52 (26)
Solar PV Sanyo Hybrid 105.84 kWp (631.4 m2)	85,447	36,742	10,254	476,280	238,140	519 (259)	46 (23)
Solar PV Sanyo Hybrid 48.72 kWp (290.7 m2)	39,333	16,913	4,720	219,240	109,620	519 (259)	46 (23)
Solar PV Sanyo Hybrid 17.64 kWp (105.2 m2)	14,241	6,124	1,709	79,380	39,690	519 (259)	46 (23)
Solar PV Sanyo Hybrid 6.3 kWp (37.6 m2)	5,086	2,187	610	31,500	15,750	576 (288)	52 (26)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:

These outputs have been calculated assuming that the roof is pitched at 20 and 35 degrees from horizontal and the panels would be oriented towards south-west (corresponding to a 95% relative output).

7.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

7.2 Wind turbines

7.2.1 Additional Site Information

The ground around the school was largely free of obstructions. A few trees would cause some turbulence for the turbine, reducing the output of the turbine up to 5%. The wind speed at the site is 6.2 m/s at 25m, this measurement was taken from The Department for Business, Enterprise & Regulatory Reform wind database. Wind speed at potential hub height would be marginal, although this would be a highly effective awareness raising tool. There is a weather station at

the school and information from this was requested. Should the wind turbine option be pursued, information from the station would help to provide a more accurate feasibility study.

7.2.2 Product information

Wind turbines generate electricity. Wind turbines are available in a range of sizes and are suitable for many different applications and situations. Images of and further information about these products can be found in the annex.

7.2.3 Carbon savings and estimated costs

Data relating to the predicted performance of a range of turbines at the Riddlesdown High School can be found in Table 9-1. The information given is based on manufacturers' predicted output at a height above ground level of 25m.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC/yr]	Financial Savings	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per KG carbon saved [£/Kg]	Payback
2.5kW Proven	2,708	1,164	325	15,000	7,500	644 (322)	46 (23)
5kW Iskra	5,819	2,502	698	20,000	10,000	400 (200)	29 (14)
6kW Proven	7,161	3,079	859	28,350	14,175	460 (230)	33 (16)
Westwind 20kW	17,141	7,371	2,057	85,000	42,500	577 (288)	41 (21)

Table 9-1: Performance of standalone wind turbines located on the Riddlesdown High School site.

7.2.4 Life cycle cost implications

An engineer would need to give the turbine(s) a yearly maintenance check.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through Renewable Obligation Certificates (ROC's).

8 Summary of options

8.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgC/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per tonne carbon saved after LCBP grant [£]	Installation and operational issues
Option 1. Pitched Roof						

Sanyo Hybrid 6.3 kWp (37.6 m2)	5,086	2,187	31,500	15,750	£288	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. Wind Turbine						
5kW Iskra	5,819	2,502	20,000	10,000	£200	The turbine requires yearly maintenance check
Option 3. All roof spaces used						
Solar PV Sanyo Hybrid 105.84 kWp (631.4 m2)	85,449	36,742	476,280	238,140	£259	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions for Riddlesdown High School site

Options 1 and 3

Both options 1 and 2 represent installation of solar PV. Option 1 demonstrates a single installation on the roof that is there easiest to access. Option 3 is the using all available roof space on the largest suitable roof area The larger of the installation, Option 3 (all roof space) offers the greatest carbon saving.

Option 2.

Option 2 shows the most viable option for a wind turbine. This system has the quickest payback time of all the wind turbines that are compatible with your site. It is recognised that the planning would be a greater issue as your school lies on a green belt, however this does not rule out the possibility of a successfully planning application.

9 Conclusion

9.1 Going forward

The aim of this study is to provide Riddlesdown High School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Further feasibility work** - where the wind turbine option is pursued, further detailed feasibility study would be required.

10 Annexes

10.1 Wind Turbines

Wind turbines

Product information

a) Swift turbine Source: *Renewable Devices*

b) Stealth D400 turbine Source: *Stealth Gen*

Annex Figure 1: Domestic-scale building-mounted wind turbines

a) Quiet Revolution Source: *XCO_2*

b) Proven WT600 Source: *Proven*

c) Turby Source: *WinEUR*

d) Proven 6 Source: *Proven*

Annex Figure 2: Stand-alone or building-mounted wind turbines

- Converts the kinetic energy in wind into mechanical energy and electricity via a generator.

Wind turbines

- Horizontal vs. vertical axis turbines

The most common turbine type is a horizontal axis turbine, typically with between 3 and 5 blades. A number of vertical axis turbines are also on the market; this type of turbine is said to be able to cope better with changes in wind direction than horizontal turbines.

- Stand-alone vs. building-mounted turbines

Horizontal axis turbines have been developed by a number of manufacturers (see Annex Figure 1) specifically for use at a domestic scale. A number of horizontal and vertical axis turbines are available as stand-alone or building-mounted technologies, as shown in Annex Table 1.

Technical details

Technology	Manufacturer	Turbine (rotor) dimensions [m]	Roof clearance required [m]	Acoustic emissions
1No. Swift 1.5kW (horizontal axis)	Renewable Devices	2.1 (diameter)	0.5	<35 dB(A)
1No. StealthGen 0.4kW (horizontal axis)	Eclectic Energy	1.1 (diameter)	1.5-2.5	2-6 dB(A) above background
1No. Quiet Revolution 6kW (vertical axis)	Quiet Revolution	3.1 (diameter) 5m (height)	3	Under test
1No. Turby 2.5kW (vertical axis)	Turby B.V.	1.9 (diameter) 2.9 (height)	n/a	45dBA wind at 10m/s & 20m away

Annex Table 1: Technical information for building-mounted wind turbines

Energy generating capacity

- The output of a wind turbine over a year depends on the pattern of the wind over this time period, not just the average speed. The energy in the wind is not proportional to the wind speed i.e. if the wind speed doubles, the energy content is 2^3 = 2*2*2 = 8 times as high. Therefore, without a complete set of wind speed measurements for the site, only an estimation of energy production can be made.
- The electrical output of a wind turbine in dependent on the model, size and location. Generally, turbines that are integrated into a development will have a rated power of between 0.6kW and 15kW. On an ideal site, manufacturers suggest that a 15kW turbine could generate 15,000-30,000 kWh/year[4].
- Building mounted turbines are relatively new editions to the renewable energy market and are indicative of the move towards installing turbines in urban and suburban areas. However, field tests are currently being undertaken to fully assess the effectiveness of these turbines.

Wind turbines

Environmental requirements

Stand-alone wind turbine:

- Minimum average wind speed of 6m/s[5]
- Large area of open ground
- No airflow turbulence (e.g. from obstacles such as buildings or trees)

Building-mounted wind turbine:

- Minimum average wind speed of 4.5 m/s at hub height
- No high obstacles in the direction of the prevailing wind (generally south-westerly in the UK)
- According to some manufacturers, wind speed can be increased through a 'roof acceleration factor', which is maximised by designing a pitched rather than flat roof.
- Depending on the model, a wind turbine can be mounted on a flat roof, a pitched roof or against a supporting wall.
- Where several wind turbines are installed on the same roof, a minimum separation distance must be kept between them to avoid airflow turbulence (the distance required varies between models).

Building design requirements

- The building structure must be sufficient to support the forces exerted by a wind turbine. Liaison with structural engineers would be required to ensure that the building structure is suitable for the installation of building-mounted turbines and to assess where the turbine would best be positioned.
- A timber-frame building would require that additional reinforcements be integrated into the design.

Maintenance

- Maintenance of small-scale turbines is generally limited to visual assessments and an annual oil check, which in most cases can be incorporated into a site's annual maintenance schedule and does not require the turbine installer to be present.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- An **inverter** and **controller** converts raw power output by the wind turbine, direct current (DC) electricity, to alternating current (AC) at a quality and standard that is acceptable to the National Grid.
- An **export meter** in order to measure the quantity of any excess energy exported back to the National Grid.

Installation and planning issues

- Smaller turbines are generally designed to operation without a gearbox and with passive yawing systems, which reduce operational noise. Turbines make more noise in higher wind speeds, but because the background noise also increases, they are barely audible.
- Wind turbines currently require planning permission although it is hoped that, in future, small building-mounted turbines may be granted 'permitted development' status. It should be noted that wind turbines, being such a visual technology, provide a positive statement regarding sustainable energy both for a development and the local authority in which they are sited.

Wind turbines

Health and Safety issues

- Although designed to operate to very high standards of safety, some building mounted turbines have experienced technical issues and are currently being reviewed.

Estimated costs

- The capital cost of the turbine can be site-specific in that the cost of mounting the turbine can be a significant part of the overall cost.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

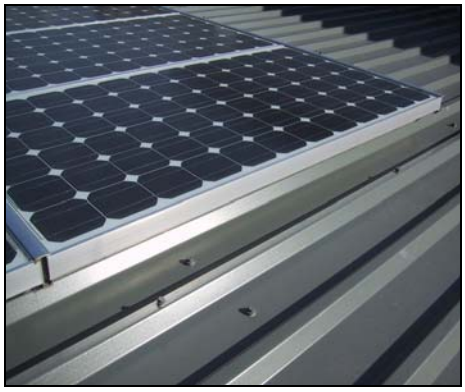
Additional Information

- **'Flicker'** is a phenomenon that occurs when the sun passes behind the blades of a wind turbine. The movement of the blades results in a flickering effect. The extent of the effect depends on the height of the sun, which changes during the year, and the size of the turbine.
- Vibrations may present issues with regard to noise. For building mounted turbines vibrations may also have structural implications, especially for larger turbines. These factors need to be considered before installation.

10.2 Solar Photovoltaics (PV)

Solar photovoltaics

Product information



a) Standard 'bolt-on' modules

b) Sun Slates

Solar photovoltaics

c) C21e

d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 3: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgC/kWp/yr]	Guideline cost[6] [£/kWp]	Guideline cost[6] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 2: Outputs of solar photovoltaic products

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 2. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Solar photovoltaics

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year, although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

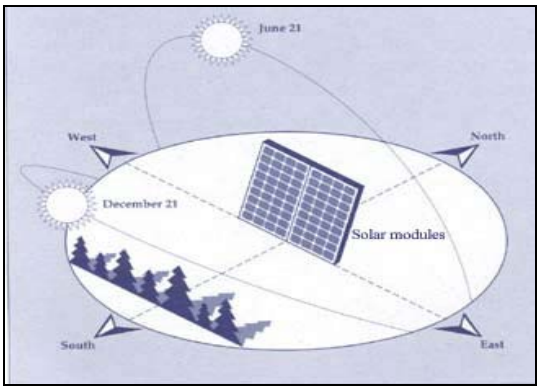
Solar photovoltaics

Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

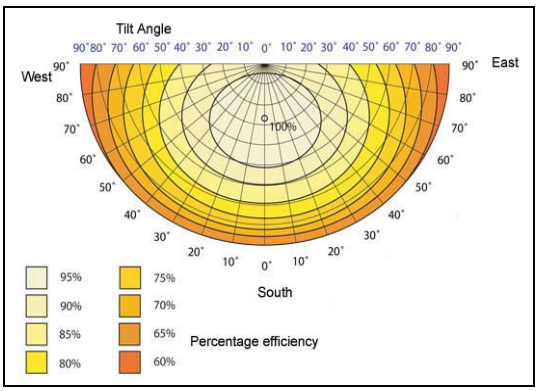
Additional Information

Annex Figure 4 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 4: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 5: The reduction in output of a solar PV panel as the tilt angle and orientations change.

10.3 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of ‘small generators’ in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Ridgeway Primary School

Study completed by CEN

11/5/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Control of Lighting	8748	740	0	0
Conversion to energy efficient lighting	8508	724	0	0
Switch Off Equipment	6561	558	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Double Glazing	3030	106	32020	302
TOTAL[1]	**26847**	**2130**	**32020**	**15**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 26847kWh
- ✔ Achieve financial savings of £2130 per year, and protect against future fuel price increases.

The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	5706	1592	89,250	626
Ground source Heat pump	5704	1546	32,544	285

- 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- 5,704 of Carbon could be saved by installing a Groundsource heat pump in to heat you areas that are currently heated by underfloor heating
- Implementing these renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed).

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Ridgeway Primary School has 778 building occupants, and the building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data.

2.1 Aerial Photo of the site (Microsoft ™)

From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and

2.2.1 Building age and tenancy, and the impact on opportunities for energy improvements

As the majority of your building is a relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and

control of energy using equipment is carefully considered to identify the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.2 Energy Consumption

The current annual gas consumption of the site is 398510 kWh pa and the current electricity consumption is 87480 kWh.

This equates to costs of £13,948 and £7,440 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	87,480	18	7,440	35	36,920	32
Gas	398,510	82	13,948	65	77,310	68

2.2.3 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

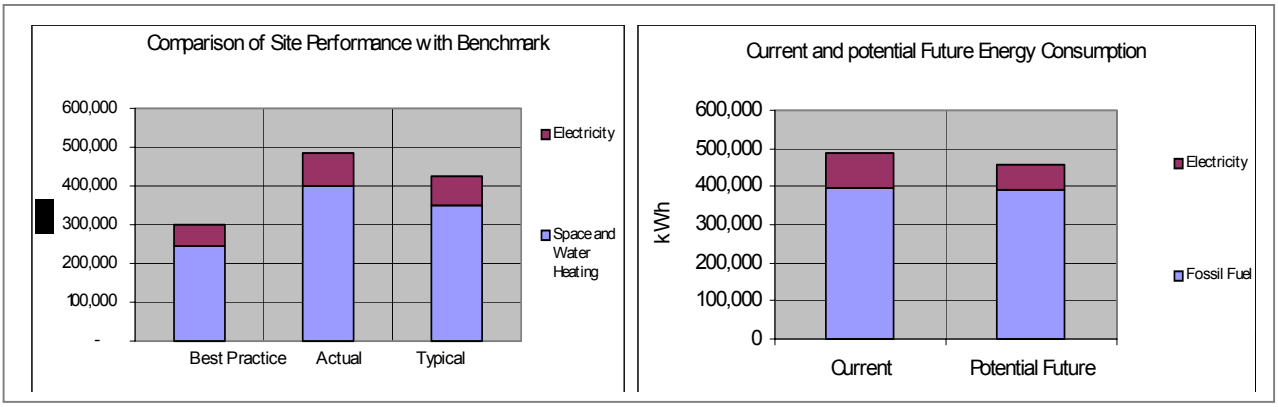


Chart 1-1 Current Energy Performance *Chart 1-2 Energy Saving Opportunities*

2.2.4 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.

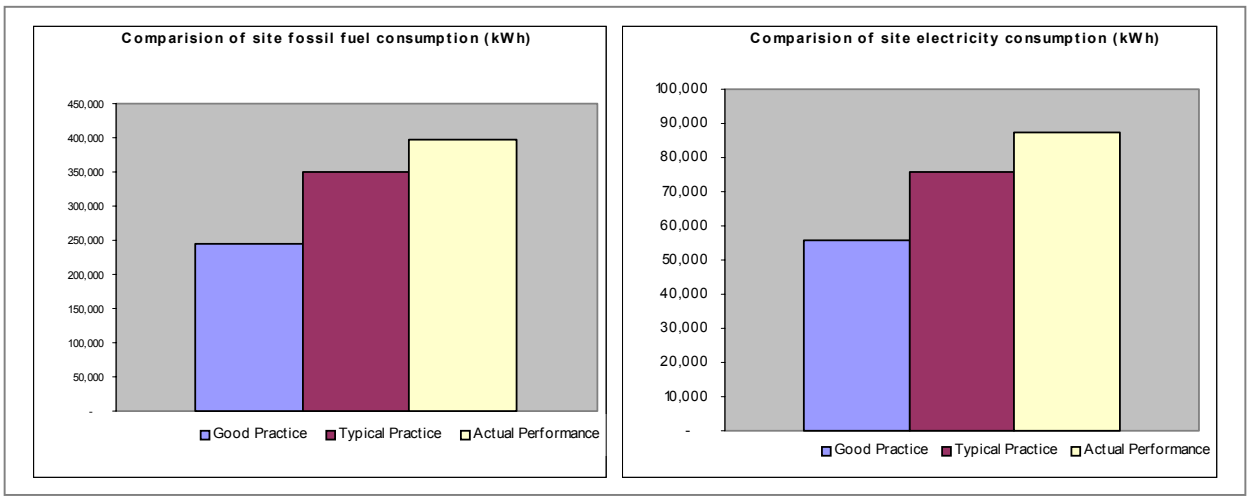


Chart 2-1 Heat consumption against benchmark, *Chart 2-2 Electricity consumption against benchmark*

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark

Your site is not reaching best or typical practice consumption levels for either gas or electricity. This may be due to unforeseen/unusual circumstances (for example equipment utilised by your organisation which is not typical of the sector), but is a clear warning to closely monitor your energy consumption. There are large potential savings to be made at this site, by reducing consumption to be more inline with benchmarks. Specific measures to achieve this reduction are outlined later in the report. In addition, please call CEN on 020 8683 6600 for more information.

Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

Your school has two different heating systems working under the same boiler. In the newest building there is an underfloor heating system and in the older building the heating is generated by radiators. This means that each area has to be treated differently in order to gain the most energy efficiency.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system:

• It was observed that your boiler and pipe work are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system.

2.2 Insulation waiting to be installed in the boiler room

• It was also observed that your underfloor heating thermostats are turned down by the staff to the minimal value, shown in figure 2.3 below.

Fig 2.3 Simply using controls effectively can save £'s at no or little cost

In order to get your heating to work the when you want it, it would be suggested that the staff are trained on the thermostat system of the under floor heating. This training would ensure that the staff know that regulation on the thermostat provides a more comfortable environment.
If this training still has no effect on regulating the temperature then it would be advised to contact your boiler company to reduce the temperature output on this system.

Zoning

Zoning of the heating system could be possible within your school, meaning that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This could provide savings through area-specific reductions in heating temperature.

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your school currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

Insulation Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Double Glazing	3030	106	32020	302

The windows within your building are not currently double-glazed, and therefore could be replaced by more thermally efficient windows. Glazing is one of the most expensive forms of insulation but has the added benefits of aesthetics and reduced condensation, as well as reduced energy consumption. By installing double-glazing, you could save £106 each year. Costs for double-glazing can vary widely so do shop around. Based on your glazing area, however, a price of £32,020 might be a guideline.

It was also identified that the windows are causing problems with draughts. This could be for a number of reasons but a low cost way of improving this is to remove all the paint on the window pane and re-apply this should lead to a better fit in the window frame.

Figure 1 Window does not tightly into the frame

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Control of Lighting	8748	740	0	0
T12 to T8 Conversion	8508	724	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

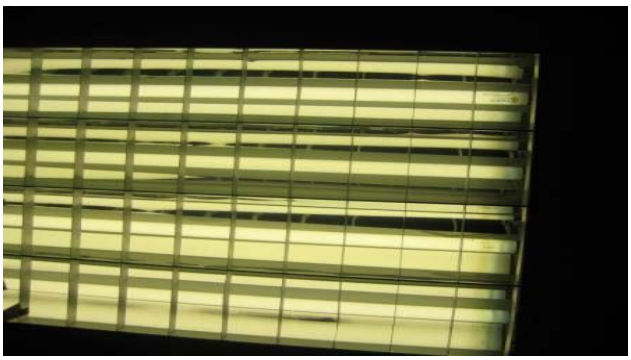
By switching off unnecessary lights, you could potentially save 8747 kWh or £740. This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can

be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights. It was noticed that the diffusers in the school where generally in need of a clean. This keeping these well maintained will increase their efficiency.

2.3a A diffusers



2.3b A reflector

Ridgeway Primary Building also contains a large number of skylights found throughout the school.,

Fig 2.4 Example of a skylight present at Ridgeway Primary

These skylights are a large source of natural light and in order to take full advantage of the benefit that they can offer they need to be maintained and clean regularly.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Screensavers can be set to display a “turn me off” message if this would help staff. Most printers and photocopiers have power save modes which are simple to use, and will automatically run at lower power when not in use. Monitors were not set to hibernate mode which would automatically power computers down. This can be done to a variety of levels and require different re-start times to suit the level of use of a computer.

Switching off equipment at night, such as projectors, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 6561kWh or £558 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

You have identified that high energy using equipment within your school includes a IT Suite, Interactive White Boards. Therefore this equipment should be carefully monitored to ensure maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Teachers and Pupils Awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report,

please contact CEN on 020 8683 6600 with your client reference to hand.

3.6 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Energy Management Plan

4.1 Summary of recommendations:

Ridgeway Primary School can reduce energy costs by a minimum of £2,130 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.

Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	×	• To close to local residents.
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	• No year round demand for hot water
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✓	• Available ground area • Compatible heating system

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. 8 ° Pitched Roof							
Solar PV Sanyo Hybrid 12.6 kWp (75.2 m2)	9,368	4,028	1,124	63,000	31,500	626 (313)	56 (28)
Option 2. 42 °Pitched Roof							
Solar PV Sanyo Hybrid 5.25 kWp (31.3 m2)	3,903	1,678	468	26,250	13,125	626 (313)	56 (28)
Option 3. GSHP							
Ground A 20.025 kWh	69,340	5,704	1,546	32,544	16,272	285 (143)	21 (11)
Option 4. All roof spaces used							
Solar PV Sanyo Hybrid – 12.6 kWp + Solar PV Sanyo Hybrid – 5.25 kWp	132721	5706	1592	89250	44625	626 (313)	56 (28)

The sustainable energy options

Options 1, 2 and 3

Both options 1,2 and 3 represent individual installations of the technologies. Option 3, the GSHP offers the greatest carbon saving.

Option 4.

Option 4 offers the maximum carbon savings, using both of the roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings. However, the payback and initial cost of this option is much larger than option 3.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Thornton Heath Early Years Centre with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has areas of pitched roofs. The first pitched roof that can be utilised is of an 8° inclination and has some shading due to vegetation; the area of roof that is un-shaded to 75m^2. There is a 45° pitched roof that is that is faces in a south east direction. As a result of this direction the PV will have a reduced output. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is available external ground area of a 4500m^2. This information will be used to assess the feasibility of Ground Source Heat Pump (GSHP) Installations

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for Ridgeway School in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Ridgeway School would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	✓
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✓
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	×
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	×
Fuel supply chain	Is there an established fuel supply chain?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	✓

Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	✓
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where piping could be installed?	✓

* Assuming that the design is defined to meet these criteria

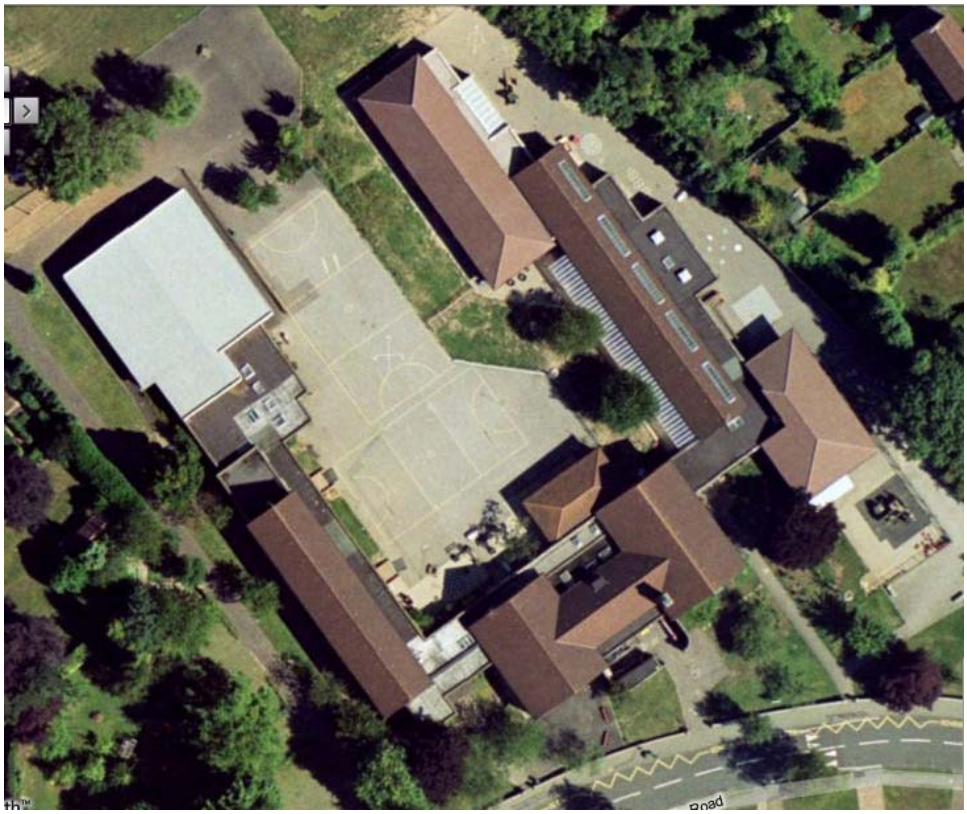
Table 5-1: Technical feasibility of each technology

7.2 Additional feasibility elements

7.2.1 Photovoltaic's

The one area of available roof will be overshadowed for a proportion of the day. This shadowing will limit the available roof area. Photovoltaic's will be assessed for further feasibility in section 6.

Wind Turbines, Solar Thermal, and Biomass will not be taken forward for further assessment



8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaic's

8.1.1 Site Information

There is a lot of open space on the roof of the buildings. However, there is a significant amount of roof that will be overshadowed by vegetation on the flatter of the two roofs. This shadowing has limited the available roof space to place PV on and there will still be some reduction of performance related to these buildings (up to 5%)

8.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 12.6 kWp (75.2 m2)	9,368	4,028	1,124	63,000	31,500	626 (313)	56 (28)
Solar PV Sanyo Hybrid 5.25 kWp (31.3 m2)	3,903	1,678	468	26,250	13,125	626 (313)	56 (28)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:

These outputs have been calculated assuming that the flatter roofs would be have the panels mounted on an A-frame pitched at 40 degrees or The roof is pitched at 42 degrees from horizontal and the panels would be oriented towards south-west (corresponding to a 95% relative output). Shadowing of the panels would further reduce the efficiency of the panels by approximately 5%

8.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROC's

8.2 Ground Source Heat Pumps

8.2.1 Additional Site Information

The ground around Ridgeway Primary School is suitable for both vertical and horizontal heat collection systems. Suitable ground is available next to the new build that has underfloor heating, compatible with GSHP.

8.2.2 Product information

Ground Source Heat Pumps generate hot water that can be used in a wet heating system. The Ground source heat uses the Earth as either a heat source, when operating in heating mode, or a heat sink, when operating in cooling mode. Images of and further information about these products can be found in the annex.

8.2.3 Carbon savings and estimated costs

Data relating to the predicted performance of a range of ground source heat pump at the Ridgeway School can be found in Table 9-1.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Financial Savings	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per KG carbon saved [£/Kg]	Payback
Ground A 20.025 kW	69,340	5,704	1,546	32,544	16,272	285 (143)	21 (11)

Table 9-1: Performance of standalone GSHP at the site

8.2.4 Life cycle cost implications

The system maintenance of a GSHP is minimal. The piping infrastructure, like utility piping infrastructures, rarely requires maintenance. Only the pump may require maintenance work and it is easily accessible. An annual check on the pressure is required; this check can be undertaken by the site owner.

Summary of options

8.3 Renewable Technology solutions

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. 8 ° Pitched Roof							
Solar PV Sanyo Hybrid 12.6 kWp (75.2 m2)	9,368	4,028	1,124	63,000	31,500	626 (313)	56 (28)
Option 2. 42 °Pitched Roof							
Solar PV Sanyo Hybrid 5.25 kWp (31.3 m2)	3,903	1,678	468	26,250	13,125	626 (313)	56 (28)
Option 3. GSHP							
Ground A 20.025 kWh	69,340	5,704	1,546	32,544	16,272	285 (143)	21 (11)
Option 4. All roof spaces used							
Solar PV Sanyo Hybrid – 12.6 kWp + Solar PV Sanyo Hybrid – 5.25 kWp	13541	5706	1592	89250	44625	626 (313)	56 (28)

The sustainable energy options

Options 1, 2 and 3

Both options 1,2 and 3 represent individual installations of the technologies. Option 3 the GSHP offers the greatest carbon saving.

Option 4.

Option 4 offers the maximum carbon savings, using both of the roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings to meet Croydon Council's aim of reducing emissions by 15%. However, the payback and initial cost of this option is much larger than option 3. For this reason option 3 will be put forward for the Local Authority Energy Finance (LAEF) scheme.

9 Conclusion

9.1 Going forward

The aim of this study is to provide Ridgeway Primary School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

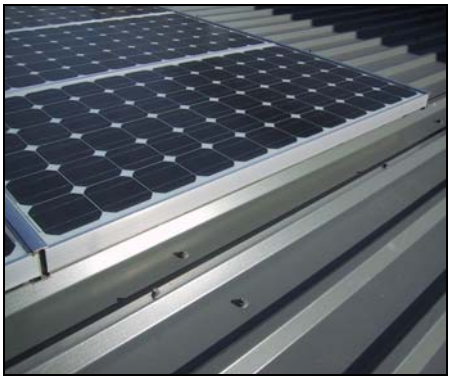
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Obstructions around the building -** large trees around the site means some overshadowing of some of the roof area where solar panels could be mounted.
3. **Further feasibility work** - where the ground source heating option is pursued, further detailed feasibility study would be required.

10 Annexes

10.1 Solar Photovoltaics (PV)

Solar photovoltaics

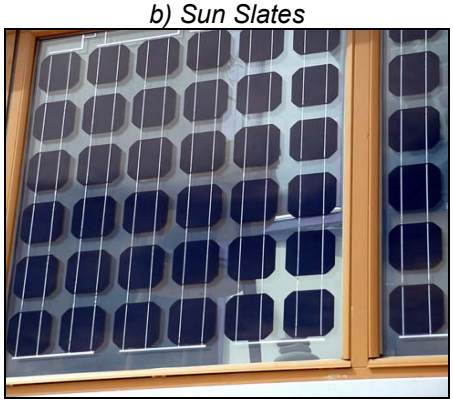
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO_2/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year, although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Solar photovoltaics

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

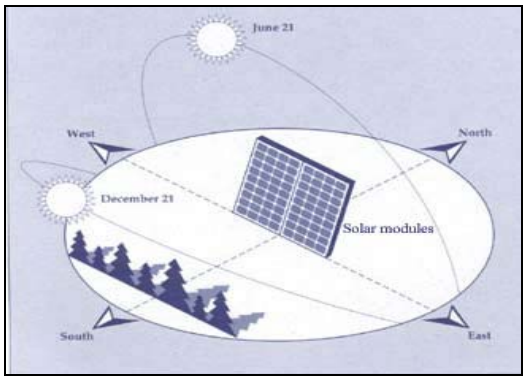
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROC's.

Solar photovoltaics

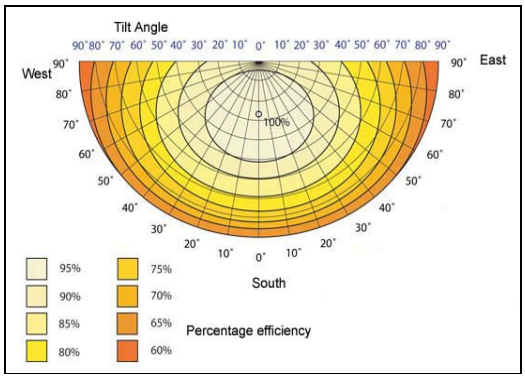
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 2: Solar variations throughout the year



***Source:* Solar Access**

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

10.2 Ground Source Heating

Ground source heating

Product information

a) GSHP pipe work
Source: Geoscience Ltd.

b) Pump housing and buffer tank
Source: Geoscience Ltd.

Annex Figure 4: Ground source heating pipe work and pump

- Ground source heating is a tried, tested and reliable means of providing space heating to buildings and is most often combined with under-floor heating. Such a heat distribution system is efficient due to low flow and return temperatures, and offers high levels of comfort for building occupants.
- A ground source heating system comprises piping buried beneath the ground (horizontally or vertically) and a heat pump to extract the heat.
- At a depth of a few metres, the temperature of the ground remains at a constant 12°C throughout the year. This constant temperature is the benefit of ground source heating over air source heating, as the installed pump is able to work at its optimal coefficient of performance (CoP). The CoP is the ratio of the units of heat energy 'out' to the units of electricity 'in', required for circulating the fluid and operating the heat pump. Piping can either be laid horizontally or vertically through borehole drilling. Fluid circulating through the pipes, extract heat from the surrounding earth. The warmed fluid runs through the heat exchanger in the heat pump, which operates in a similar way to a 'reverse' refrigerator. The heat pump raises the temperature of the fluid. This fluid, with an 'upgraded' temperature, can then be used for underfloor heating.

Ground source heating

Technical details

- **Vertical closed loop fields** – a borehole is drilled to a depth of between 15 to 100 metres. The size of the overall system will depend on the space heating requirements.
- **Horizontal closed loop fields** – pipes are buried in horizontal trenches which are dug to a depth of 1 – 2 metres.
- **Open loop fields** - water does not return once it passes through the system.
- The flow temperature of underfloor heating, around 45°C, is lower than that required for domestic hot water at 50-60°C. The Coefficient of Performance (COP) of the pump, which is the ratio of the units of heat out to units of electricity in, will be lower when generating hot water compared to when supplying space heating.
- The heat pump housing would be similar in size to a large refrigerator, although different manufacturers use different system configurations. There would have to be sufficient space for maintenance and repair access.
- By operating the ground source heat pump overnight and storing the heat in a thermal store, users may be able to take advantage of cheaper electricity tariffs.

Energy generating capacity

- The ground source heat pump should have a CoP of 3 or more, in order to gain good carbon savings. That means that for every unit of electricity put into the system, 3 units of heat are produced. The water produced is a 'low-grade' temperature, around 40°C, which is unsuitable for traditional radiator systems that require much higher water temperatures. However, it is ideal for underfloor heating.
- Ground source heat pumps can also be used for heating water, although not all manufacturers recommend this configuration. Heating water to a useful temperature means that the CoP reduces i.e. the system becomes less efficient. If heat pump systems are to be used for space and water heating, it is preferable that they run from different pumps. In this way, when the heating demand is low, one pump can be turned off rather than run at part load.

Environmental requirements

- Vertical drilling may be possible in areas that are free from obstructions. Where possible, borehole drilling on contaminated land should be avoided, although methods of boring in such areas have been developed.
- A ground survey is required in order for the system to be correctly sized, as the rate of heat transfer will be dependent on soil properties. A drilling license may also be required.
- Laying the pipes horizontally in trenches is cheaper than boring vertical boreholes. However, a large area of open ground is required.

Building design requirements

- Horizontal pipes can be buried beneath paving and car parks but are generally not laid beneath buildings.
- Sufficient space for the pump and buffer tank is required.

Maintenance

- System maintenance is minimal. The piping infrastructure, like utility piping infrastructures, rarely requires maintenance. Only the pump may require maintenance work and it is easily accessible.

Ground source heating

Auxiliary equipment required

- Thermal store
- Low grade temperature heat distribution system

Installation and planning issues

- The pipes, buried below ground, do not require maintenance. The only visible part of a ground source heating system is the pump itself, which can be housed in a container about the size of a refrigerator and can be easily accessed should any maintenance be required.
- If a ground source heat pump is to be installed, it should be considered from the earliest stages in a development's design process, as a suitable heating system needs to be installed.

Estimated costs

- Electricity is required to operate the pump. Installing a heat pump to replace a gas-fired heating system is less economically favourable than one replacing electrical or oil heating systems. Vertical bore holes are more expensive than horizontal trenches.

Additional Information

- **Ground source cooling** is the inverse of the ground source heating system and operates, in effect, like a large refrigerator. One system can be installed to operate as a heating and cooling system. Such a system can increase the CoP, as during the cooling cycle, heat is put back into the ground to be extracted again later during the heating cycle.
- Natural and passive ventilation should be considered before mechanical ventilation. Air conditioning should not be encouraged, especially on residential developments, due to the environmental impact it would have.

10.3 Financing low and zero carbon technologies

Financing low and zero carbon solutions
Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for St James the Great

Study completed by CEN

10/20/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following table provides the key recommendations for your school.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Control of Lighting	9596	820	0	0
Conversion to energy efficient lighting	9298	791	0	0
Switch Off Equipment	7197	612	0	0
TOTAL[1]	**26091**	**2220**	**0**	**0**

Our initial assessment indicates with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 26091kWh
- ✔ Achieve financial savings of £2220 per year, and protect against future fuel price increases.

Our initial analysis suggests that there would be no insulation cost and therefore no payback period for the suggested measures. The specific measures recommended, financial information and technical details are of course included in the attached report.

1.2 Renewable Energy Options

The following table provides key renewable options available to your organisation. It was noted that you organisation already had a array of solar PV which was installed 2004. Your school is therefore aware that renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. The solar PV that is being suggested below would be a increase of your exsiting array. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	50

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets CEN can then provide access to grant funding and discounted installations (should you wish to proceed).

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. The first priority in considering a energy reform is reducing the need for this energy, and then using this energy more efficiency. The next consideration after implementation of the low/no cost scheme's is renewable energy. As your school already knows renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

St James the Great has 480 building occupants, and the building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data. From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment.

2.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore, your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2 Energy Consumption

The current annual gas consumption of the site is 207800 kWh pa and the current electricity consumption is 95960 kWh. This equates to costs of £7273 and £8160 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	95960	32	8160	53%	40500	50
Gas	207800	68	7273	47%	40310	50

2.3 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

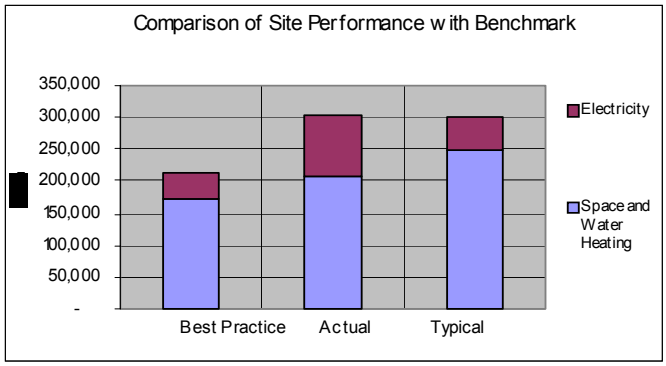

Chart 1-1 Current Energy Performance

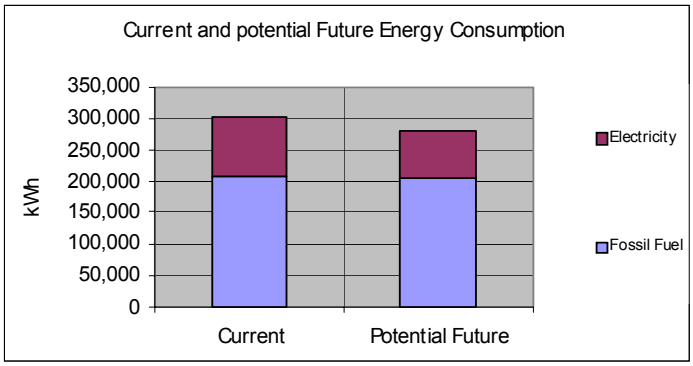

Chart 1-2 Energy Saving Opportunities

2.2.1 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.

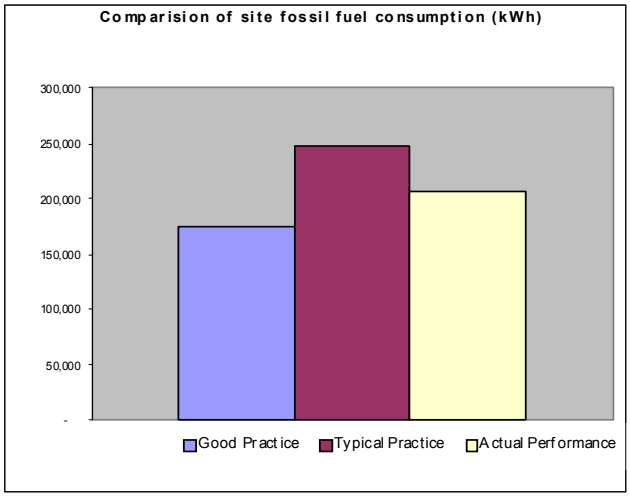

Chart 2-1 Heat consumption against benchmark,

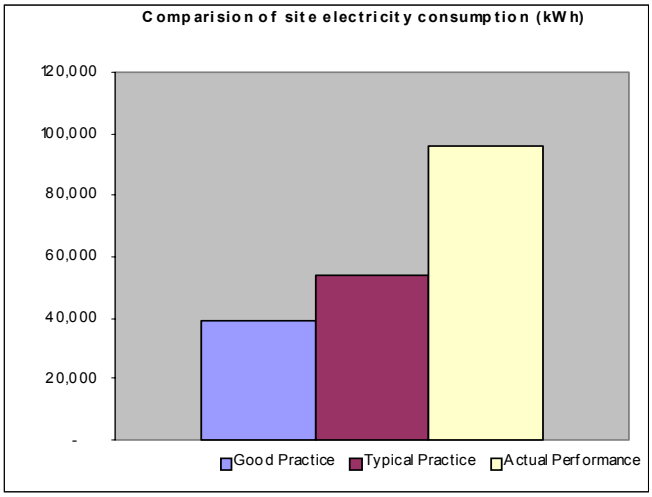

Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

2.3 Summary of Energy Performance Compared with Benchmark

The site could potentially improve its electricity consumption levels as they are currently above typical consumption levels for your sector. Particular areas of this report to consider include lighting and machinery, and ensuring that equipment is turned off when not in use, and power is not wasted.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• It was noted that there are locks over the Thermostactic Radiator Values (TRV's), for child safety, that can only be changed by the site manager. Teacher training on how to change the temperature on the TVR's will save energy, as it will encourage the teachers to reduce the temperature rather than open windows.

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

• It was observed that your boiler and pipework are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system.

- Several windows were open whilst the heating was on suggesting that the temperature is set too high.

Zoning

There is 5 heating zone system installed in your school,. This means that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This could provide savings through area-specific reductions in heating temperature. This zoning control should be reviewed with the heating management company to help overcome the overheating problems that you presently suffer from in some of the classrooms.

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall. Insulation type, cost and efficiency will vary greatly according to the type of building structure your school currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Control of Lighting	9596	£820	£0	0.0
T12 to T8 Conversion	9298	£791	£0	0.0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building or room unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting. This would a potentially be relativity easy for your school as you have zone lighting present in all the rooms. This zoned lighting in the building would enable, when daylight is sufficient, lights nearest the windows should be switched off whilst those deeper in eth room can be left on to create an even light throughout the room.

By switching off unnecessary lights, you could potentially save 9595.8 kWh or £820.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. Another low/no cost measure is to swirch of lights that are on in rooms with skylights present during day light hours.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs,

specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Screensavers can be set to display a “turn me off” message if this would help staff. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Monitors were not set to hibernate mode which would automatically power computers down. This can be done to a variety of levels and require different re-start times to suit the level of use of a computer.

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 7197kWh or £612 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

You have identified that high energy using equipment within your school includes a IT suite and interactive white board. Therefore this equipment should be carefully monitored to ensure maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

In addition, your school hours may suit different energy tariffs. For example a day/night tariff will help you achieve savings if your organisation often operates through the night.

3.6 Teachers and Pupils Awareness and School Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.

Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

3.7 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Energy Management Plan

4.1 Summary of recommendations:

St James the Great can reduce energy costs by a minimum of £2,220 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.

Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.

Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.

Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)

Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.

Adopt better management of the heating and hot water systems to identify and reduce overheating.

Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.

Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.

Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.

Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:
Renewable Energy Appraisal

4 Executive Summary Renewable Energy

4.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• No year round demand for hot water
Wood-fuel heating	Thermal	✗	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✗	• No available ground area • Incompatible heating system

Summary of feasible technologies

4.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Adding to Original Display							
Solar PV Sanyo Hybrid 14.7 kWp (87.7 m2)	11,868	5,103	1,424	73,500	36,750	576 (288)	52 (26)
Option 2. Pitched Roof							
Solar PV Sanyo Hybrid 7.35 kWp (43.9 m2)	5,934	2,552	712	36,750	18,375	576 (288)	52 (26)
Option 3. All roof spaces used							
Solar PV Sanyo Hybrid – 14.7 kWp + Solar PV Sanyo Hybrid – 7.35 kWp	17,801	7,655	2,136	110,250	55,125	576 (288)	52 (26)

The sustainable energy options

Options 1 and 2
Both options 1 and 2 represent individual installations of the technology. The larger of the installation, Option 1 (adding to original display) offers the greatest carbon saving.

Option 3.
Option 3 offers the maximum carbon savings, using both of the roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings.

4.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist St James the Great with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

5 Roof and ground areas

5.1 Roof

There are two available areas of pitched roof. One already houses an array that was installed in 2004, however there is space for addition PV to be installed. There is another south facing roof, but as there is a deciduous tree to the south of the building which would present significant shading issues particularly during the summer when the tree was in full foliage.

5.2 Ground Area

There is a 7500 m2 outside area that is owned by St James the Great. This information will be used to assess the feasibility of Ground Source Heat Pump Installations.

6 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the St James the Great School site in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if St James the Great School would still wish to consider this technology as an option.

6.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✓
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✓
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	×
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	×
Fuel supply chain	Is there an established fuel supply chain?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×

Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	×
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	✓
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

6.2 Additional feasibility elements

6.2.1 Photovoltaic's

Part of the roof will be overshadowed for a proportion of the day during winter. This shadowing will limit the available roof area. Photovoltaics will be assessed for further feasibility in section 6.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

7 Renewable Technology Assessments

7.1 Solar photovoltaics

7.1.1 Site Information

The school is situated on a large plot of owned land this decreases the disturbance to local residents. There are two available pitched roofs that face in a southerly direction that could accommodate a PV array. Once of these roofs already houses an installation from a 2004 project.

7.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

7.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Adding to Original Display							
Solar PV Sanyo Hybrid 14.7 kWp (87.7 m2)	11,868	5,103	1,424	73,500	36,750	576 (288)	52 (26)
Option 2. Pitched Roof							
Solar PV Sanyo Hybrid 7.35 kWp (43.9 m2)	5,934	2,552	712	36,750	18,375	576 (288)	52 (26)
Option 3. All roof spaces used							
Solar PV Sanyo Hybrid – 14.7 kWp + Solar PV Sanyo Hybrid – 7.35 kWp	17,801	7,655	2,136	110,250	55,125	576 (288)	52 (26)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the roofs are pitched at 35 and 20 degrees from horizontal and the panels would be oriented towards south (corresponding to a 99% and 95% relative output respectively). Shadowing of the panels would further reduce the efficiency of the panels by approximately 5%

7.1.4 Life cycle cost implications
There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

Summary of options

7.2 Renewable Technology solutions

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
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Option 3. All roof spaces used							
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Table 7-1: Renewable energy solutions for the St James the Great site

7.3 Options 1 and 2

Both options 1 and 2 represent individual installations of the technology. The larger of the installation, Option 1 (adding to original display) offers the greatest carbon saving.

Option 3.

Option 3 offers the maximum carbon savings, using both of the roof spaces. The site uses considerably more electricity than the PV panels produce, so the largest possible installation size will provide the greatest carbon savings to meet Croydon Council's aim of reducing emissions by 15%.

8 Conclusion

8.1 Going forward

The aim of this study is to provide St James the Great School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

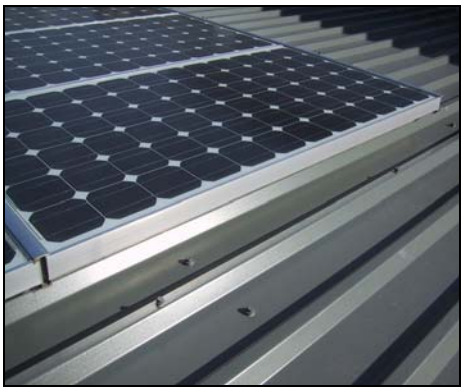
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Awareness raising** – As the school already has an existing installation, an increase in this would not provide an increased community awareness raising opportunity.
3. **Existing installation** – the existing installation already occupies the optimum roof position.

9 Annexes

9.1 Solar Photovoltaics (PV)

Solar photovoltaics

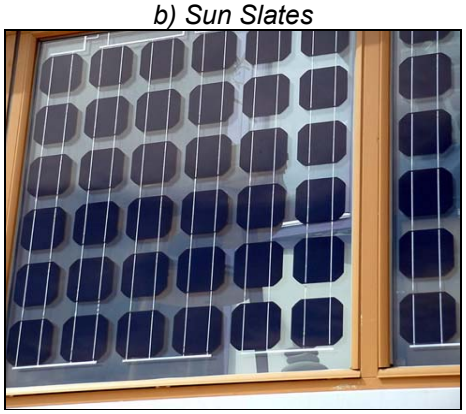
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO_2/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year, although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Solar photovoltaics

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

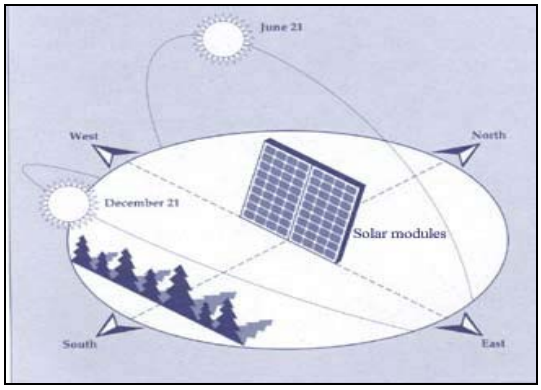
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

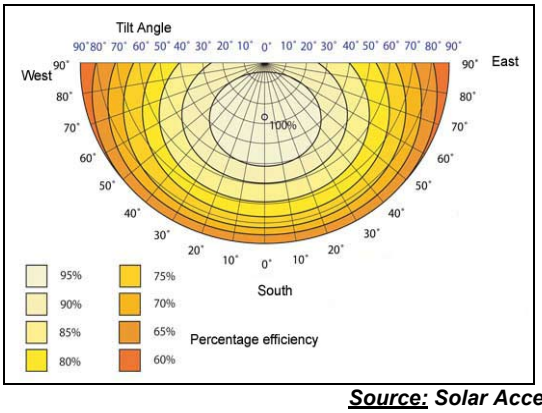
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

creative environmental networks

Sustainable Energy Report for Thornton Heath Children's Centre

Study completed by CEN

10/14/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	1540	131	0	0
Control of Lighting	1440	120	0	0
T12 to T8 Conversion	1230	105	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Cavity Wall Insulation	1000	80	580	7
TOTAL[1]	**5210**	**440**	**580**	**1**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 5210kWh
- ✔ Achieve financial savings of £440 per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures could be as low as £580. This would imply a simple pay back of only 1 year. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	50

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Thornton Heath Children's Centre has 100 building occupants, and the building type has been classified as ‘Education buildings Primary’ for the purposes of making comparisons with benchmark data.
From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.1 Energy Consumption

The current annual gas consumption of the site is 4320 kWh pa and the current electricity consumption is 67670 kWh. This equates to costs of £151 and £5,750 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	67670	94	5,750	97	28560	97
Gas	4320	6	151	3	840	3
Oil	0	0	0		0	0

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

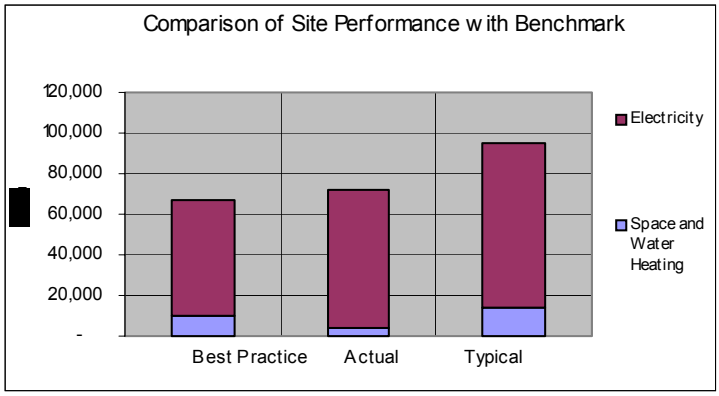


Chart 1-1 Current Energy Performance

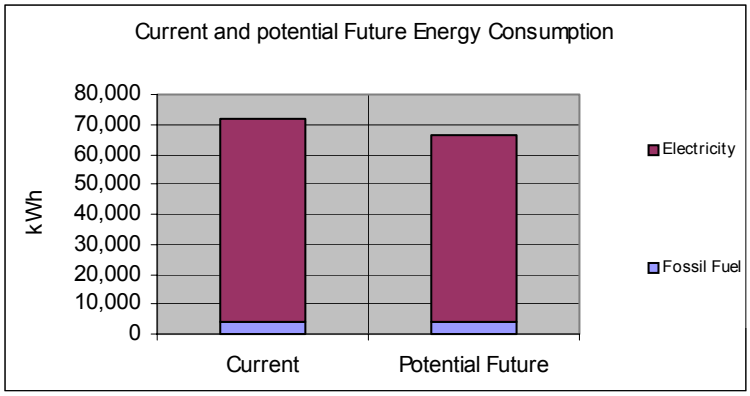
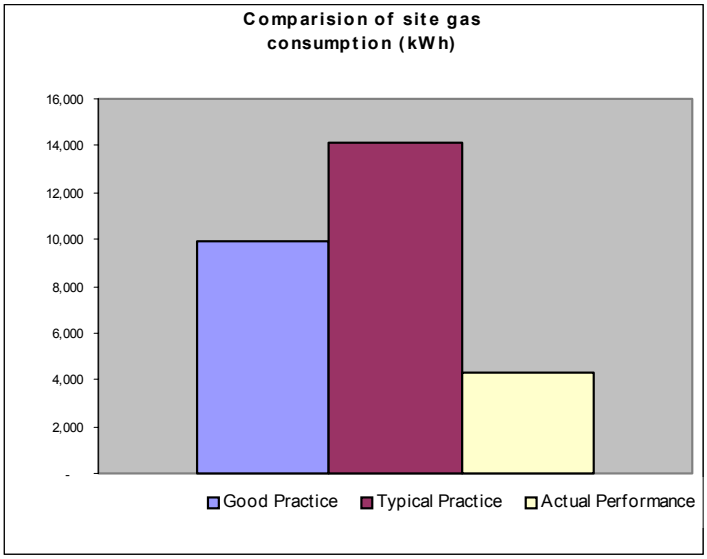


Chart 1-2 Energy Saving

2.2.3 Opportunities

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



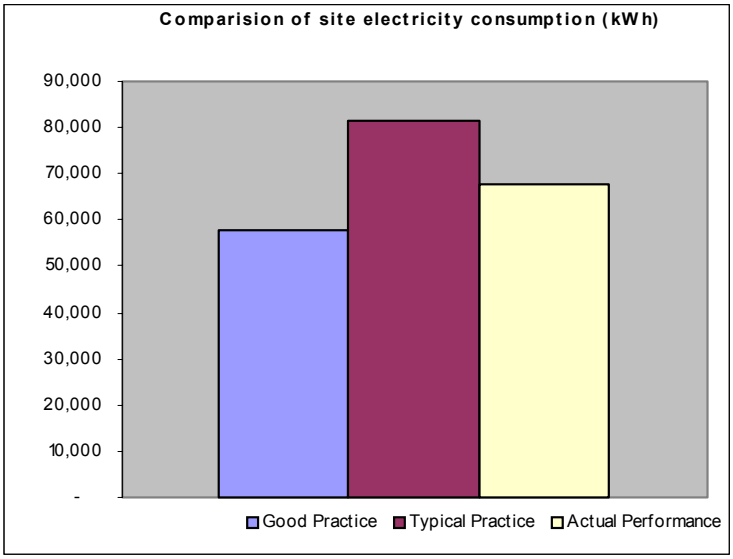


Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Please note that you did not enter your energy costs, and so these have been estimated based on current typical market prices. We

also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark

The site is performing well according to typical consumption within similar buildings in the same sector. Best practice involves a greater level of energy efficiency and associated cost savings, and therefore should be strived for as an overall target, by incorporating the measures detailed in this report. Gas constitutes a very small part of your energy consumption and the focus should be on your electricity usage which has not yet reached good practice. It is very important to reduce waste and not be complacent with regards to energy usage. Therefore the measures detailed in this report have identified additional improvements you can make, and will help you save money and improve efficiency.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation. As all heating is providing by electricity this constitutes the majority of your energy costs. Electricity is an expensive way to provide heating and should be a focus for energy efficiency.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better could deliver a £131 saving pa with no investment. Staff should be trained on the correct use of room thermostats as these have been set to a variety of temperatures. It appears that staff set thermostats to very low (one thermostat was turned to 1°) when the room is too warm and overly high when the room is too cold. Thermostats should be set to the desired temperature and the heating system will automatically adjust to deliver this.

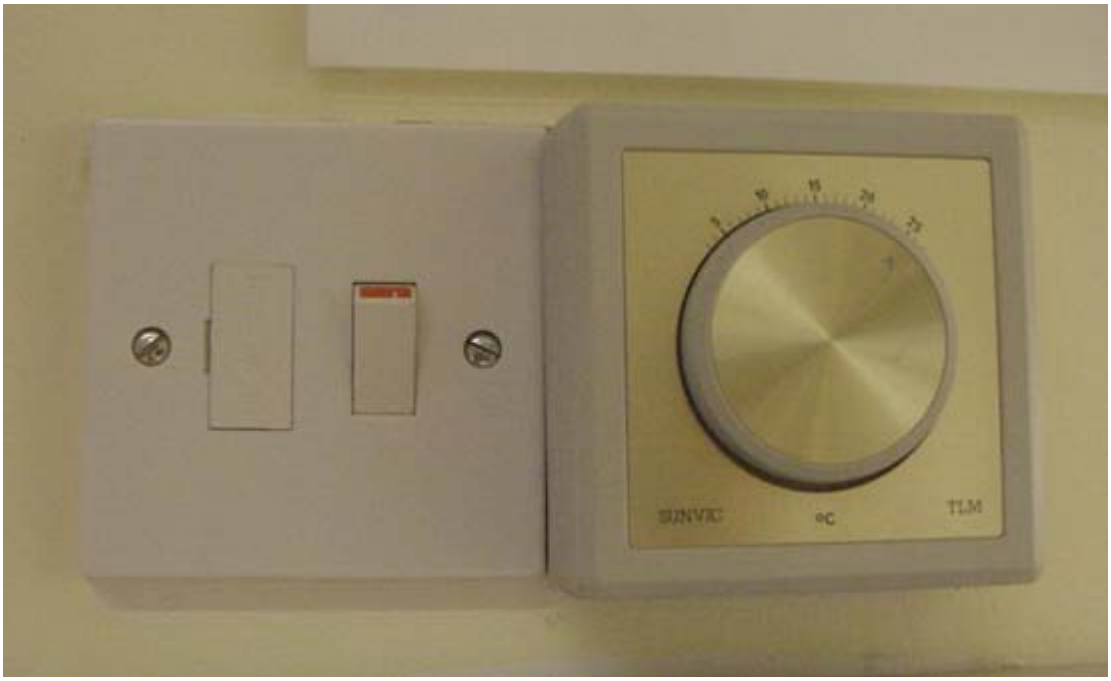


Figure 1 Thermostat set to 25°

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity.

Zoning

Your school currently has zoning within the heating system. However, it is vital to monitor how the different zones work together, and if there are undesired variations between the zone temperature. This could lead to additional further savings.

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your school currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and

recommend installers, please call 020 8683 6600 for more information on insulation measures.

Insulation Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Cavity Wall Insulation	1000	80	580	7

It was observed that you have cavity walls, but it is not known if you have cavity wall insulation. This is one of the most cost effective forms of insulation, and can provide a good return on investment, as highlighted in the table above.

Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. It was suggested that PVC strip curtains could be installed where doors need to be left open to ensure free flow.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings				
Control of Lighting	1440	120	0	0
T12 to T8 Conversion	1230	105	0	0
Energy Efiicient Lighting	390	33.	40	1.2

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building or room unnecessarily. This could be combined by labelling light

switches to help teachers select the correct lighting. There is zoned lighting in the building and when daylight is sufficient, lights nearest the windows should be switched off whilst those deeper in eth room can be left on to create an even light throughout the room.

By switching off unnecessary lights, you could potentially save 1440kWh or £120. This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours.

Figure 2 existing halogen light

You could fit 10 energy efficient bulbs to replace existing halogen lights. This would save 390kWh each year. The payback period for this would be 1.2 years.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

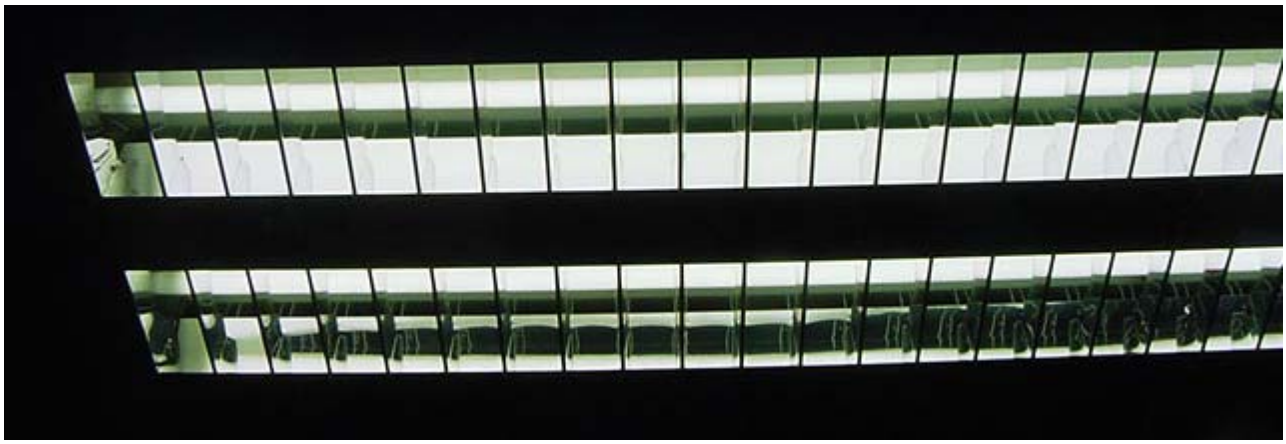


Figure 3 Reflector light fitting at the Children's Centre

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large total cost. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Screensavers can be set to display a “turn me off” message if this would help staff. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Monitors were not set to hibernate mode which would automitcally power computers down. This can be done to a variety of levels and require different re-start times to suit the level of use of a computer.

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

You have identified that high energy using equipment within your school includes an Immersion heater and electric radiators. Therefore this equipment should be carefully monitored to ensure

maximum efficiency. For further advice about this type of equipment, please call CEN on 020 8683 6600.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated). Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

In addition, your school hours may suit different energy tariffs. For example a day/night tariff will help you achieve savings if your organisation often operates through the night. This may be particularly suitable for pre-heating the immersion tank overnight.

3.6 Teachers and pupils Awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change

6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

3.7 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

4 Energy Management Plan

4.1 Summary of recommendations:

Thornton Heath Children's Centre can reduce energy costs by a minimum of £440 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Develop an Action Plan

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.

Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	×	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	• Incompatible hot water heating system
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	×	• No available ground area

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,090	1,329	216	25,200	12,600	759 (379)	117 (58)

The sustainable energy options

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy

technologies

4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Thornton Heath Early Years Centre with identifying the most suitable sustainable energy solution for the site.

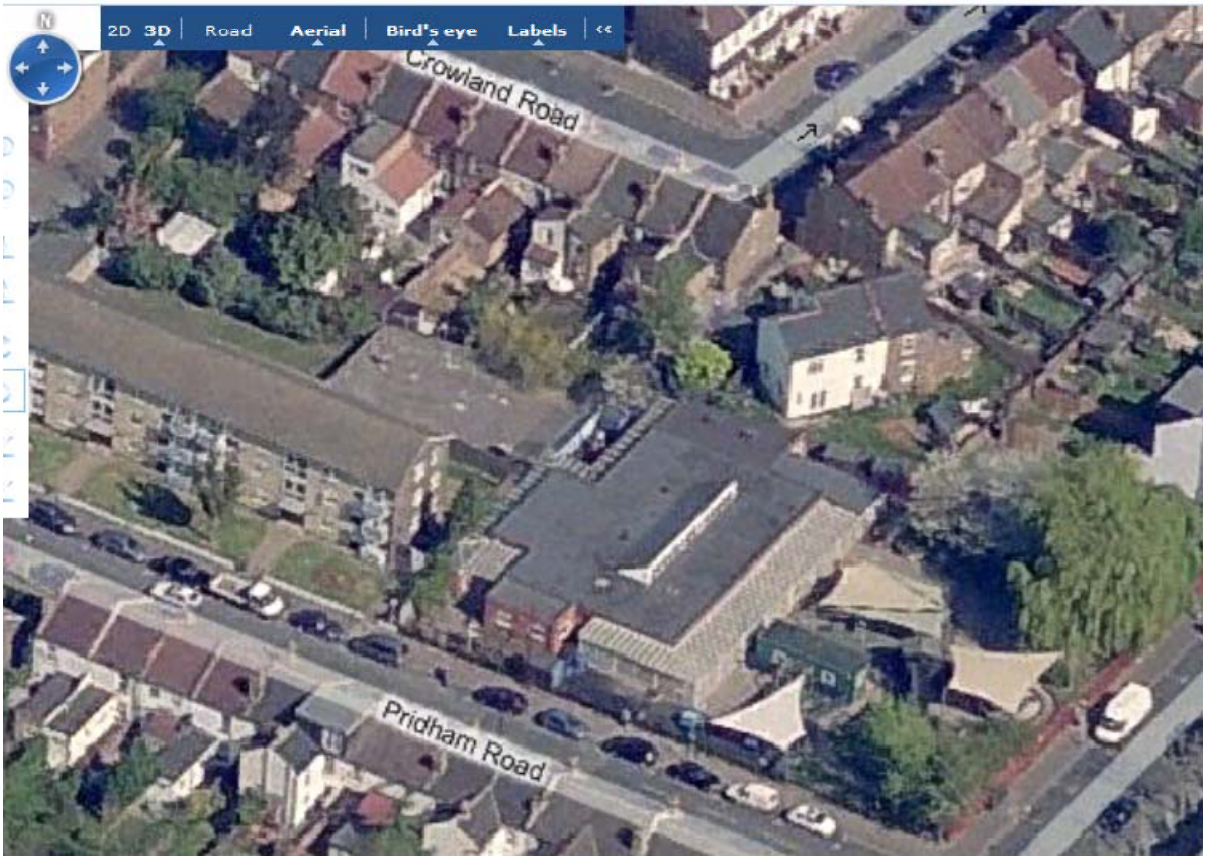
For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

There is an available flat roof area of approximately 32m^2. The area available is also severely limited by the elevated skylights serving the centre of the building as solar panels should not reduce the amount of light available internally. There may also be the possibility of incorporating solar panels in to a new foyer area, but this would be subject to plans being submitted.

This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies



6.2 Ground Area

There is no available external ground area free from obstructions. This information will be used to assess the feasibility of Ground Source Heat Pump Installations.

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the Thornton Heath Early Years Centre site in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Thornton Heath Early Years Centre would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	✗
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✗
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✗
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	✗
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	✗
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	✗
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	✗

Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	✗
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	✗
Flue	Can the flue be designed to meet planning authority requirements?	✗
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	✓
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	✗
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✗
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✗

Table 5-1: Technical feasibility of each technology

7.2 Additional feasibility elements

7.2.1 Photovoltaic's

Roof area is limited and subject to on roof inspection, could detrimentally affect access to light through the elevated skylights.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaics

8.1.1 Site Information

Roof area is limited and subject to on roof inspection, could detrimentally affect access to light through the elevated skylights. There will be some minimal shadowing from surrounding buildings leading to some reduction of performance related to these buildings (up to 5%)

8.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [$kgCO_2$/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,090	1,329	216	25,200	12,600	759 (379)	117 (58)

Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the flat roofs would be have the panels mounted on an A-frame pitched at 40 degrees from horizontal and that they would be oriented towards south-east (corresponding to a 95% relative output) Shadowing of the panels would further reduce the efficiency of the panels by approximately 5%

8.1.4 Life cycle cost implications
There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

9 Summary of options

9.1 Renewable Technology solutions

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [$kgCO_2$/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 4.2 kWp (25.1 m2)	3,090	1,329	216	25,200	12,600	759 (379)	117 (58)

Renewable energy solutions for the site

10 Conclusion

10.1 Going forward

The aim of this study is to provide Thornton Heath Early Years Centre with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

1. **Obstructions around the building –** surrounding buildings will cause some overshadowing
2. **Availability of space –** the elevated skylights will reduce the available roof area. On roof investigation is needed to determine if the reduction in light to eth building would be acceptable.

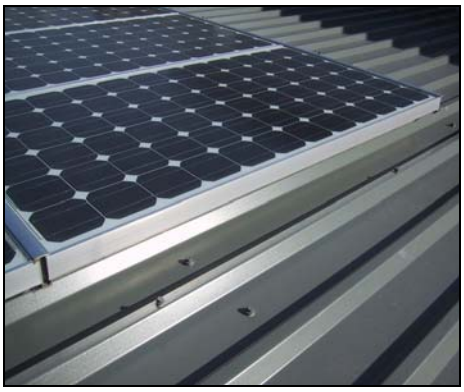
It should also be noted that the current heating system is compatible with a Ground Source Heat Pump but that the existing outdoor area is not suitable for eth heat collection system. If the external area is to be re-developed Thornton Heath Early Years Centre should consider the installation of a Ground Source Heat Pump, particularly as the heating is provided by electricity, a particularly high cost form of heating. CEN would be able to provide more advice in this eventuality. More information on GSHP can be found in the annex.

11 Annexes

11.1 Solar Photovoltaics (PV)

Solar photovoltaics

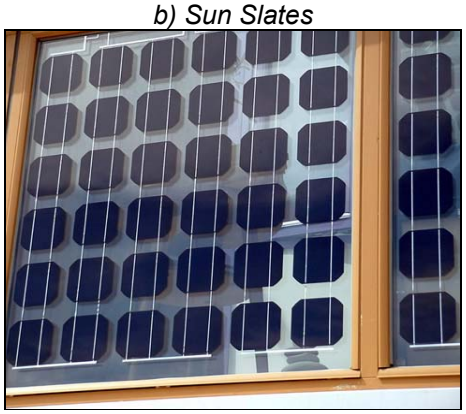
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO_2/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year (see **Error! Reference source not found.** and Annex Figure 3 for more details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Solar photovoltaics

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

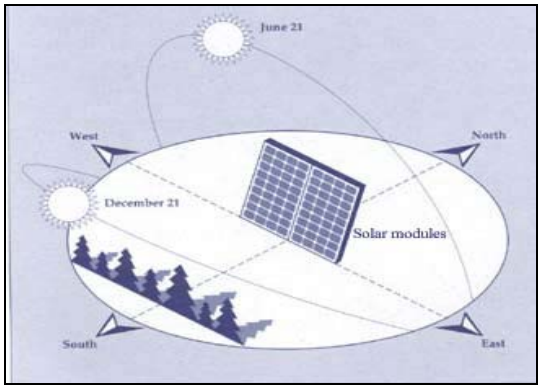
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

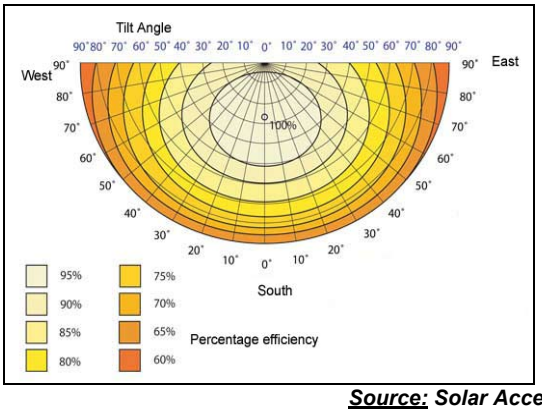
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 2: Solar variations throughout the year



Source: Solar Access

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

11.2 Ground Source Heating

Ground source heating

Product information

a) GSHP pipe work
Source: Geoscience Ltd.

b) Pump housing and buffer tank
Source: Geoscience Ltd.

Annex Figure 4: Ground source heating pipe work and pump

- Ground source heating is a tried, tested and reliable means of providing space heating to buildings and is most often combined with under-floor heating. Such a heat distribution system is efficient due to low flow and return temperatures, and offers high levels of comfort for building occupants.
- A ground source heating system comprises piping buried beneath the ground (horizontally or vertically) and a heat pump to extract the heat.
- At a depth of a few metres, the temperature of the ground remains at a constant 12°C throughout the year. This constant temperature is the benefit of ground source heating over air source heating, as the installed pump is able to work at its optimal coefficient of performance (CoP). The CoP is the ratio of the units of heat energy 'out' to the units of electricity 'in', required for circulating the fluid and operating the heat pump. Piping can either be laid horizontally or vertically through borehole drilling. Fluid circulating through the pipes, extract heat from the surrounding earth. The warmed fluid runs through the heat exchanger in the heat pump, which operates in a similar way to a 'reverse' refrigerator. The heat pump raises the temperature of the fluid. This fluid, with an 'upgraded' temperature, can then be used for underfloor heating.

Ground source heating

Technical details

- **Vertical closed loop fields** – a borehole is drilled to a depth of between 15 to 100 metres. The size of the overall system will depend on the space heating requirements.
- **Horizontal closed loop fields** – pipes are buried in horizontal trenches which are dug to a depth of 1 – 2 metres.
- **Open loop fields** - water does not return once it passes through the system.
- The flow temperature of underfloor heating, around 45°C, is lower than that required for domestic hot water at 50-60°C. The Coefficient of Performance (COP) of the pump, which is the ratio of the units of heat out to units of electricity in, will be lower when generating hot water compared to when supplying space heating.
- The heat pump housing would be similar in size to a large refrigerator, although different manufacturers use different system configurations. There would have to be sufficient space for maintenance and repair access.
- By operating the ground source heat pump overnight and storing the heat in a thermal store, users may be able to take advantage of cheaper electricity tariffs.

Energy generating capacity

- The ground source heat pump should have a CoP of 3 or more, in order to gain good carbon savings. That means that for every unit of electricity put into the system, 3 units of heat are produced. The water produced is a 'low-grade' temperature, around 40°C, which is unsuitable for traditional radiator systems that require much higher water temperatures. However, it is ideal for underfloor heating.
- Ground source heat pumps can also be used for heating water, although not all manufacturers recommend this configuration. Heating water to a useful temperature means that the CoP reduces i.e. the system becomes less efficient. If heat pump systems are to be used for space and water heating, it is preferable that they run from different pumps. In this way, when the heating demand is low, one pump can be turned off rather than run at part load.

Environmental requirements

- Vertical drilling may be possible in areas that are free from obstructions. Where possible, borehole drilling on contaminated land should be avoided, although methods of boring in such areas have been developed.
- A ground survey is required in order for the system to be correctly sized, as the rate of heat transfer will be dependent on soil properties. A drilling license may also be required.
- Laying the pipes horizontally in trenches is cheaper than boring vertical boreholes. However, a large area of open ground is required.

Building design requirements

- Horizontal pipes can be buried beneath paving and car parks but are generally not laid beneath buildings.
- Sufficient space for the pump and buffer tank is required.

Maintenance

- System maintenance is minimal. The piping infrastructure, like utility piping infrastructures, rarely requires maintenance. Only the pump may require maintenance work and it is easily accessible.

Ground source heating

Auxiliary equipment required

- Thermal store
- Low grade temperature heat distribution system

Installation and planning issues

- The pipes, buried below ground, do not require maintenance. The only visible part of a ground source heating system is the pump itself, which can be housed in a container about the size of a refrigerator and can be easily accessed should any maintenance be required.
- If a ground source heat pump is to be installed, it should be considered from the earliest stages in a development's design process, as a suitable heating system needs to be installed.

Estimated costs

- Electricity is required to operate the pump. Installing a heat pump to replace a gas-fired heating system is less economically favourable than one replacing electrical or oil heating systems. Vertical bore holes are more expensive than horizontal trenches.

Additional Information

- **Ground source cooling** is the inverse of the ground source heating system and operates, in effect, like a large refrigerator. One system can be installed to operate as a heating and cooling system. Such a system can increase the CoP, as during the cooling cycle, heat is put back into the ground to be extracted again later during the heating cycle.
- Natural and passive ventilation should be considered before mechanical ventilation. Air conditioning should not be encouraged, especially on residential developments, due to the environmental impact it would have.

11.3 Financing low and zero carbon technologies

Financing low and zero carbon solutions
Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for West Thornton Primary School

Study completed by CEN

12/8/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your building. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	41410	1449	0	0
Control of Lighting	11761	1000	0	0
Switch Off Equipment	8821	750	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Roof Insulation	29940	1048	6104	5.8
TOTAL[1]	**91932**	**4250**	**6100**	**1.4**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 91932kWh
- ✔ Achieve financial savings of £4250 per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures could be as low as £6100. This would imply a simple pay back of only 1.4 years. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	52

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies.
We offer free follow-up support and advice, helping you to implement the recommendations.
We will support you in engaging building occupants and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your organisation is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable.

2.2 An Overview of the Site

The building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data. From the nature of the organisation (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to identify the savings within this report

Your organisation currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the organisation and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.1 Energy Consumption

The current annual gas consumption of the site is 233,889 kWh pa and the current electricity consumption is 117,611 kWh. This equates to costs of £8,186 and £10,000 respectively within the consumption year provided. It is noted that there have been some problems with obtaining accurate billing data, this has resulted in data that we believe is inaccurate. Therefore, all savings and costs will be subject to change upon review. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	117611	33	10000	55	51	53
Gas	233889	67	8186	45	44	47

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data.

The energy performance for gas consumption is thought to be incorrect and should be reviewed when more billing data is available. It is provided here for completeness, but should not be used as a guide to performance.

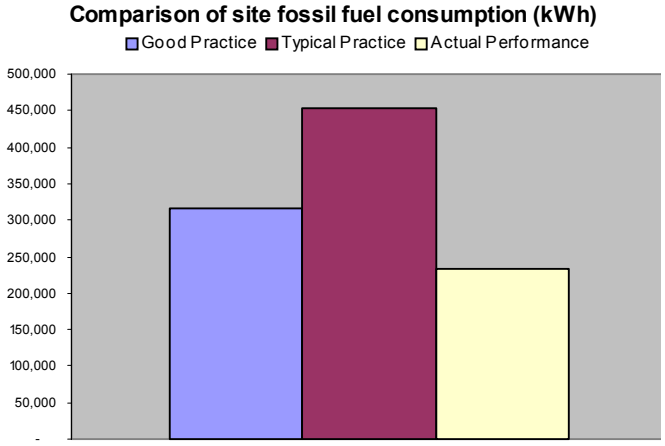


Chart 1-1 Current Energy Performance

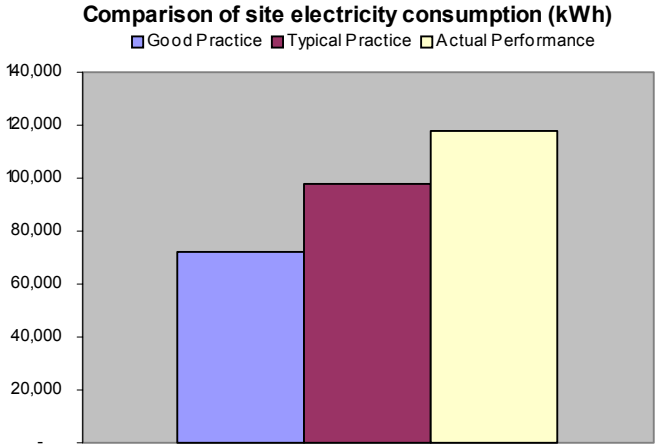


Chart 1-2 Energy Saving Opportunities

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.

The energy performance for gas consumption is thought to be incorrect and should be reviewed when more billing data is available. It is provided here for completeness, but should not be used as a guide to performance.

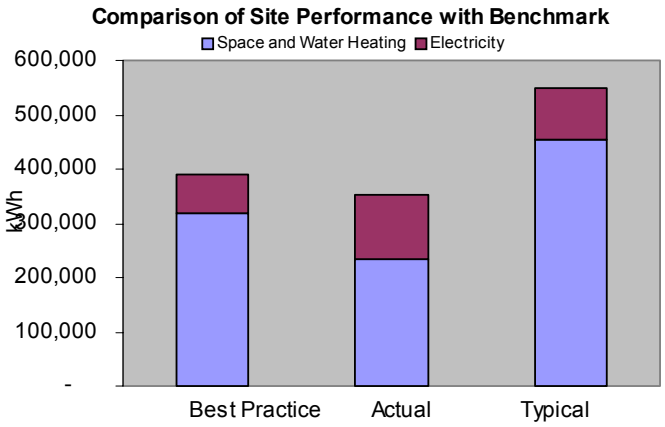


Chart 2-1 Heat consumption against benchmark,

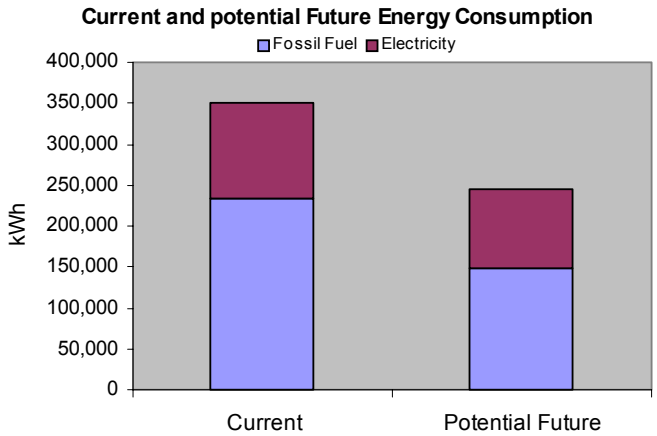


Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Energy costs were not available. so they have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark
Recommendations are made on observations made during the site visit rather than comsumption data. Both electricity and energy used for space heating could be improved. Particular areas of this report to consider include lighting and machinery, and ensuring that equipment is turned off when not in use, and power is not wasted, as well as improving insulation levels.

Monitoring and Continuous Improvement
A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. This is particularly important at West Thornton were accurate consumption records were not available. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

Figure 1 Room thermostat turned up very high

• Better control & reducing your internal temperature could deliver a £1449 saving pa with no investment. If rooms are cold, thermostsats should be turned to the desired temperature which will then be maintained, not to maximum temperatures.

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity. The current temperature settings for the building have been estimated, as there are idnividual thermostats around the building. However, based on our experiences on site, and average temperatures felt by the auditor and site occupants, the temperature has been estimated at 22degrees. If you reduce your building temperature by 3 Degrees, you could save around 41410 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Figure 3 Windows opened to reduce temperature during the heating season

Figure 2 Radiator fitted with TRV

- Training for staff and correct use of TRVs (Thermostatic Radiator Valves) could deliver £654. TRVs are an easy way for room occupants to control the local temperature. It should be ensured that TRVs are used rather than the current tendency to open windows to reduce temperature during the heating season.

It was observed that your pipes are not insulated in all areas. When pipe insulation is old, it may be possible to improve efficiency by replacing or upgrading some of the insulation.

Zoning

Your organisation currently has zoning within the heating system. However, it is vital to monitor how the different zones work together, and if there are undesired variations between the zone temperature. This could lead to additional further savings

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your organisation currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

Insulation Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Roof Insulation	29940	1048	6104	5. 8

Figure 4 Access to loft space

No access to the loft space was provided. It is thought that there is loft insulation but this is considerably below the 270mm Building Regulations. There is easy access to the loft space through classrooms and this is recommended as an easy to implement measure.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Control of Lighting	11761	1000	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

Figure 6 Blinds closed and lights on

Figure 5 Blinds closed in most classrooms

By switching off unnecessary lights, you could potentially save 11761.1kWh or £1000.This has been identified from estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. When glare issues allow, blinds should be open to maximise natural lighting and reduce the need for artificial lighting. Lights are zoned so that banks of lights closest to the window can be turned off when natural light is sufficient, whilst maintaining an even level of light throughout classrooms.

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new

lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

3.4 Equipment

Individual pieces of equipment within your School will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Figure 7 Projector left on showing screensaver

Figure 8 Computers screensavers left on when not in use

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 8821kWh or £750 through switching off computers and other common office equipment. If your School is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artificial and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your School can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

This is very important for West Thornton where accurate consumption data was not available. Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

3.6 Teachers and Pupil Awareness and School Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among building occupants
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other building occupants are aware of their environmental impacts and any environmental policy which your organisation may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this Energy Check, you have indicated that you are interested in saving energy and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600.

4 Water

Water consumption can make up a significant part of any organisation's utility bills and reducing consumption is becoming increasingly important in today's changing climate.

Behavioural changes

A large part of your water use can be saved by altering the way that building users use water. These small changes can soon add up to a large reduction in water use.
It was identified that there were no stickers or labels near taps and water appliances encouraging people to save water and turn off taps. Small stickers could be designed in-house and will not only encourage water saving in your organisation but may effect your building users' behaviour when they are in the wider community.

Water saving measures

Taps
Water use from taps could account for up to 25% of your water use, with flow rates up to 20 litres per minute, depending on pressure.
It was identified that tap aerators were not present in your organisation. Tap aerators are simple devises that fit into existing tap nozzles and mix air with water under pressure as it emerges from the tap. The apparent flow rate is not affected. Water savings of up to 10 litres per minute may be achieved. Costing in the region of £5, they are a cheap measure and do not require specialist fitting.
Toilets
We identified the potential to install up to 20 water saving devices in toilet cisterns around your organisation. Each water saving device can save between 1-2.5litres for every flush. There are two types of water saving device which can be used in your cisterns; a hippo and a save-a-flush. Both can be easily installed by a member of staff and up to 50 of each can be sent to you for free by Thames Water if you are in their supply area. Check their website for further details.

Harvesting Rainwater

Approximately 3.6 million litres of water falls onto a typical 4000 square meter roof each year. Most of this water runs into the sewage main and is lost.
Your organisation has plants or vegetables that are watered from the mains supply costing your West Thornton Primary money. You should consider installing water butts on down pipes to harvest rainwater and use this water instead. Depending on the amount of watering that you require, you could save up to 5,000 litres of water each year per water butt. Water butts usually cost around £25 to £35 each and are easily installed.

Monitoring, measuring and billing

The water meter is not read and recorded frequently. Reading your meter frequently not only helps you to be billed accurately by your supplier but can also help you to identify leaks and measure reductions in consumption.
Consumption figures or meter readings can be plotted into a simple graph and displayed so that building users can see how much they are consuming and the reduction in consumption

when they try to save water. Readings should be recorded at regular intervals into a simple chart on a weekly or fortnightly basis. This can be done by your site manager at the same time each week as part of the openning or closing proceedure.

5 Energy Management Plan

5.1 Summary of recommendations:

West Thornton Primary School can reduce energy costs by a minimum of £4,250 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

5.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.
Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.
Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.
Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.
Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

5.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

5.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:
• The efficiency and consumption of plant (eg; boilers and lighting).
• The running cost of energy consuming plant and equipment.
• The suitability and efficiency of installed plant and equipment.
• The cost of plant running over weekends and lights left on unnecessarily.

5.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

5.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

5.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

6 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

Section 2:
Renewable Energy Appraisal

7 Executive Summary Renewable Energy

7.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	×	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	×	• No year round hot water demand
Wood-fuel heating	Thermal	×	• No available space for fuel storage and delivery access
Ground source heating	Thermal	×	• No available ground area • Incompatible heating system

Summary of feasible technologies

7.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. South east rear roof							
Solar PV Sanyo Hybrid 21 kWp (125.3 m2)	16,262	6,993	1,138	94,500	47,250	541 (270)	83 (42)
Option 2. South west Year 5 roof							
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,439	1,049	171	18,900	9,450	721 (360)	111 (55)
Option 3. South west Year 6 roof							
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,195	944	154	18,900	9,450	801 (400)	123 (61)

The sustainable energy options

Options 1, 2 and 3
Both options 1 and 2 represent individual installations of the technologies. The larger of the installations, Option 3 (the rear roof) offers the greatest carbon saving.

7.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist West Thornton Primary School with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

8 Roof and ground areas

8.1 Roof

The building has three areas of south east or south west facing roof pitched at approximately 40°. A nearby tree does present some degree of shading to the south west roof over the Year 6 classrooms. The large rear south east facing roof has an available roof area of approximately 140m^2, the Year 5 and year 6 south west roofs have an available roof area of approximately 27m^2 each, although the Year 6 roof will be calculated as 10% shaded. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

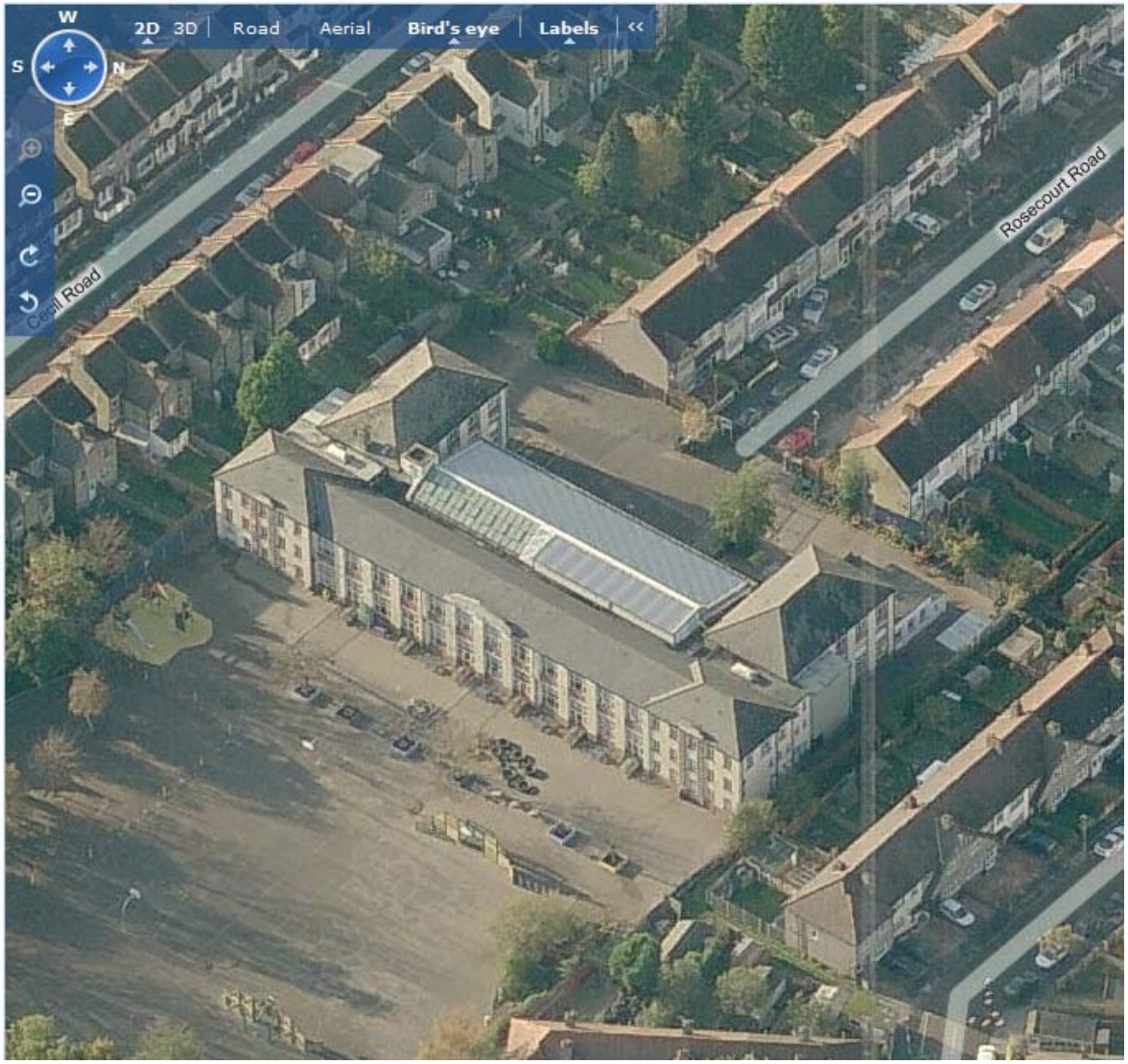
8.2 Ground Area

There is no available external soft ground area. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

9 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the West Thornton Primary School site in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if West Thornton Primary School would still wish to consider this technology as an option.



List of feasibility criteria per technology

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Fuel supply chain	Has the existence of an established fuel supply chain been verified?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	×
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	×

* Assuming that the design is defined to meet these criteria

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

[3] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

10 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

10.1 Solar photovoltaics

10.1.1 Site Information
There are three available areas of pitched roof.

10.1.2 Product information
Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

10.1.3 Carbon savings , estimated costs and Payback time.
The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

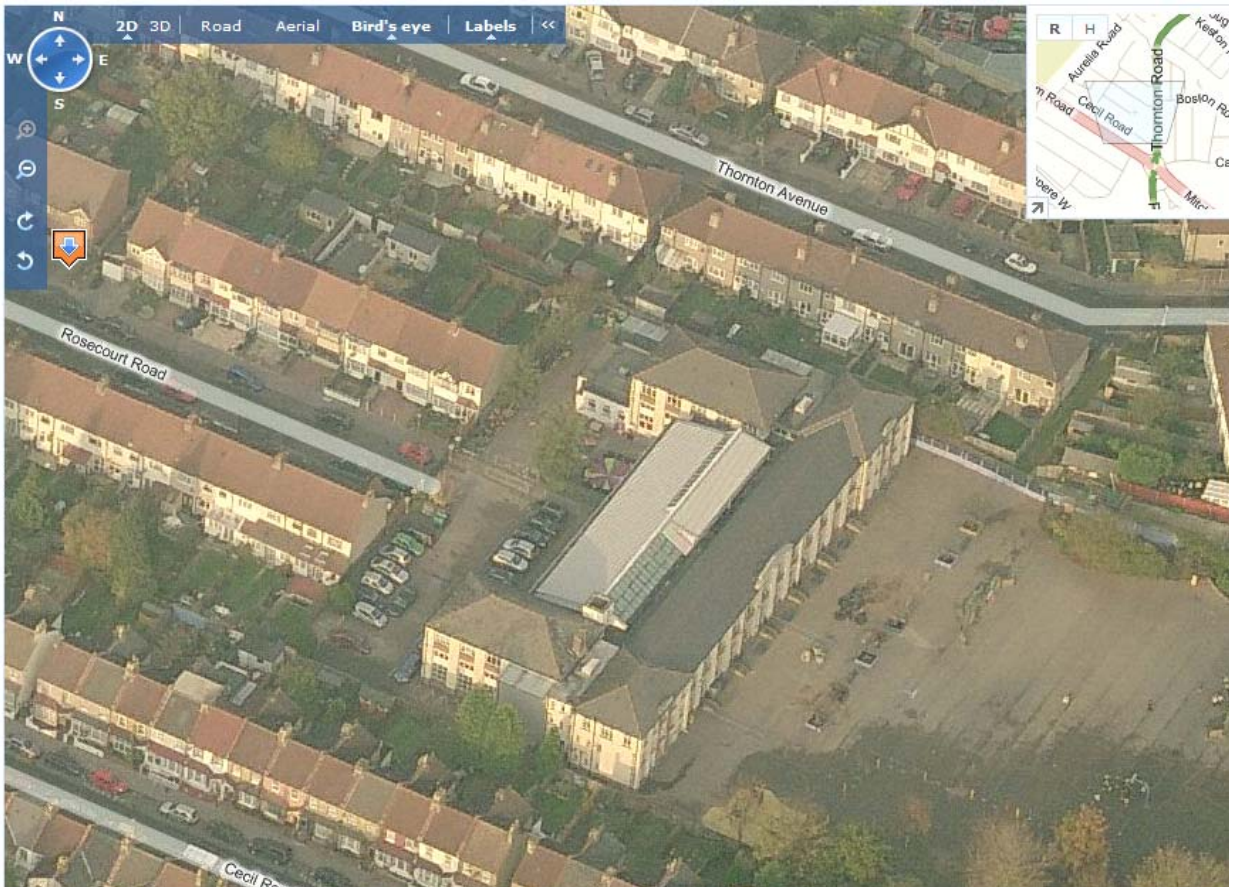
	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [$kgCO_2$/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 21 kWp (125.3 m2)	16,262	6,993	1,138	94,500	47,250	541 (270)	83 (42)
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,439	1,049	171	18,900	9,450	721 (360)	111 (55)
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,195	944	154	18,900	9,450	801 (400)	123 (61)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that The roof is pitched at 40 degrees from horizontal and the panels would be oriented towards south-east or south west (corresponding to a 95% relative output). Shadowing of the south west Year 6 panels would further reduce the efficiency of the panels by approximately 10%

10.1.4 Life cycle cost implications
There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs



11 Summary of options

11.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t saved	Installation and operational issues
Option 1. South east rear roof						
Solar PV Sanyo Hybrid 21 kWp (125.3 m2)	16,262	6,993	94,500	47,250	541 (270)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. South west Year 5 roof						
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,439	1,049	18,900	9,450	721 (360)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 3. South west Year 6 roof						
Solar PV Sanyo Hybrid 3.15 kWp (18.8 m2)	2,195	944	18,900	9,450	801 (400)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Table 7-1: Renewable energy solutions for the Archway Methodist Church site

Options 1, 2 and 3
Both options 1 and 2 represent individual installations of the technologies. The larger of the installations, Option 3 (the rear roof) offers the greatest carbon saving.

12 Conclusion

12.1 Going forward

The aim of this study is to provide West Thornton Primary School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

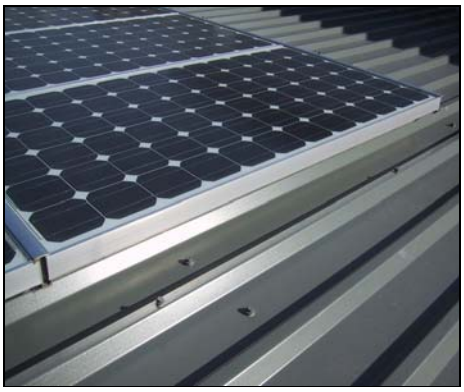
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.
2. **Obstructions around the building –** a tree to the south of the south east facing Year 6 roof could result in overshadowing of the roof where solar collectors or panels could be mounted.

13 Annexes

13.1 Solar Photovoltaics (PV)

Solar photovoltaics

Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e

d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgCO_2/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.

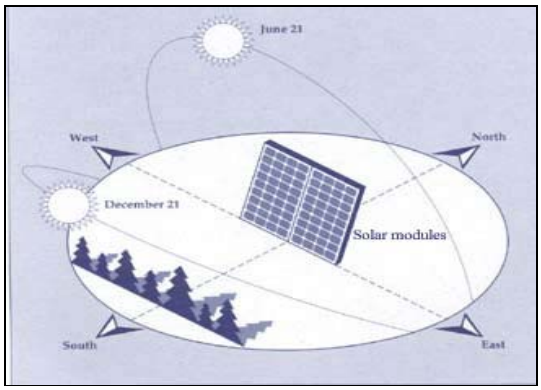
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

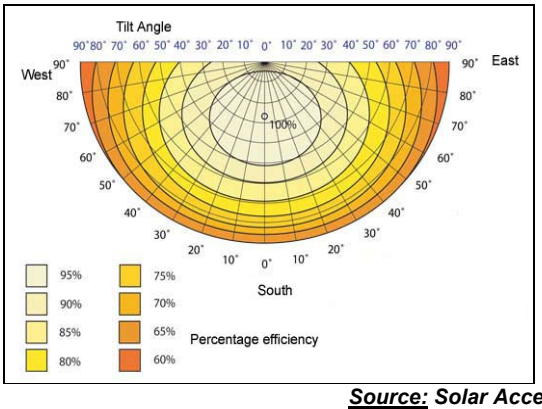
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

13.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional

funding is applicable, the financial case for the technologies would be significantly more compelling.

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Whitehorse Manor Infant School

Study completed by CEN

12/8/2008

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Section 1:
Energy Efficiency

1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your building. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	41150	1440	0	0
Control of Lighting	11943	1020	0	0
Switch Off Equipment	8957	761	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Installation of New Boiler	142890	5000	20000	4
TOTAL[1]	**204940**	**8220**	**20000**	**2**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 204940kWh
- ✔ Achieve financial savings of £8220 per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures could be as low as £20000. This would imply a simple pay back of only 2 years. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 An Overview of the Site

Whitehorse Manor Infant School has 463 building occupants, and the building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data.
From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment

2.2.1 Building age and tenancy, and the impact on opportunities for energy improvements

Although your building is relatively old, the school has done a lot to make the structure of the building energy efficient. There is still improvements that can be made to the school and insulation can always be increased. We recommend that all of the equipmet used in the building is constantly replaced, when defunct, with high efficency technology, much like the new energy efficient computers that the school is implementing. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of energy using equipment is carefully considered to maxmise the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which can be carried out, however many low cost and behavioural measures can be undertaken as quick wins.

2.1.1 Energy Consumption

The current annual gas consumption of the site is 642980 kWh pa and the current electricity consumption is 119430 kWh.
This equates to costs of £0 and £0 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	119430	16	**10,150**	**31%**	50400	29
Gas	642980	84	**22,504**	**69%**	124740	71

2.1.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

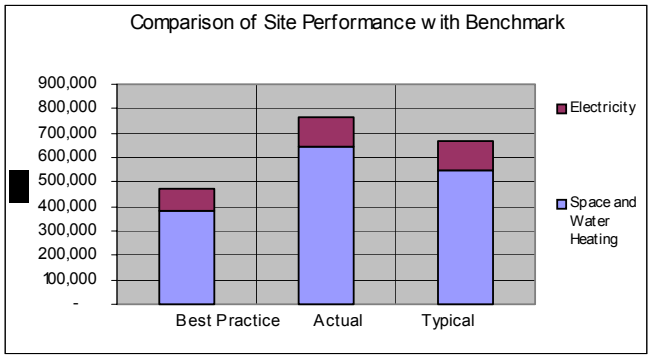


Chart 1-1 Current Energy Performance

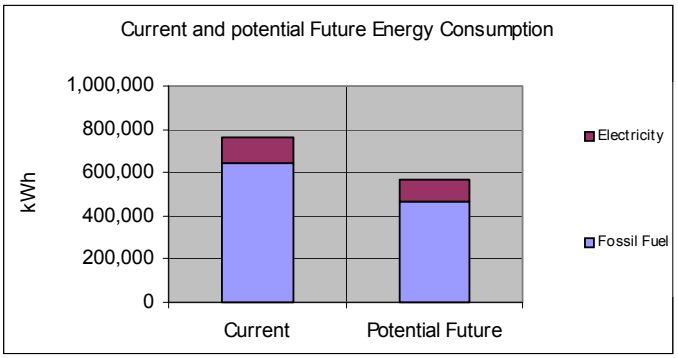
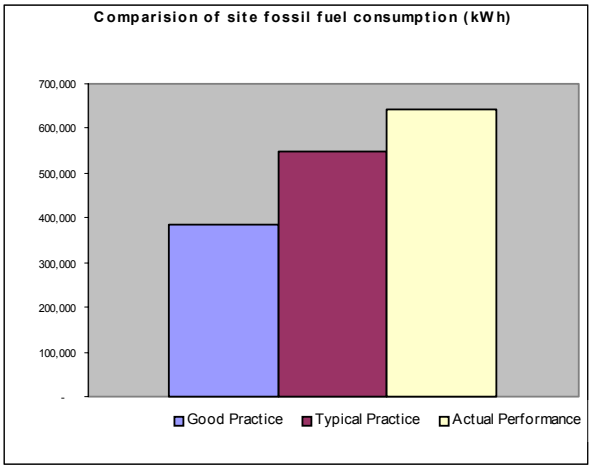


Chart 1-2 Energy Saving Opportunities

2.1.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



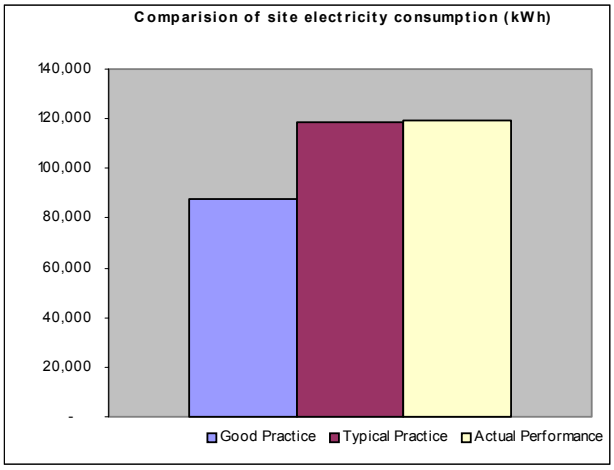


Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

2.1.4 Summary of Energy Performance Compared with Benchmark

Whitehorse Manor Infant School is not reaching best or typical practice consumption levels for either gas or electricity. This may be due to unforeseen/unusual circumstances, but there was considerable bad practice employed by the school and this is a clear warning to closely monitor your energy consumption. There are large potential savings to be made at this site, by reducing consumption, specific measures to achieve this reduction are outlined later in the report.

2.1.5 Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline

consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better control & reducing your internal temperature could deliver a £1440 saving pa with no investment

• Installing TRVs (Thermostatic Radiator Valves) could deliver £179.9 savings pa with an investment of £720

• Installation of a new boiler could cost around £20000 and would deliver a £5000 saving each year. This would represent a payback of 4 years. This cost does not include any plant room refurbishment, removal of old boilers or civil work and may vary according to the installer.

• It was observed that your boiler and pipework are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system.

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. However, whilst walking around the school, it was observed that the windows were open due to over heating.

The school seems to suffer from considerable overheating, with many rooms opening windows to reduce the internal temperature. Obviously any heat lost through an open window is energy that needn't have been used. Using TRV's in rooms where they are in place before opening windows would be a simple behavioral measure that teachers and pupils could be aware of. This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Window left open to reduce school temperature with heating on full

This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity.

It was observed that current temperature controls are set to 22 Degrees.

If you reduce your building temperature by 1 Degrees, you could save around 41150 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures.

Zoning

Zoning of the heating system could be possible within your school, meaning that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This could provide savings through area-specific reductions in heating temperature.

Isolating your boilers could save money

It would appear that you would not need to take action in terms of isolating your boiler

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

Insulation type, cost and efficiency will vary greatly according to the type of building structure your organisation currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
Control of Lighting	11943	1020	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting.

By switching off unnecessary lights, you could potentially save 11943kWh or £1020.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours.

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

Standard tunsgsten lights and fluorescent lights are not the only bulbs which can be replaced by more energy efficient lighting. Further savings can be achieved through considering the other sources of light within your building. F Lamps and circular lamps can also be replaced by compact fluorescent lamps, and the most efficient types of metal halide, mercury, halogen or sodium lights should also be purchased when replacing old bulbs.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 8957kWh or £761.2 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not

occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste.

We strongly recommend that you confirm that your energy is being supplied at a competitive rate. A number of websites enable this comparison to be made online, and you can often negotiate a contract price at lower rates with a supplier.

In addition, your school hours may suit different energy tariffs. For example a day/night tariff will help you achieve savings if your organisation often operates through the night.

Different energy suppliers charge different rates, and use energy from different sources. Confirming correct tariffs can achieve significant savings and also benefit the environment.

3.6 teachers and pupils Awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among building occupants
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other building occupants are aware of their environmental impacts and any environmental policy which your organisation may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this Energy Check, you have indicated that you are interested in saving energy and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600.

4 Energy Management Plan

4.1 Summary of recommendations:

Whitehorse Manor Infant School can reduce energy costs by a minimum of £8220 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.

Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.

Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.

Use quantified savings or projected savings to motivate spending on improving efficiencies in energy

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• Insufficient summer hot water demand
Wood-fuel heating	Thermal	✗	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✗	• Incompatible heating system

Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
ROOF AREA A 27.72 kWp (165.4 m2)	22,379	9,623	1,567	124,740	62,370	519 (259)	80 (40)
ROOF AREA B 10.92 kWp (65.1 m2)	8,816	3,791	617	54,600	27,300	576 (288)	88 (44)
ROOF AREA C 2.1 kWp (12.5 m2)	1,695	729	119	12,600	6,300	691 (346)	106 (53)
ROOF AREA D 6.3 kWp (37.6 m2)	5,086	2,187	356	31,500	15,750	576 (288)	88 (44)
ROOF AREA E 22.68 kWp (135.3 m2)	18,310	7,873	1,282	102,060	51,030	519 (259)	80 (40)

The sustainable energy options

The options above give potential for any size of installation. None of the areas are better than the other, so it is up to the school and the panel where to locate them. However, there is a maximum £50,000 match funding.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced

and carbon offset through their application, guideline system costs and operational information.

3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Whitehorse Manor Infants and Junior School Name with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The buildings have a number of flat and pitched areas. The roof area is in between the two schools and has a number of different sized areas that would be suitable for solar technologies. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is a large ground area, but ground source technologies are not going to be considerewd in this report. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the Whitehorse Manor Infants and Junior School site in order to rule out unfeasible options.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[2]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✓
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Fuel supply chain	Has the existence of an established fuel supply chain been verified?	✓
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	×
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	×
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✓
Vertical piping	Is there an area of open land ground suitable for vertical piping? Can underground obstacles be avoided?	✓

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

7.2 Additional feasibility elements

7.2.1 Photovoltaic's

Photovoltaics will be assessed for further feasibility in section 6.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

[2] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

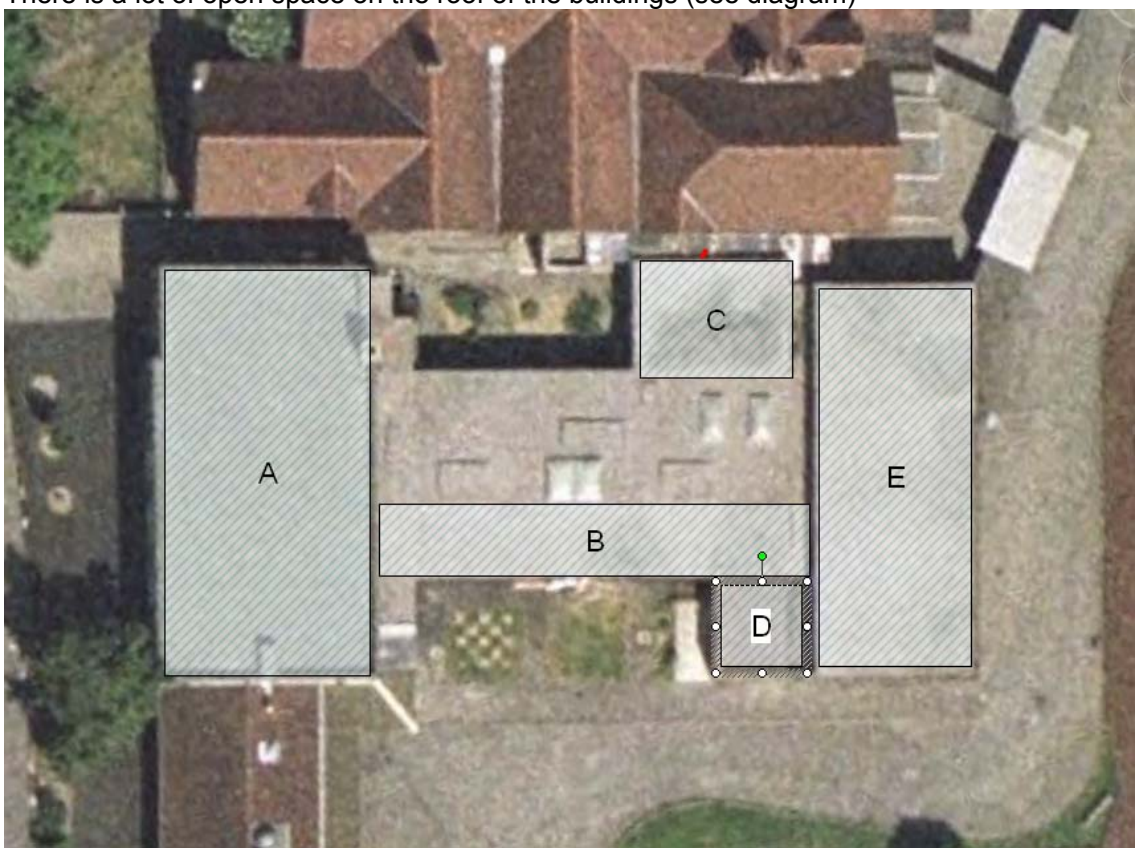
8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaics

8.1.1 Site Information

There is a lot of open space on the roof of the buildings (see diagram)



8.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of, and further information about, these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
ROOF AREA A 27.72 kWp (165.4 m2)	22,379	9,623	1,567	124,740	62,370	519 (259)	80 (40)
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ROOF AREA E 22.68 kWp (135.3 m2)	18,310	7,873	1,282	102,060	51,030	519 (259)	80 (40)

Table 6-1: Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the flat roofs would be have the panels mounted on an A-frame pitched at 40 degrees from horizontal and that they would be oriented towards south-west (corresponding to a 95% relative output)

8.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

9 Conclusion

9.1 Going forward

The aim of this study is to provide Whitehorse School with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

10 Annexes

10.1 Wind Turbines

Wind turbines

Product information

a) Swift turbine Source: *Renewable Devices*

b) Stealth D400 turbine Source: *Stealth Gen*

Annex Figure 1: Domestic-scale building-mounted wind turbines

a) Quiet Revolution Source: *XCO_2*

b) Proven WT600 Source: *Proven*

c) Turby Source: *WinEUR*

d) Proven 6 Source: *Proven*

Annex Figure 2: Stand-alone or building-mounted wind turbines

- Converts the kinetic energy in wind into mechanical energy and electricity via a generator.
- Horizontal vs. vertical axis turbines

The most common turbine type is a horizontal axis turbine, typically with between 3 and 5 blades.

Wind turbines

A number of vertical axis turbines are also on the market; this type of turbine is said to be able to cope better with changes in wind direction than horizontal turbines.

- Stand-alone vs. building-mounted turbines

Horizontal axis turbines have been developed by a number of manufacturers (see Annex Figure 1) specifically for use at a domestic scale. A number of horizontal and vertical axis turbines are available as stand-alone or building-mounted technologies, as shown in Annex Table 1.

Technical details

Technology	Manufacturer	Turbine (rotor) dimensions [m]	Roof clearance required [m]	Acoustic emissions
1No. Swift 1.5kW (horizontal axis)	Renewable Devices	2.1 (diameter)	0.5	<35 dB(A)
1No. StealthGen 0.4kW (horizontal axis)	Eclectic Energy	1.1 (diameter)	1.5-2.5	2-6 dB(A) above background
1No. Quiet Revolution 6kW (vertical axis)	Quiet Revolution	3.1 (diameter) 5m (height)	3	Under test
1No. Turby 2.5kW (vertical axis)	Turby B.V.	1.9 (diameter) 2.9 (height)	n/a	45dBA wind at 10m/s & 20m away

Annex Table 1: Technical information for building-mounted wind turbines

Energy generating capacity

- The output of a wind turbine over a year depends on the pattern of the wind over this time period, not just the average speed. The energy in the wind is not proportional to the wind speed i.e. if the wind speed doubles, the energy content is 2^3 = 2*2*2 = 8 times as high. Therefore, without a complete set of wind speed measurements for the site, only an estimation of energy production can be made.
- The electrical output of a wind turbine in dependent on the model, size and location. Generally, turbines that are integrated into a development will have a rated power of between 0.6kW and 15kW. On an ideal site, manufacturers suggest that a 15kW turbine could generate 15,000-30,000 kWh/year[3].
- Building mounted turbines are relatively new editions to the renewable energy market and are indicative of the move towards installing turbines in urban and suburban areas. However, field tests are currently being undertaken to fully assess the effectiveness of these turbines.

[3] Proven 15kW turbine: data from website.

Wind turbines

Environmental requirements

Stand-alone wind turbine:

- Minimum average wind speed of 6m/s[4]
- Large area of open ground
- No airflow turbulence (e.g. from obstacles such as buildings or trees)

Building-mounted wind turbine:

- Minimum average wind speed of 4.5 m/s at hub height
- No high obstacles in the direction of the prevailing wind (generally south-westerly in the UK)
- According to some manufacturers, wind speed can be increased through a 'roof acceleration factor', which is maximised by designing a pitched rather than flat roof.
- Depending on the model, a wind turbine can be mounted on a flat roof, a pitched roof or against a supporting wall.
- Where several wind turbines are installed on the same roof, a minimum separation distance must be kept between them to avoid airflow turbulence (the distance required varies between models).

Building design requirements

- The building structure must be sufficient to support the forces exerted by a wind turbine. Liaison with structural engineers would be required to ensure that the building structure is suitable for the installation of building-mounted turbines and to assess where the turbine would best be positioned.
- A timber-frame building would require that additional reinforcements be integrated into the design.

Maintenance

- Maintenance of small-scale turbines is generally limited to visual assessments and an annual oil check, which in most cases can be incorporated into a site's annual maintenance schedule and does not require the turbine installer to be present.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- An **inverter** and **controller** converts raw power output by the wind turbine, direct current (DC) electricity, to alternating current (AC) at a quality and standard that is acceptable to the National Grid.
- An **export meter** in order to measure the quantity of any excess energy exported back to the National Grid.

Installation and planning issues

- Smaller turbines are generally designed to operation without a gearbox and with passive yawing systems, which reduce operational noise. Turbines make more noise in higher wind speeds, but because the background noise also increases, they are barely audible.
- Wind turbines currently require planning permission although it is hoped that, in future, small building-mounted turbines may be granted 'permitted development' status. It should be noted that wind turbines, being such a visual technology, provide a positive statement regarding sustainable energy both for a development and the local authority in which they are sited.

Health and Safety issues

- Although designed to operate to very high standards of safety, some building mounted turbines have experienced technical issues and are currently being reviewed.

[4] London Toolkit

Wind turbines

Estimated costs

- The capital cost of the turbine can be site-specific in that the cost of mounting the turbine can be a significant part of the overall cost.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

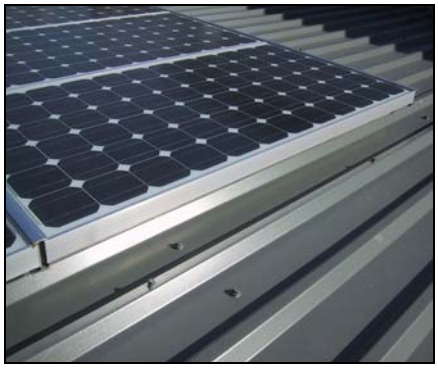
Additional Information

- **'Flicker'** is a phenomenon that occurs when the sun passes behind the blades of a wind turbine. The movement of the blades results in a flickering effect. The extent of the effect depends on the height of the sun, which changes during the year, and the size of the turbine.
- Vibrations may present issues with regard to noise. For building mounted turbines vibrations may also have structural implications, especially for larger turbines. These factors need to be considered before installation.

10.2 Solar Photovoltaics (PV)

Solar photovoltaics

Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e

d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 3: Solar products

Solar photovoltaics

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kg CO_2//kWp/yr]	Guideline cost[5] [£/kWp]	Guideline cost[5] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 2: Outputs of solar photovoltaic products

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 2. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year (see **Error! Reference source not found.** and Annex Figure 5 for more details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

[5] Cost includes supply and installation for >20kWp. Price per kWp will increase as system size decreases (by up to 20%). Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

Solar photovoltaics

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

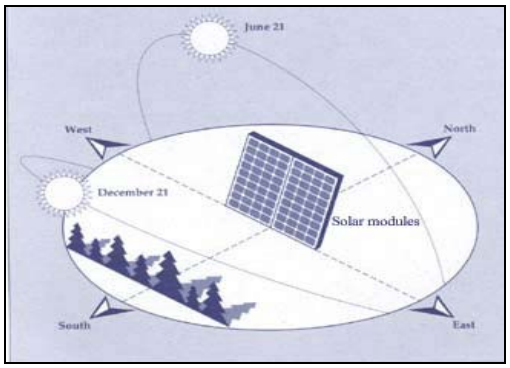
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

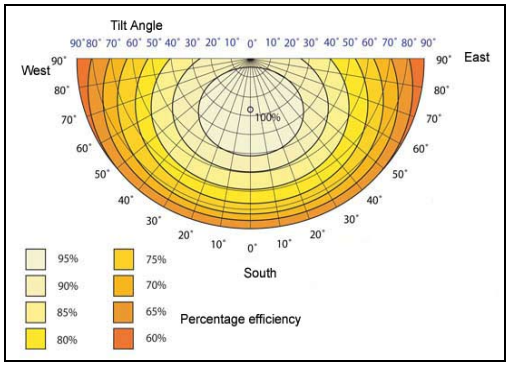
Additional Information

Annex Figure 4 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 4: Solar variations throughout the year



Source: Solar Access

Annex Figure 5: The reduction in output of a solar PV panel as the tilt angle and orientations change.

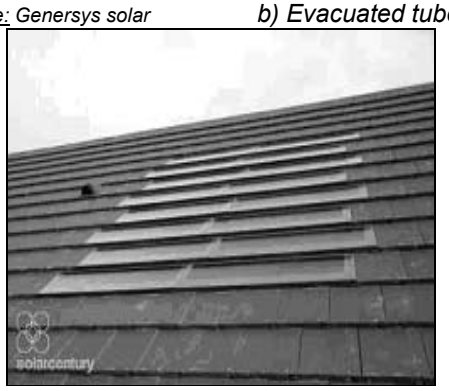
10.3 Solar Thermal

Solar thermal

Product information

a) Flat-plate collector Source: *Genersys solar*

b) Evacuated tube collector Source: *solardirect.com*



c) C21t Source: *solarcentury.com*

Annex Figure 6: Solar thermal installations

- There are two types of collector – **flat-plate** and **evacuated tube**. Per m^2, flat-plate collectors have a lower output than evacuated tube collectors, but they are the most cost effective collector type. Solar thermal tiles, an example of which can be seen in Annex Figure 6c, are less efficient than flat-plate collectors per m^2 installed, but integrate more fully into a tiled roof. Data for these different types of collectors is provided in Annex Table 3:

Technology	Dimensions [mm]	Heat generated [kWh/yr]	Carbon savings [kg CO_2//yr]	Guideline cost[6] [£]
Genersys flat-plate collector	75 x 1034 x 2040	950	49	1500
Solarcentury C21t tile	1220 x 420	136	7	400-500

Annex Table 3: Flat-plate solar collector product information

- Heat collected in the solar thermal collectors is transferred to water in a thermal store. Solar thermal systems must be sized to the anticipated heat requirement, as excess heat production cannot be exported. No extra benefit is gained by increasing the collector area, as little additional useful heat would be generated.
- Heat absorbed in the solar thermal collectors is transferred to water in a central twin-coil hot water cylinder or water store.

[6] Indication of supply cost of collector only

Solar thermal

Technical details

The two tables below show details for flat plate and evacuated tube solar collectors.

System	Schuco-Sol CH
Dimensions – per panel	2153mm x 1254 mm
Output per panel[7] [kWh/year]	1260
Supply and installation cost (£) – per panel	2340
Maintenance – per panel	Glycol replacement approximately every 10 years
Product life (yrs)	25 (panel, other elements e.g. pumps may have shorter life span)

Source: Future Heating

Annex Table 4: Flat-plate solar collector product information

System	Lazer2
Dimensions – per panel	1276mm x 2110mm
Output per panel[8] [kWh/year]	1213
Supply and installation cost (£) – per panel	1755
Maintenance (£/yr) – per panel	Glycol replacement approximately every 10 years
Product life (yrs)	25 (panel, other elements e.g. pumps may have shorter life span)

Annex Table 5 Evacuated tube solar collector product information

Energy generating capacity

- As a rule of thumb, 454kWh of gas is displaced each year per m^2 of flat plate collector, compared to 582kWh gas per year per m^2 evacuated tube collector[9]. This value varies with panel type and system layout. Assuming that the collector is replacing boiler-generated heat[10], this would result in a carbon dioxide saving of 99kgCO2/year for a flat plate collector and 127kgCO2/year for an evacuated tube collector.
- Many solar collector manufacturers claim that a solar thermal system can provide 50-70% (on average over the course of a year) of a household's hot water requirements.
- A solar thermal system can pre-heat[11] the hot water requirements of a single house or multiple dwellings. Depending on the exact system configuration, a communal system can result in a more efficient use of the collected heat because, due to a more regular pattern of consumption, a higher proportion of the collected heat will be used.
- Solar thermal can equally be used on non-residential buildings, but care should be taken if the building is likely to be out of use for long periods, e.g. schools.
- Depending on the exact system configuration, a communal system may result in a more efficient use of the collected heat as a higher proportion of the collected heat will be used due to a more regular pattern of consumption.

[7] This value will vary depending on the solar fraction, or the percentage contribution of the solar thermal collectors, to the overall hot water supply.
[8] This value will vary depending on the solar fraction, or the percentage contribution of the solar thermal collectors, to the overall hot water supply.
[9] London Toolkit
[10] Boiler efficiency assumed to be 87%
[11] During the summer months, when solar resources are high, the collectors can produce enough heat to make the use of the backup boilers unnecessary.

Solar thermal

Environmental requirements

- As with PV panels, the collector must be free from overshadowing.

Building design requirements

- As with solar PV technology, the optimum orientation for mounting solar thermal collectors is due south with a 30° pitch.
- For individual systems, storage space must be available to house hot water tanks within dwellings.
- For communal systems, a plant room is required.

Maintenance

- Solar water heating systems generally come with a 5-10 year warranty and require little maintenance. A yearly check by the householder and a more detailed check by a professional installer every 3-5 years should be sufficient (Always consult your system supplier for exact maintenance requirements).

Auxiliary equipment required

- A cylinder is required to store and heat the water / heat exchange
- Solar thermal can be incorporated into a range of heating system configurations

Installation and planning issues

- As can be seen in Annex Figure 6, the flat-plate solar collector looks similar in appearance to a Velux-style window. The collector can be installed to sit flush with the roofline. Obtaining planning permission for a solar thermal system in a conservation area is not always possible, although trying to ensure that the collectors are not visible from the road can facilitate this process.
- In a domestic system, the heated fluid from a solar thermal system is fed into a twin-coil hot water cylinder[12]. For larger, communal systems, the installation of one or a number of buffer vessels (for the storage of the heated water) is required and this should be considered when sizing the plant room.
- Ideally, in order to minimise pipe work, and therefore heat loss, the solar collectors should be mounted on the roof area directly above the flats that they will be servicing, rather than in a single array. If possible, the pipe work can then run directly through the building to the dwelling being supplied with solar hot water.

Health and Safety issues

- As with PV.
- Overheating leading to overexpansion if expansion vessels are insufficiently sized.

Estimated costs

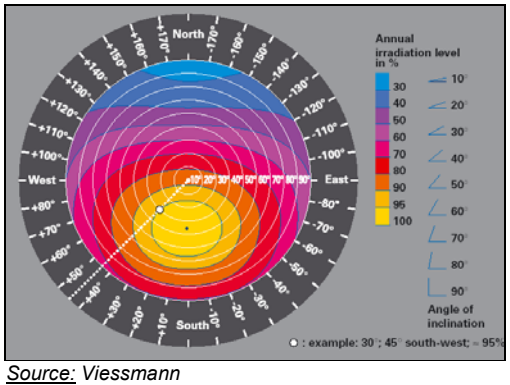
- A flat-plate collector, including a twin-coil unvented cylinder costs in the region of £ 930 per m^2 collector installed (installed price). A vacuum tube collector, including a twin-coil unvented cylinder costs in the region of £ 945 per m^2 collector installed (installed price). See Annex Table 4 and Annex Table 5 for further solar collector product information.

[12] There are systems available that are compatible with combination boilers. However, in the case of the drain back systems that are commercially available, as a cylinder and a drain back vessel are required, space saved through the use of a combination boiler is function limited.

Solar thermal

Additional Information

The output of solar thermals is dependent on the tilt angle and orientation changes. This relationship is shown in Annex Figure 7.



Source: *Viessmann*

Annex Figure 7: The reduction in output of a solar thermal panel as the tilt angle and orientations change

10.4 Wood-Fuel Heating

Product information

Annex Figure 8: Wood fuel boilers

- Modern systems are fully automated and highly efficient. Features include automatic ignition, automatic de-ashing, careful control over air injection and recirculation of the flue gases to ensure a complete and clean combustion and continual monitoring of the flue gases and system operation.
- There is a range of fuels available, such as logs, wood chip and pellets an can be made from a wide range of materials such as forestry thinnings, tree surgery waste, clean waste timber and energy crops: the suitability of each fuel is dependent on a number of factors, including available storage space, local fuel supply chains and the heat demand and consumption patterns.

Technical details

- Biomass technologies have developed greatly over recent years and are therefore very different to many people's perceptions. Modern wood-fuel boilers are highly efficient, clean and smokeless.
- There are two main types of wood fuel which can be used in biomass boilers – **pellet** and **chip**. Both have various advantages and disadvantages, but the main differences are that pellet fuel is a manufactured product and therefore more expensive, but also has a higher energy density, lower moisture content and more standardised quality than chip. Chip is much cheaper, but due to its bulk, is harder to deliver and to store. Logs can be used within stoves, and can be highly effective at a smaller scale, providing heat to smaller buildings and usually used in a domestic setting, but require high manual involvement, and usually do not come with a boiler.
- Boilers can operate with **individual** or **communal** systems.
- For **individual** systems, a stove would be located in the dwelling and would provide direct space heating, i.e. no wet heat distribution system. The domestic hot water requirements are met through the use of a back-boiler. The drawback of this system is that during summer months, when little or no space heating is required, the stove must operate to provide hot water; this would result in the dwelling being heated. Alternatively, a gas boiler or immersion heater could be used to supply hot water during the summer months, but this would not be ideal in terms of space required for additional equipment, capital outlay or running costs. There are small individual biomass boilers on the market which will provide hot water,
- For **centralised** systems boilers are available with an integral hot water energy storage or buffer tank that stores water up to 90º C, enabling the supply of heat to be further decoupled from the combustion of the fuel. All systems will normally require more space than a gas boiler for the same heat load, not only because wood-fuel boilers tend to be larger but also because room for fuel storage is necessary.

Energy generating capacity

- Depending on the modulating capability of the boiler and whether the system has been configured with an accumulator tank, biomass boilers are able to meet just the base load or the whole annual heat demand.
- Annex Table 6 below gives an indication of the relative energy contents of wood chip, pellet and logs.

	Biomass fuel type		
	Chip	*Pellet*	*Log*
Energy content [kWh/t]	3500	4700	4200
Density [t/m^3]	0.25	0.65	0.48
Cost [£/t]	50	150	60
Cost [£/kWh]	0.014	0.032	0.014

Annex Table 6: Energy contents and indicative costs of a range of wood fuels

Environmental requirements

- A reliable fuel supply is essential.

Building design requirements

- In order for a biomass system to be installed on a site, there are a number of requirements that must be fulfilled. It must be ensured that there is sufficient space in the plant room for the biomass boiler and auxiliary equipment, e.g. buffer tank, fuel transfer, gas boiler. The fuel storage hopper should be located close to the boiler. If there is limited space for a suitably sized plant room to be incorporated into the building, an underground plant room could be considered.
- Good approach access for fuel delivery vehicle - firstly onto the site (possibly including turning circle), and secondly the direct approach to the fuel store.
- Fuel silos must be kept separate from the boiler for safety reasons and should be watertight (as far as possible) and well ventilated. The design of the fuel store must be considered alongside the available equipment of the fuel supplier. Underground stores provide faster delivery times and therefore less noise, disruption and ongoing costs. However, they are more capitally expensive than an above ground store. Surface silos will be more labour intensive to refill but will be cheaper to install initially.
- If pellets are blown from the truck into the store, there is no specific requirement in terms of the location of the store i.e. an underground or ground level store would be viable. For wood chips, the lorry needs to be able to tip into the fuel store. An underground fuel store and plant room is the easiest option (hatch for delivery of fuel is then at ground level), otherwise a ramp may need to be built to allow a lorry / tipper trailer to achieve a height that it can tip from.

Maintenance

- Automated feeding and de-ashing systems mean that maintenance requirements are minimised. In addition, the majority of boilers have a built-in modem, which automatically contacts the site engineer if a performance problem is detected. Smaller boilers normally require an annual visit while much larger boilers may need a quarterly visit. Most UK installers offer ongoing maintenance contracts.

Auxiliary equipment required

- Fuel store
- Fuel transfer system
- Buffer tank
- Backup boiler (optional)

Additional Information

- Although a combustion process, biomass is considered to be a renewable energy technology because it is a **carbon-neutral process**. This is because the carbon expended during combustion has recently been absorbed from the atmosphere during the growth of the tree. Additionally, the combustion of the material releases the same volume of carbon as would be produced from the decomposition of the organic material. Furthermore, decomposing wood also releases methane, a more harmful greenhouse gas, which is not produced during combustion. Carbon is also expended through fuel harvesting, processing, and transportation but usually only a few percent of the carbon associated with fossil fuels. To minimise carbon associated with transportation, it is recommended that a fuel supply should be locally sourced if possible.
- Automated wood-fuel systems bring several benefits: development of local renewable energy source and local job creation, promotion of improved forestry management, reduction of reliance on fluctuating fossil fuel prices and potential cheaper running costs than mains gas.
- Wood -fuel technologies perform better when working at maximum capacity. The sizing of the system is determined from both space and water heating requirements and takes into account peak energy demands and kWh required for each month.
- A number of possible configurations enable biomass boilers to be used most efficiently. Biomass boilers work most effectively when they are meeting a base heat load that is consistent throughout the year with an auxiliary, possibly gas boiler to meet the peak load. If this load varies significantly during the year then a modular system can be installed (i.e. several smaller size biomass boilers instead of one main boiler enable to switch one off during the warmer season), ensuring that the operating boilers are working at full load hence creating a more efficient system. Buffer tanks can be installed for heat storage. When the heat demand is low, excess heat can be stored in the buffer tanks to enable the boiler to work at full capacity. When the heat demand is high, heat stored in the buffer tank can be used to meet this peak demand.

10.5 Ground Source Heating

Ground source heating

Product information

a) GSHP pipe work
Source: Geoscience Ltd.

b) Pump housing and buffer tank
Source: Geoscience Ltd.

Annex Figure 9: Ground source heating pipe work and pump

- Ground source heating is a tried, tested and reliable means of providing space heating to buildings and is most often combined with under-floor heating. Such a heat distribution system is efficient due to low flow and return temperatures, and offers high levels of comfort for building occupants.
- A ground source heating system comprises piping buried beneath the ground (horizontally or vertically) and a heat pump to extract the heat.
- At a depth of a few metres, the temperature of the ground remains at a constant 12°C throughout the year. This constant temperature is the benefit of ground source heating over air source heating, as the installed pump is able to work at its optimal coefficient of performance (CoP). The CoP is the ratio of the units of heat energy 'out' to the units of electricity 'in', required for circulating the fluid and operating the heat pump. Piping can either be laid horizontally or vertically through borehole drilling. Fluid circulating through the pipes, extract heat from the surrounding earth. The warmed fluid runs through the heat exchanger in the heat pump, which operates in a similar way to a 'reverse' refrigerator. The heat pump raises the temperature of the fluid. This fluid, with an 'upgraded' temperature, can then be used for underfloor heating.

Technical details

- **Vertical closed loop fields** – a borehole is drilled to a depth of between 15 to 100 metres. The size of the overall system will depend on the space heating requirements.
- **Horizontal closed loop fields** – pipes are buried in horizontal trenches which are dug to a depth of 1 – 2 metres.
- **Open loop fields** - water does not return once it passes through the system.
- The flow temperature of underfloor heating, around 45°C, is lower than that required for domestic hot water at 50-60°C. The Coefficient of Performance (COP) of the pump, which is the ratio of the units of heat out to units of electricity in, will be lower when generating hot water compared to when supplying space heating.
- The heat pump housing would be similar in size to a large refrigerator, although different manufacturers use different system configurations. There would have to be sufficient space for maintenance and repair access.
- By operating the ground source heat pump overnight and storing the heat in a thermal store, users may be able to take advantage of cheaper electricity tariffs.

Ground source heating

Energy generating capacity

- The ground source heat pump should have a CoP of 3 or more, in order to gain good carbon savings. That means that for every unit of electricity put into the system, 3 units of heat are produced. The water produced is a 'low-grade' temperature, around 40°C, which is unsuitable for traditional radiator systems that require much higher water temperatures. However, it is ideal for underfloor heating.
- Ground source heat pumps can also be used for heating water, although not all manufacturers recommend this configuration. Heating water to a useful temperature means that the CoP reduces i.e. the system becomes less efficient. If heat pump systems are to be used for space and water heating, it is preferable that they run from different pumps. In this way, when the heating demand is low, one pump can be turned off rather than run at part load.

Environmental requirements

- Vertical drilling may be possible in areas that are free from obstructions. Where possible, borehole drilling on contaminated land should be avoided, although methods of boring in such areas have been developed.
- A ground survey is required in order for the system to be correctly sized, as the rate of heat transfer will be dependent on soil properties. A drilling license may also be required.
- Laying the pipes horizontally in trenches is cheaper than boring vertical boreholes. However, a large area of open ground is required.

Building design requirements

- Horizontal pipes can be buried beneath paving and car parks but are generally not laid beneath buildings.
- Sufficient space for the pump and buffer tank is required.

Maintenance

- System maintenance is minimal. The piping infrastructure, like utility piping infrastructures, rarely requires maintenance. Only the pump may require maintenance work and it is easily accessible.

Auxiliary equipment required

- Thermal store
- Low grade temperature heat distribution system

Installation and planning issues

- The pipes, buried below ground, do not require maintenance. The only visible part of a ground source heating system is the pump itself, which can be housed in a container about the size of a refrigerator and can be easily accessed should any maintenance be required.
- If a ground source heat pump is to be installed, it should be considered from the earliest stages in a development's design process, as a suitable heating system needs to be installed.

Estimated costs

- Electricity is required to operate the pump. Installing a heat pump to replace a gas-fired heating system is less economically favourable than one replacing electrical or oil heating systems. Vertical bore holes are more expensive than horizontal trenches.

Ground source heating

Additional Information

- **Ground source cooling** is the inverse of the ground source heating system and operates, in effect, like a large refrigerator. One system can be installed to operate as a heating and cooling system. Such a system can increase the CoP, as during the cooling cycle, heat is put back into the ground to be extracted again later during the heating cycle.
- Natural and passive ventilation should be considered before mechanical ventilation. Air conditioning should not be encouraged, especially on residential developments, due to the environmental impact it would have.

10.6 Financing low and zero carbon technologies

Financing low and zero carbon solutions

Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Government Grants

The Whitehorse Manor Infants and Junior School may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the Whitehorse Manor Infants and Junior School could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Financing low and zero carbon solutions

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Wolsey Infant School

Study completed by CEN

10/14/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	41990	1470	0	0
Control of Lighting	6588	560	0	0
Top Energy Efficiency Measures	**Energy Savings (kWh pa)**	**Cost Savings (£ pa)**	**Installation Cost (£)**	**Payback period (years)**
Roof Insulation	43740	1531	10487	7
TOTAL[1]	92,318	£3,560	£10,490	2.9

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of **92,318** kWh
- ✔ Achieve financial savings of **£3,560** per year, and protect against future fuel price increases.

Our initial analysis suggests the cost of implementing these measures would be in the region of **£10,490**. This would imply a simple pay back of only 2.9 years. The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisation's image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	50

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed).

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiently. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Wolsey Infant School has 400 building occupants, and the building type has been classified as 'Education Buildings Primary' for the purposes of making comparisons with benchmark data.

From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and technology within the school.

2.2.1 Building age and tenancy, and the impact on opportunities for energy improvements

As parts of your building are relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the

use and control of energy using equipment is carefully considered to identify the savings within this report.

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.2 Energy Consumption

The current annual gas consumption of the site is 341680 kWh pa and the current electricity consumption is 65880 kWh. This equates to costs of £11,958 and £5,600 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		Annual Cost		Annual CO_2 emissions	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	65880	16	**£5,600**	**32**	27800	30
Gas	341680	84	**£11,958**	**68**	66290	70

2.2.3 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

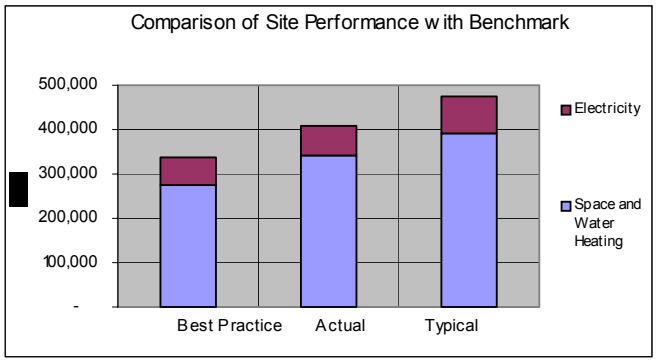


Chart 1-1 Current Energy Performance

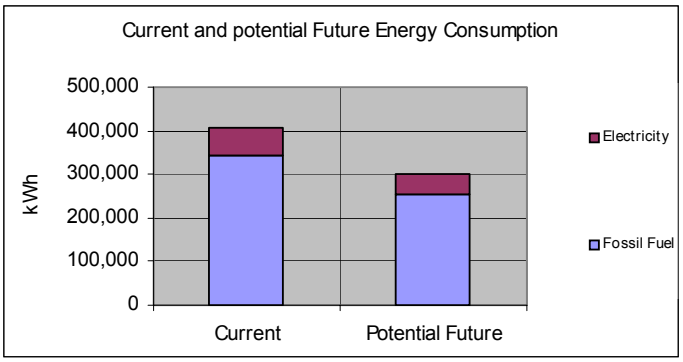
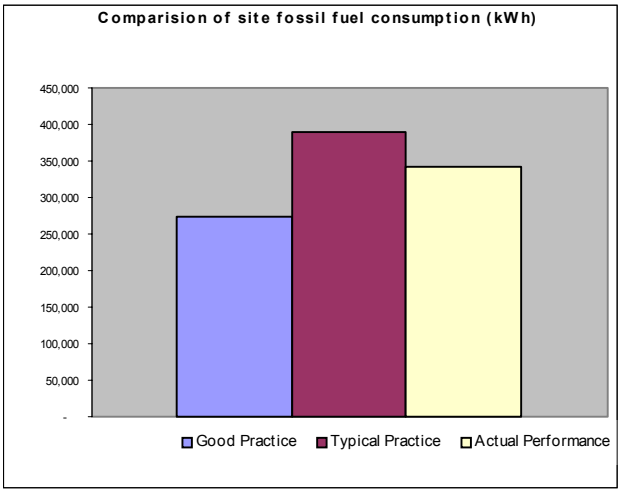


Chart 1-2 Energy Saving Opportunities

2.2.4 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



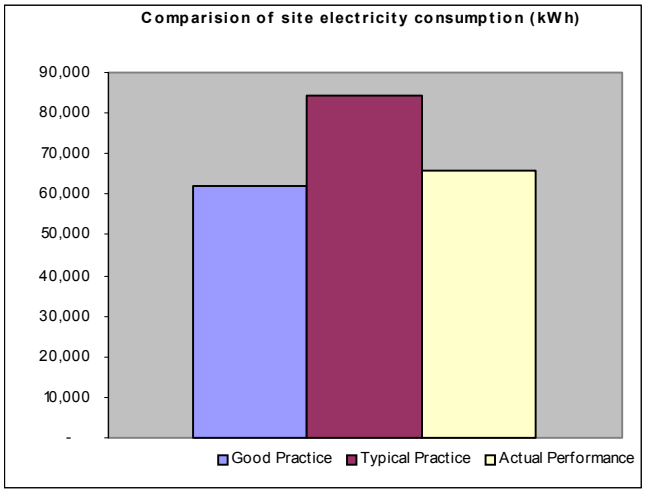


Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on

your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark

The site is performing well according to typical consumption within similar buildings in the same sector. Best practice involves a greater level of energy efficiency and associated cost savings, and therefore should be strived for as an overall target, by incorporating the measures detailed in this report. Performing well against the industry standard is a positive result for your company. However, it is very important to reduce waste and not be complacent with regards to energy usage. Therefore the measures detailed in this report have identified additional improvements you can make, and therefore help you save money and improve efficiency.

Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. There are currently issues with the proportional allocation of utility bills between the Infant and Junior schools. It is believed that this issue is being investigated by Croydon Council. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don’t measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

- Better control & reducing your internal temperature could deliver a £1470 saving pa with no investment

- Installing TRVs (Thermostatic Radiator Valves) co
investment of £354. At the current time the valve
any upgrading of grilles or radiators is planned, TR
trained in how to use them. At the current time cla
opening windows during the heating season which
consumption. As all classrooms have multiple rad
overheat, ie south facing rooms or those at the sta
be turned off. The Site Manager can do this at no

Figure 1 Radiator valve behind grille

- It was observed that your boiler and pipework are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system. Pipe insulation should be upgraded in areas of the school that regularly experience overheating to reduce this problem and to ensure sufficient heat is delivered to colder classrooms.

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower

levels of physical activity. It was estimated that current temperature controls are set to 21 degrees. If you reduce your building temperature by 2 degrees, you could save around 41990 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures. Training is currently being provided for the Site Manger to have better control over the heating system. If no upgrades to the heating controls are planned, a high degree of manual control will help considerably reduce heating costs through matching external temperatures and reacting to experienced building temperatures. The boiler running time should also be reduced as IT equipment and human metabolic processes will give out heat during the day. This means that the heating system can be turned off well before the end of the day whilst still maintaining comfortable temperatures.

Zoning

Zoning of the heating system could be possible within your school, meaning that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This could provide savings through area-specific reductions in heating temperature. There are 3 zones on site: Dining and Assembly; Juniors and Infants If the Assembly area is being used outside usual hours, it should be ensured that only this zone is heated. Further zones allow more specific heat delivery and are strongly recommended as part of a heating control upgrade.

Figure 2 Three heating zones and hot water control can be operated seperately

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

sible for you to have roof insulation retrofitted encapsulated.

Figure 3 Cavity wall brickwork at Wolsey Juniors showing holes where insulation has been retrofitted

Insulation type, cost and efficiency will vary greatly according to the type of building structure your school currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

Figure 5 Draught proofing doors and windows would result in significant energy savings and comfort improvements

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	Installation Cost	Payback (Years)
T12 to T8 Conversion	6588	560	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting. Lights in each classroom are zoned. Staff should keep lights nearest the windows turned off and turn on banks of light deeper in the room as required to ensure even lighting of classrooms.

By switching off unnecessary lights, you could potentially save 6588kWh or £560.This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. Lights were left on in unoccupied rooms; staff training pupils could be put up to remind staff to turn off lights.

Figure 6 Lights could be turned out in corridors as natural lighting is sufficient

Blinds and curtains should be open when natural light is sufficient to negate the need for artificial light. Several blinds and curtains had been drawn to reduce IWB glare, but left down when the projector was no longer being used. When blinds require replacing, white slatted blinds should be considered as these reduce glare and overheating from light penetration in summer but still allow some light to enter the room.

Figure 8 Curtains do not need to be drawn at the back of the classroom where glare on projectors is not an issue

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

Almost any 1.5 inch (also known as T12) diameter fluorescent tube, can be replaced instantly with a slimmer 1 inch diameter (or T8) tube. These bulbs commonly use around 8% less energy than the equivalent. Your organisation could potentially fit T8 bulbs to replace existing lights to provide the savings detailed in the table above. These bulbs cost the same amount as T12, and therefore can be replaced when existing bulbs blow (at no additional cost). When replacing fluorescent bulbs, specify a triphosphor coating on all new tubes as this will make the bulbs last longer and remain brighter than normal fluorescent tubes.

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Figure 9 Diffuser fitting

Figure 10 Reflector fitting

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers.

Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. Therefore there are several further investments you can make which will reduce your energy consumption further. These are recommended at Wolsey Infants in infrequently used areas such as cloakrooms, photcopier rooms and toilets.

Fig 3-2 Lighting offers simple, low cost savings

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use. Screens in the IT rooms should be switched off when computers are not in use. In standard classrooms, unused computers should be completely switched off.

Figure 11 Screens and computers in IT suite left on

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

You could potentially save 4941kWh or £420 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off

during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g. heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste. There are currently issues with the proportional allocation of utility bills between the Infant and Junior schools. It is believed that this issue is being investigated by Croydon Council. For more accurate billing and monitoring, it may be desirable to install separate meters for the two schools and to agree a percentage cost responsibility for shared areas, ie, the dining hall and kitchen.

3.6 Teacher and Pupil Awareness and School Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:
1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.

Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

4 Energy Management Plan

4.1 Summary of recommendations:

Wolsey Infant School can reduce energy costs by a minimum of £3,560 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.

Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.

Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating. Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

4.8 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

The table below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• Incompatible hot water demand
Wood-fuel heating	Thermal	✗	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✗	• Incompatible heating system

Summary of feasible technologies

5.2 Recommendations

Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Installation and operational issues
Option 1. PV Large Installation						
Solar PV Sanyo Hybrid 63.84 kWp (380.9 m2)	49,962	21,484	287,280	143,640	535 (267)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. PV Small installation						
Solar PV Sanyo Hybrid 11.34 kWp (67.7 m2)	8,875	3,816	56,700	28,350	594 (297)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

The sustainable energy options

Option 1

Option 1 is the largest possible PV installation using all available roof space.

Option 2

Option 2 represents a smaller installation costed in line with available grant funding.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Wolsey Infants with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has a large area of flat roof. The total unshaded flat roof area available is estimated as 720m^2. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is 10,175 m^2 of soft ground area. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for the Wolsey Infants site in order to rule out unfeasible options.

- Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Wolsey Infants would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Table 5-1 shows the list of technical criteria necessary for a technology to be feasible.

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	×
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	×
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	×
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	×
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	×
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	×
Fuel supply chain	Is there an established fuel supply chain?	×
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	×
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	×

Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	×
Flue	Can the flue be designed to meet planning authority requirements?	×
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	×
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	✓
Piping	Is there a large area of open land where piping could be installed?	✓

* Assuming that the design is defined to meet these criteria

Table 5-1: Technical feasibility of each technology

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaics

8.1.1 Site Information

There is a lot of open space on the roof of the buildings. A structural survey may need to be carried out to determine roof integrity, but the initial site visit suggests that the roof would be suitable for solar PV.

8.1.2 Product information

Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.

The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 63.84 kWp (380.9 m2)	49,962	21,484	3,497	287,280	143,640	535 (267)	82 (41)
Solar PV Sanyo Hybrid 11.34 kWp (67.7 m2)	8,875	3,816	621	56,700	28,350	594 (297)	91 (46)

Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the flat roofs would be have the panels mounted on an A-frame pitched at 40 degrees from horizontal and that they would be oriented towards south.

8.2 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

9 Summary of options

9.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kgC O_2/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Installation and operational issues
Option 1. PV Large Installation						
Solar PV Sanyo Hybrid 63.84 kWp (380.9 m2)	49,962	21,484	287,280	143,640	535 (267)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. PV Small installation						
Solar PV Sanyo Hybrid 11.34 kWp (67.7 m2)	8,875	3,816	56,700	28,350	594 (297)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Renewable energy solutions for the Archway Methodist Church site

9.1.1 Options

Option 1

Option 1 is the largest possible PV installation using all available roof space.

Option 2

Option 2 represents a smaller installation costed in line with available grant funding.

10 Conclusion

10.1 Going forward

The aim of this study is to provide Wolsey Infants with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

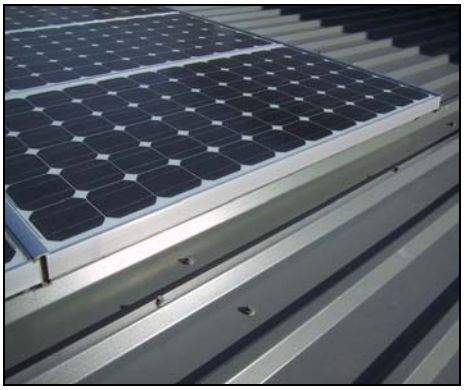
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.

11 Annexes

11.1 Solar Photovoltaics (PV)

Solar photovoltaics

Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e

d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kgC/kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Solar photovoltaics

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in **Annex Table 1**. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year, although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Solar photovoltaics

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Health and Safety issues

- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

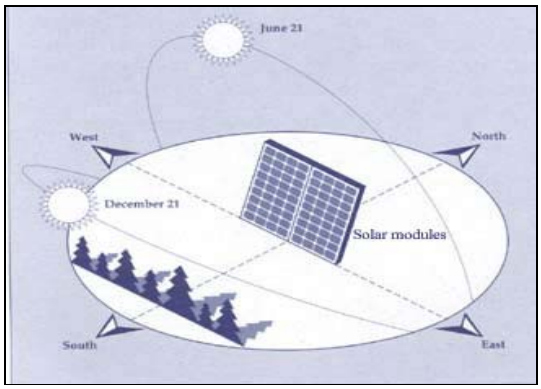
Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

Solar photovoltaics

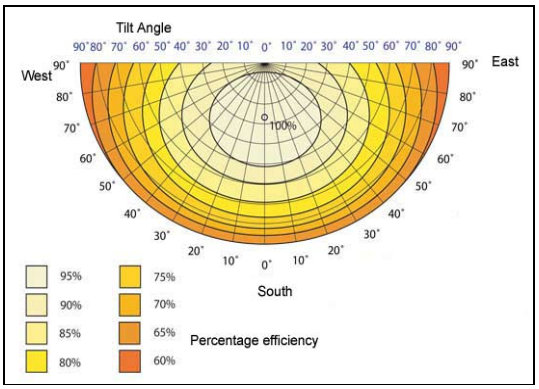
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: *NREL*

Annex Figure 2: Solar variations throughout the year



Source: ***Solar Access***

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

11.2 Financing low and zero carbon technologies

Financing low and zero carbon solutions
Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

Financing low and zero carbon solutions

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of ‘small generators’ in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.

creative environmental networks

Sustainable Energy Report for Wolsey Junior School

Study completed by CEN

10/15/2008

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1 Executive Summary

1.1 Reducing energy consumption and fuel bills

The following Table provides the key recommendations for your school. It includes the low and no cost measures that will deliver the greatest saving, as well as the energy efficiency measures that will deliver the best return on investment.

Top No/Low cost Measures	Energy Savings (kWh pa)	Cost Saving (£ pa)	Installation Cost (£)	Payback period (years)
Reduce Internal Temperature	53440	1870	0	0
Control of Lighting	8384	710	0	0
Switch Off Equipment	6288	534	0	0
TOTAL[1]	**68112**	**3110**	**0**	**0**

Our initial assessment indicates that through the recommended energy efficiency measures along with a few simple low (or no) cost measures, your organisation could achieve the following.

- ✔ Deliver environmental benefit with an energy saving of 68112kWh
- ✔ Achieve financial savings of £3110 per year, and protect against future fuel price increases.

The specific measures recommended, financial information and technical details are of course included in the attached report.

[1] Please note that total and cumulative savings do not incorporate the inter-relationships between measures.

1.2 Renewable Energy Options

The following Table provides key renewable options available to your organisation. Renewable energy is an excellent investment, which can save costs in the longer term, and improve your organisations image. In addition the costs noted below do not include grants available, which can often be at least 50% of the cost

Top Renewable options	CO_2 Savings (Kg pa)[2]	Cost Savings (£ pa)	Guideline Installation cost (£)	£/KgCO_2
Solar PV (per kWp)	110	80	5800	52

- ✔ 110kg of Carbon could be saved each year with the installation of a Solar PV (per kWp) system.
- ✔ Implementing this renewable energy system will enable you to make a visible statement of your commitment to corporate social responsibility

1.3 Next Steps

CEN would be delighted to assist you in taking the next steps to realising the benefits of energy efficiency measures and renewable energy technologies. We offer free follow-up support and advice, helping you to implement the recommendations. We will support you in engaging teachers and pupils and developing an Energy Plan, setting out actions & targets. CEN can then provide access to grant funding and discounted installations (should you wish to proceed)

Of course the above support does not commit you to anything, but should you wish, CEN will then support you through the process to installation, and may be able to assist you in identifying grants available for energy saving systems.

If you would like further information on any aspect of this report please do not hesitate to contact 020 8683 6600.

[2] Please note that all costs and savings indicated within this report are indicative estimates based on your figures and industry benchmarks. Therefore if these measures are undertaken, where appropriate the necessary suppliers, installers and designers should be consulted to provide confirmed accurate details.

2 Introduction

Reducing energy consumption makes perfect sense – saving money, enhancing reputation and improving the environment.

2.1 About the Report

One of the main energy areas for your school is renewable energy. Renewable energy is a great opportunity for organisations to improve their environmental impact and green credentials and potentially reduce the running costs of their energy processes. The first priority before considering renewable energy is reducing the need for this energy, and then using this energy more efficiency. Before investing in renewable energy, we advise that an organisation first considers these aspects, as they can often lead to immediate savings with little cost. Different technologies will be viable for different locations and further information about this can be found within this report, with savings where applicable. For more information please call CEN on 020 8683 6600

2.2 An Overview of the Site

Wolsey Junior School has 410 building occupants, and the building type has been classified as 'Education buildings Primary' for the purposes of making comparisons with benchmark data.

From the nature of the school (including size) benchmark data has been used within this report to assess energy performance against industry standards, and also assess equipment and

1.1.1 Building age and tenancy, and the impact on opportunities for energy improvements

As your building is relatively old, it is likely that the energy efficiency of the building will be relatively poor. Therefore your organisation could substantially benefit from incorporating the measures indicated in this report. In particular, changes to the building insulation and heating system could provide significant energy savings. We recommend that you check the efficiency of your building and equipment, and monitor energy consumption. Behavioural measures often have very high associated energy savings with zero cost, and therefore we recommend that the use and control of

energy using equipment is carefully considered to identify the savings within this report

Your school currently does not own the premises as the building is owned by the council. Therefore, any installation works suggested within this report may need to be agreed or negotiated with the council. The budget available from both the school and council may dictate the scale of work which could be completed, however many low cost and behavioural measures can be undertaken as quick wins.

2.2.1 Energy Consumption

The current annual gas consumption of the site is 434870 kWh pa and the current electricity consumption is 83844 kWh.
This equates to costs of £0 and £0 respectively within the consumption year provided. The following table provides a summary of your annual energy consumption:

	Annual Consumption		**Annual Cost**		**Annual CO_2 emissions**	
Utility	**kWh**	**%**	**£**	**%**	**$kgCO_2$**	**%**
Electricity	83844	16	**£7,130.00**	**32**	35382	30
Gas	434870	84	**£15,220.45**	**68**	84364	70
Oil	0	0	0		0	0

2.2.2 Current Building Performance

The following graphs highlight your current energy consumption, and costs before and after implementing the areas indicated by this report, including a comparison with benchmark data:

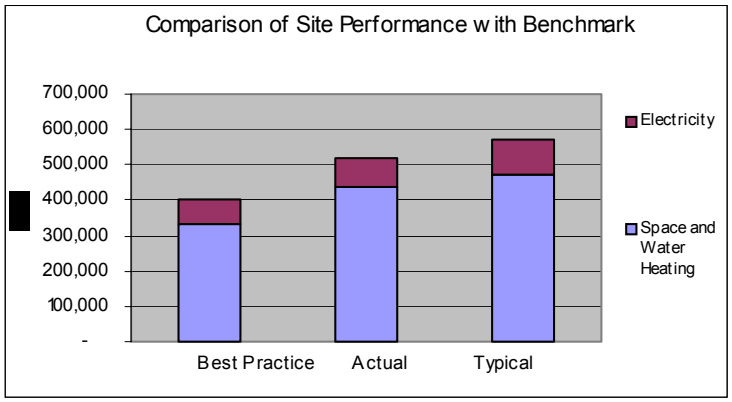


Chart 1-1 Current Energy Performance

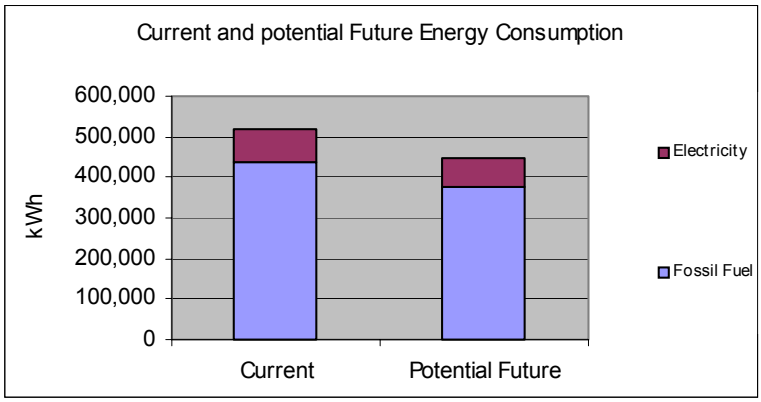
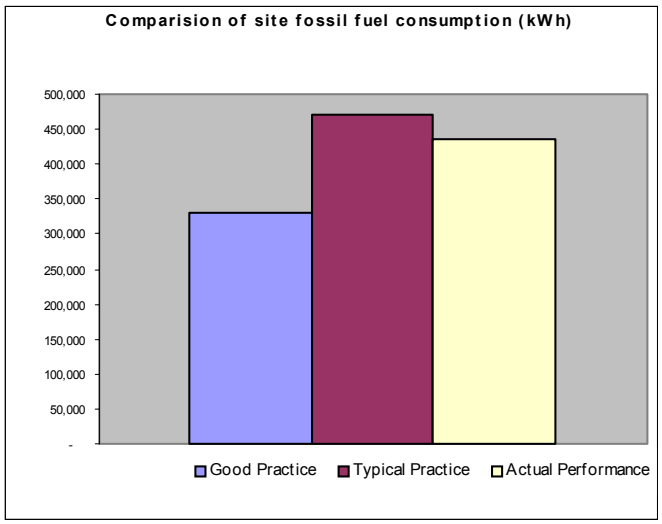


Chart 1-2 Energy Saving Opportunities

2.2.3 Comparison with Benchmark Data

The following graphs demonstrate the comparison between industry best practice for your sector, typical practice and the current energy consumption at your site.



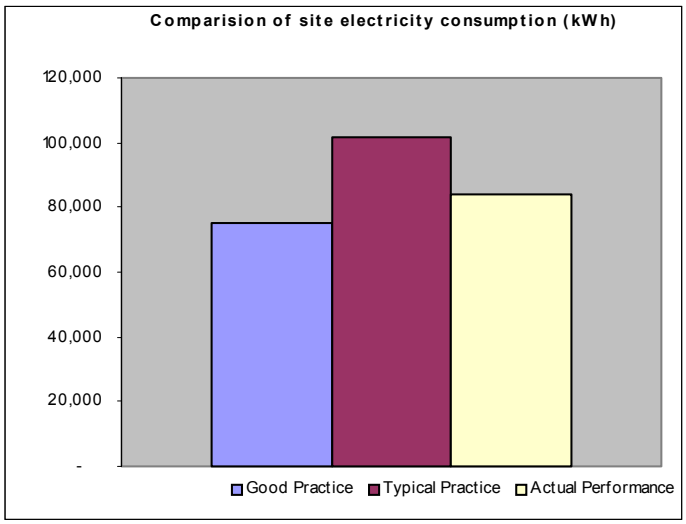


Chart 2-1 Heat consumption against benchmark, Chart 2-2 Electricity consumption against benchmark

Fuel prices vary across the country, and often change quickly. Please note that if you did not enter your energy costs, they will have been estimated based on current typical market prices. We also estimate that fossil fuel prices will rise by around 6% p.a. The savings you make on your energy bills now will grow year on year making energy efficiency an area that your organisation cannot afford to ignore.

Summary of Energy Performance Compared with Benchmark

The site is performing well according to typical consumption within similar buildings in the same sector. Best practice involves a greater level of energy efficiency and associated cost savings, and therefore should be strived for as an overall target, by incorporating the measures detailed in this report. Performing well against the industry standard is a positive result for your company. However, it is very important to reduce waste and not be complacent with regards to energy usage. Therefore the measures detailed in this report have identified additional improvements you can make, and therefore help you save money and improve efficiency.

Monitoring and Continuous Improvement

A good way to achieve reductions in energy use is to monitor and record electricity and gas consumption each month and set benchmarks for continuous improvement. For heating consumption (e.g. gas) this may vary significantly through the year, so should be compared with similar periods in different years. For electricity consumption, it can be useful to establish baseline consumption (e.g. minimum consumption overnight if possible) and compare this with daytime consumption, or periods of unusual consumption to see why and how electricity is being consumed. There are currently issues with the proportional allocation of utility bills between the Infant and Junior schools. It is believed that this issue is being investigated by Croydon Council. For more information please see the Monitoring section of this report. Remember, you cannot manage what you don't measure.

3 Energy Efficiency

3.1 Heating systems and Controls

Heating is one of the biggest consumers of energy within an organisation. Heating consumption and bills can be reduced within your organisation through a combination of improved controls, equipment and insulation.

We have identified these potential savings that your organisation may be able to achieve through making changes to your heating system.

• Better control & reducing your internal temperature could deliver a £1870 saving pa with no investment.

• Installing TRVs (Thermostatic Radiator Valves) could deliver £121savings pa with an investment of £576. AT the current time the valve fitting is inside the protective grille. If any upgrading of grilles or radiators is planned, TRVs should be included and staff trained in how to use them. At the current time classroom temperature is lowered by opening windows during the heating season which greatly increases energy consumption. As all classrooms have multiple radiators, where classrooms regularly overheat, ie south facing rooms or those at the start of the pipe run, a single radiator can be turned off. The Site Manager can do this at no cost.

Figure 1 radiator valve behind grille

• It was observed that your boiler and pipework are sufficiently insulated. When insulation is old, it may be possible to improve efficiency by replacing or upgrading this insulation, therefore this should be monitored alongside maintenance of the boiler and heating system. Pipe insulation should be upgraded in areas of the school that regularly experience overheating to reduce this problem and to ensure sufficient heat is delivered to colder classrooms.

Figure 2 Windows open when heating is on

The recommended temperature for your organisation, according to the Carbon Trust, is around 19-21 degrees centigrade. This will vary within different parts of your building, and depend if there are additional processes occurring, additional heat producing machinery, or higher/lower levels of physical activity. It was estimated that current temperature controls are set to 21 Degrees. If you reduce your building temperature by 2 Degrees, you could save around 53440 kWh each year.

This is a zero cost measure, but will require testing of temperature controls, and consultation with teachers to ensure that working conditions are comfortable. If high temperatures have been set to overcome under-heating problems, then this issue should be considered together with other heating system and insulation measures. Training is currently being provided for the Site Manger to have better control over the heating system. F no upgrades to the heating controls are planned, a high degree of manual control will help considerably reduce heating costs through matching external temperatures and reacting to experienced building temperatures. The boiler running time should also be reduced as IT equipment and human metabolic processes will give out heat during the day. This means that the heating system can be turned off well before the end of the day whilst still maintaining comfortable temperatures.

The thermostat is located in eth school hall which does not accurately reflect the temperature being experienced by most building occupants. This thermostat should be relocated during heating control upgrades.

Some hot water taps where leaking which means that hot water was being heated unnecessarilly. These can be repaired by the Site Manager. If the problem is found to be that staff cannot turn the taps off tightly enough, self-closing taps should be considered.

Zoning

Zoning of the heating system could be possible within your school, meaning that temperatures of rooms with high occupancy levels/electronic equipment can be kept cooler than those without. This could provide savings through area-specific reductions in heating temperature. There are 3 zones on site: Dining and Assembley; Juniors and Infants If the Assembley area is being used outside usual hours, it should be ensured that only this zone is heated. Further zones allow more specific heat delivery and are strongly recommended as part of a heating control upgrade.

Figure 3 Three heating zones and hot water control can be operated seperately

Fig 3-1 Simply using controls effectively can save £'s at no or little cost

3.2 Insulation

All buildings lose heat through the walls, ceiling, floor and windows. If these areas are better insulated, then less heat will be lost, and therefore less energy will be required to heat the building overall.

You currently have filled cavity walls. It is not possible for you to have roof insulation retrofitted as you have flat roofs which have been asbestos encapsulated.

Figure 4 Cavity wall brickwork at Wolsey Juniors showing holes were insulation has been retrofitted

Insulation type, cost and efficiency will vary greatly according to the type of building structure your school currently occupies. It is always recommended that before considering any type of insulation you check any existing insulation and your building structure. CEN can help with quotes and recommend installers, please call 020 8683 6600 for more information on insulation measures.

We identified several draught areas within the school. Draught proofing is a simple and low cost measure, which can usually be fitted by the school caretaker or site manager. Materials are inexpensive and the improvements in both comfort and energy savings are significant. Therefore this is recommended as a priority measure for the school.

3.3 Lighting

Lighting is a cost effective way to reduce fuel bills. Reducing both the amount and time that lighting is used can be done through behavioural change and investment in controls. In addition inefficient lighting can be replaced with more efficient lights that use up to 75% less energy.

The following table summarises the opportunities for saving money on lighting:

Lighting Savings	Saving (kWh)	Cost Saving (£)	InstallationCost	Payback (Years)
Control of Lighting	8384	710	0	0

Other opportunities for you to reduce your bills on lighting include:

Encourage task lighting – making sure only occupied areas are lit, i.e. make sure that 1 teacher is not lighting the entire building unnecessarily. This could be combined by labelling light switches to help teachers select the correct lighting. Lights in each classroom are zoned. Staff should keep lights nearest the windows turned off and turn on banks of light deeper in the room as required to ensure even lighting of classrooms.

By switching off unnecessary lights, you could potentially save 8384kWh or £710. This has been identified from your estimations on how many hours lights are on, the type of lights you currently use, the percentage of lights which are on in unoccupied areas/out of hours, and your overall working hours. Lights were frequently left on in unoccupied rooms; staff training and posters and stickers designed by pupils could be put up to emind staff to turn off lights. Energy monitors in each

class can also have responsibility for turning out lights. The School Council have already discussed this as an action to take forward.

Figure 5 Black out blind reduces natural light

Figure 6 Lights could be turned out in corridors as natural lighting is sufficient

Blinds should be open when natural light is sufficient to negate the need for artificial light. Several blinds had been drawn to reduce IWB glare, but left down when the projector was no longer being used. When blinds require replacing, white slatted blinds should be considered as these reduce glare and overheating from light penetration in summer but still allow some light to enter the room.

Figure 7 In the school hall curtains could be open as there is no task work or glare issues, particularly on a low light day

Your building was not found to have any traditional tungsten lights. These lights can usually hold energy efficient light bulbs which use 75% less energy, at little extra cost. If you buy/install new lights or change any fittings within your building we recommend that you fit energy efficient light bulbs wherever possible.

Figure 8 Blackout blinds do not need to be drawn at the back of the classroom where glare on projectors is not an issue

As well as changing bulbs, fittings can also make a big difference to lighting energy. Fluorescent tubes usually fit into one of two types of fitting – diffusers or reflectors. Diffusers are generally plastic cases designed to reduce glare, while reflectors are generally mirrors reflecting and increasing the useful light received in the room. As reflectors will increase the light within an area, bulbs can often

be replaced with lower wattages or removed entirely. There are additional considerations of glare, dimming capability and various frequencies of lights.

Figure 9 Diffuser fitting

Figure 10 Reflector fitting

Investments in controls can often yield further savings. Lighting controls come in a variety of forms but can include Time Operated, Daylight Linked, Presence / Occupancy Sensors or Dimmers. Occupancy sensors help to ensure that lights are only operational when someone is there to require them. Sensors can save up to 30% on lighting costs. However, this option is not always suitable – for example where people are still for long periods at desks. Time delay controls and photo-electric cells can provide similar benefits, and dimmers add additional elements of control over levels of lighting. These are recommended at Wolsey Juniors in infrequently used areas such as cloakrooms, photcopier rooms and toilets.

3.4 Equipment

Individual pieces of equipment within your school will usually consume relatively small amounts of energy. However, cumulatively, they can represent a large proportion of your electrical consumption. Therefore it is very important that equipment is only on when it is being used.

Awareness campaigns are excellent ways of improving the switching off of equipment. This needs to include all teachers and pupils (i.e. cleaners, security etc) to be effective. As with lighting, stickers can also improve awareness of this.

It is essential to switch off computers and other office equipment when not required. Screen savers do not save energy, and in older computers the monitor can actually use up to 70% of the total computers energy. Most printers and photocopiers have powersave modes which are simple to use, and will automatically run at lower power when not in use.

Figure 11 These screens have been left on although computers have been turned off

Switching off equipment at night, such as vending machines, is an immediate and zero cost way to reduce energy use. Smaller actions, for example simply filling up the kettle to the minimum level required, will also save energy.

Figure 12 In this unoccupied classroom, the projector and IWB have been left on, lights are on and blinds are drawn reducing the use of natural light

You could potentially save 6288kWh or £534.7 through switching off computers and other common office equipment. If your school is very IT intensive, this value could be even higher.

Refrigeration can be a significant energy consumer. Simple measures can be taken to reduce this consumption. Excessive cooling (as with excessive heating) wastes energy, and doors left open/poorly insulated will also use more energy and also pose health risks. Open fronted refrigeration units can be fitted with night blinds, and refrigerator lights should be turned off during the nights to prevent further energy waste. In addition, any additional source of heat should be removed from the refrigeration area to improve the heat balance. For further information please contact us on the number provided above.

Air conditioning/ventilation controls can deliver significant savings – it takes energy to heat and cool air down, and if that air is then removed, the money used to heat/cool the air is lost, and the old air needs to be replaced with new air at the correct temperature. Natural ventilation should be maximised wherever possible. Ventilation systems should not be running when the building is not occupied, and indeed can often be set to only be used at certain times or the day/week/year. Careful consideration between the balance of heating and ventilation (both artifical and physical – i.e. opening windows) is required, to ensure that energy is not being used unnecessarily (e.g.

heating and cooling simultaneously). Air conditioning should be set to come on at 24°C and should not compete with heating. Leaving air conditioning on at night will greatly increase running costs.

3.5 Monitoring, measuring and billing

It is recommended that meter readings where possible are recorded for all utilities on a monthly or even weekly basis to identify trends and patterns, and most importantly potential problems such as water/gas leaks that will allow you to make corrections and hence reduce your fuel bill further.

In addition, the meter readings taken by your school can then be compared to those found on your bill, helping you identify any overcharging errors from your supplier (estimated readings are often used by utility companies to save costs in meter reading, and are sometimes over estimated).

Improved monitoring and targeting will maintain energy performance and prevent future energy waste. There are currently issues with the proportional allocation of utility bills between the Infant and Junior schools. It is believed that this issue is being investigated by Croydon Council. For more accurate billing and monitoring, it may be desirable to install separate meters for the two schools and to agree an percentage cost responsibility for shared areas, ie, the dining hall and kitchen.

3.6 Teachers and pupils Awareness and school Integration

When implementing the actions described within this report, it is recommended that you involve your teachers as much as possible, to enable them to provide input into the changes, and also better understand how to reduce energy consumption. An energy plan setting targets and activities could be considered as a valuable tool to engage teachers, and also clarify which actions you wish to take forward and any other actions you consider practical.

An Energy Plan could include the following actions:

1) Monitor energy consumption and account for primary uses of energy
2) Agree to realistic energy saving targets
3) Adopt a policy of “Good Practice” in the operation of heating and electrical equipment
4) Raise awareness of energy use among teachers and pupils
5) Encourage no-cost behavioural change
6) Use cost savings to finance further investments in energy efficiency or renewable technologies

A member of staff could be designated as an "energy champion" or environment champion. They would have responsibility for checking equipment and lights are turned off, and making sure other teachers and pupils are aware of their environmental impacts and any environmental policy which your school may have.
Energy and environmental action could be taken a step further within a management system. BS8555 and ISO14001 programmes can help you manage your organisation more efficiently, and gain recognition for your efforts and successes.

By completing this school Energy Check, you have indicated that you are interested in energy efficiency, and the potential benefits this can bring to both financial bottom line and environmental improvement. The guidance within this report is indicative according to the size and type of your organisation. If you require further advice or help on any of the matters arising out of this report, please contact CEN on 020 8683 6600 with your client reference to hand.

4 Energy Management Plan

4.1 Summary of recommendations:

Wolsey Junior School can reduce energy costs by a minimum of £3110 per year by adopting an energy action strategy. The school must employ the following steps as part of its strategy:

1) Promote awareness amongst students and staff
2) Monitor energy consumption
3) Account for the primary uses of energy
4) Adopt a policy of 'good practice'
5) Encourage behavioural change amongst students and staff

The energy and cost savings will only be achieved if the measures detailed in this report are properly implemented.

The school needs to draft a clear and simple energy strategy with defined responsibilities, targets and objectives. This should entail the following actions:

4.2 Promote Awareness

Set up an 'energy team' to raise awareness amongst staff and students of how much energy is used; how to reduce the school's energy use; and to engage staff and students in behaving more environmentally responsible.

Nominate 20-30 students and members of staff to act as 'energy monitors' to perform tasks such as switching off lights or taking temperature readings.

Thermometers should be prominently installed in classrooms to indicate the comfort level within the building to staff.

Add stickers or posters in classrooms to remind students and staff to switch off lighting and electrical equipment when the rooms are unoccupied.

Report the observed energy savings to staff and students through postings on notice boards and in classrooms.

4.3 Monitor Energy Consumption

Keep records of annual figures for gas, electricity and water consumption in addition to cost. This will help provide a basis to determine savings compared with previous years.
Conduct a proper survey of the school in order to determine which appliances and plant need to be replaced.
Identify the barriers to making changes to the school's energy use (e.g. finance; manpower; time; or security restrictions).

4.4 Account for Primary Uses of Energy

Place a more accurate cost on wasteful practices such as overheating, lighting after hours and leaking water pipes.
Develop an action plan of prioritised activities to reduce energy consumption where excessive use is taking place (reduce temperature set points; reduce run time of boilers; replace lighting with more efficient type; introduce controls on plant;)
Using the findings of the energy survey, arrive at:

- The efficiency and consumption of plant (eg; boilers and lighting).
- The running cost of energy consuming plant and equipment.
- The suitability and efficiency of installed plant and equipment.
- The cost of plant running over weekends and lights left on unnecessarily.

4.5 Account for Primary Uses of Energy

Develop a system to monitor where and how energy is being used in each of the main school energy cost centres and how efficiently it is being managed.
Adopt better management of the heating and hot water systems to identify and reduce overheating.
Adjust the main boiler controls as recommended above to ensure the school is not over heated or heated when there is no demand.
Adopt behavioural change and electronic controls to reduce the costs of lighting by 20-30 per cent per annum.
Better management of the IT suite could reduce electricity consumed here by half.

4.6 Encourage No-cost Behavioural Change

Reduce the amount of wasted electricity: switch off or minimise use of equipment in all areas outside school hours, including computers; vending machines; lighting; office equipment and ventilation fans.
Switch off or minimise use of equipment in areas which are not in use, including plant rooms; meeting rooms; store rooms and consider the installation of timer or occupancy controls.
Prevent over-heating of the school by adopting a heating schedule that meets the needs of staff and students

4.7 Use Savings to Invest in Further Energy Efficiency Measures

Establish the effectiveness of measures taken by monitoring energy consumption and evaluate success of adopted measures and promote continuous improvement.
Use quantified savings or projected savings to motivate spending on improving efficiencies in energy use.

4.8 Funding for Energy Efficiency Measures from Croydon Council

Croydon Council is now in its third year of Carbon Trust and internal match funding for an innovative and successful programme to support Council buildings in implementing energy saving measures – The Local Authority Energy Finance (LAEF) scheme. The first year of the scheme alone yielded annual carbon dioxide emission savings of 400 tonnes/annum. It is now tried and trusted within the Borough as a powerful financial incentive in assisting the urgently needed shift to increased energy efficiency across all of the Council's buildings.

Croydon's schools have been the main beneficiaries of the LAEF scheme with 44 projects completed to date and with projects at the pipeline stage in excess of £100,000. As interest has grown in the scheme, more and more schools have begun to realise the potential advantages, both financial and environmental, in making full use of the fund. This has been well demonstrated by a growing number of schools in the Borough signing up for their second or third LAEF project.

The LAEF scheme works by funding the upfront costs of energy saving technology, for example cavity wall and loft insulation, draught proofing, lighting controls and pool covers. The loan is then paid back interest free as annual savings are realised on subsequent energy bills. Repayments are

no more than the value of the energy saved and once the loan is repaid all savings are kept by the school. Essentially the measures pay for themselves. With energy prices almost guaranteed to rise for the foreseeable future, the financial benefits of energy saving technologies will only increase.

Croydon Council is committed to improving and encouraging energy efficiency in schools and in the community. If your school would like to take advantage of this opportunity please contact me to discuss the financial details and current technology in further detail. Free, no obligation quotes are available at your request.

Section 2:
Renewable Energy Appraisal

5 Executive Summary Renewable Energy

5.1 Results of renewable feasibility assessment

Table 4.1 below provides a summary of the feasibility assessment.

Technology	Generation	Feasible?	Reasons
Wind turbines (stand-alone)	Electrical	✗	• Insufficient open area for installation of a stand-alone wind turbine
Solar photovoltaics	Electrical	✓	• Areas of east to west (through south) facing unshaded pitched roofs
Solar thermal	Thermal	✗	• Incompatible hot water demand
Wood-fuel heating	Thermal	✗	• No available space for fuel storage and delivery access
Ground source heating	Thermal	✗	• Incompatible heating system

Table 4-1: Summary of feasible technologies

5.2 Recommendations

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Savings [kgCO_2//yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Option 1. Large PV installation							
Solar PV Sanyo Hybrid 47.67 kWp (284.4 m2)	38,486	16,549	2,694	214,515	107,258	519 (259)	80 (40)
Option 2. Small PV installation							
Solar PV Sanyo Hybrid 10.71 kWp (63.9 m2)	8,647	3,718	605	53,550	26,775	576 (288)	88 (44)

Sustainable energy options

Option 1

Option 1 is the largest possible PV installation using all available roof space.

Option 2

Option 2 represents a smaller installation costed in line with available grant funding.

5.3 Methodology

The approach that has been taken in this study is as follows:

1. Calculate the current carbon emissions related to the energy use of the building through space heating and electricity use.
2. For the feasible technologies, estimate suitable system sizes giving energy produced and carbon offset through their application, guideline system costs and operational information.
3. Calculate percentage of carbon offset through the use of renewable energy technologies
4. Determine the best combinations of technologies to achieve the most cost-effective sustainable energy solution for the site.

The relative merits and challenges related to each of the technology options can then assist Wolsey Juniors with identifying the most suitable sustainable energy solution for the site.

For each of the technology options, indicative supply and installation costs have been indicated. However, accurate costs cannot be established at this stage as design changes or site-specific factors e.g. ground survey, could impact the cost of integrating renewable carbon technologies on the site. Supply and installation costs are based on benchmark data; the financial data provided in this report is indicative only and is intended to assist the decision-making process when determining the most suitable sustainable energy solution. Where any of the proposed energy solutions are taken forwards, further feasibility studies could be required to accurately size the systems, after which a formal tender should be carried out in order to achieve competitive and accurate prices.

6 Roof and ground areas

6.1 Roof

The building has a large area of flat roof. The total unshaded flat roof area available is estimated as 595m^2. This information will be used to calculate the potential sizing for PV and solar thermal renewable technologies

6.2 Ground Area

There is 10,175 m^2 of soft ground area. This information will be used to assess the feasibility of Ground Source Heat Pump Installations

7 Feasibility study of the technologies

In this section, the technical viability of the following renewable technologies has been assessed for Wolsey Juniors in order to rule out unfeasible options.

Building-mounted wind turbines: Building-mounted wind turbines are not yet a proven technology. A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. Therefore, CEN does not recommend the installation of building-mounted wind turbines in the current market environment. However, as the technology is continuing to develop, CEN can provide information on their characteristics, design requirements and the output estimated by the manufacturers, if Wolsey Juniors would still wish to consider this technology as an option.

7.1 List of feasibility criteria per technology

Technology	Criteria	
Stand-alone wind turbines		
Wind speed	Is the average wind speed greater than 6 m/s at hub height?[3]	✗
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✗
Open land around proposed site	Is there sufficient open land for the turbine to be installed?	✗
Distance to nearest property	Are surrounding properties far enough away to be unaffected by turbine noise/flicker?	✗
Solar photovoltaics		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓*
Solar thermal		
Roof orientation	Are the roofs flat or orientated southeast/southwest (through south)?	✓
Roof space	Is there sufficient unshaded roof area?	✓
Hot water demand	Is there a year round hot water demand?	✗
Heating system	Would a solar thermal collector be compatible with the planned heating system?	✓
Hot water storage	Is there room for hot water storage vessels?	✓
Wood-fuel heating		
Heat demand	Is there a year round heat demand?	✗
Delivery logistics	Is there sufficient space for a delivery vehicle e.g. vehicular access to storage hopper, turning circle?	✗
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	✗
Plant room	Is there sufficient space for a wood-fuel boiler and associated auxiliary equipment?	✓
Ground source heating		
Heat distribution system	Is there a low-grade heat distribution system e.g. underfloor heating?	✗
Ground conditions	Has a basic ground study concluded that the site is suitable for ground source heat pumps?	✓
Piping	Is there a large area of open land where piping could be installed?	✓

* Assuming that the design is defined to meet these criteria

Technical feasibility of each technology

[3] Based on benchmark and manufacturers' data, a stand-alone turbine could be viable at a wind speed of around 5m/s at the height of the turbine and may be a more cost-effective way of providing renewable energy generated on-site compared to other technologies. Ideally, however, the wind speed would be greater than 6m/s.

Wind Turbines, Solar Thermal, Biomass and GSHP will not be taken forward for further assessment

8 Renewable Technology Assessments

Please note that all carbon saving percentages provided are in relation to carbon emissions related to the year round energy use

8.1 Solar photovoltaics

8.1.1 Site Information
There is a lot of open space on the roof of the buildings. A structural survey may need to be carried out to determine roof integrity, but the initial site visit suggests that the roof would be suitable for solar PV.

8.1.2 Product information
Solar photovoltaic (PV) cells generate electricity. They are available in a range of products, such as bolt-on panels, solar tiles and glass-glass laminates. Images of and further information about these products can be found in the Annex.

8.1.3 Carbon savings , estimated costs and Payback time.
The estimates in Table 6-1 are based on the use of 210 Wp panels to generate the maximum amount of electricity for the available roof space.

An indication of energy generation and cost data related to the use of PV panels installed on the roof is provided.

	Savings			Cost			
Technology	Energy generated [kWh/yr]	Carbon Dioxide Savings [kgCO_2/yr]	Financial Savings [£/yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP)	Payback (aft. LCBP) [yr]
Solar PV Sanyo Hybrid 47.67 kWp (284.4 m2)	38,486	16,549	2,694	214,515	107,258	519 (259)	80 (40)
Solar PV Sanyo Hybrid 10.71 kWp (63.9 m2)	8,647	3,718	605	53,550	26,775	576 (288)	88 (44)

Examples of carbon savings and costs for PV panels

Assumptions:
These outputs have been calculated assuming that the flat roofs would be have the panels mounted on an A-frame pitched at 40 degrees from horizontal and that they would be oriented towards south.

8.1.4 Life cycle cost implications

There is limited maintenance associated with PV panels. Products generally have a 20 year guarantee, although they have been known to operate effectively after this time. The inverter that converts the direct current (DC) electricity to alternating current (AC) may require occasional servicing.

If the electricity is generated when there is no electricity consumption, it can be exported to the Grid. These units of electricity can either be sold directly to the utility company or sold through ROCs

9 Summary of options

9.1 Renewable Technology solutions

Technology	Energy generated [kWh/yr]	Carbon Savings [kg CO_2//yr]	Guideline cost [£]	Guideline cost after LCBP grant [£]	Cost per ton CO_2[£/t] (aft. LCBP	Installation and operational issues
Option 1. PV Large Installation						
Solar PV Sanyo Hybrid 47.67 kWp (284.4 m2)	38,486	16,549	214,515	107,258	519 (259)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years
Option 2. PV Small installation						
Solar PV Sanyo Hybrid 10.71 kWp (63.9 m2)	8,647	3,718	53,550	26,775	576 (288)	The panels will require cleaning every 5 years to maximize output Maintenance on the inverter may be required after 10 years

Renewable energy solutions for the Wolsey Juniors site

9.2 Options

Option 1

Option 1 is the largest possible PV installation using all available roof space.

Option 2

Option 2 represents a smaller installation costed in line with available grant funding.

10 Conclusion

10.1 Going forward

The aim of this study is to provide Wolsey Juniors with an assessment of the potential for integrating renewable carbon technologies in the most cost effective way. Further feasibility assessments may be requires when taking forward the installation to the next stage. Certain assumptions have been made at this stage of the assessment and costs may vary with further investigation.

The recommendations made in the report are based on the following criteria: cost, carbon offset, site suitability and local planning guidelines.

Each solution has its merits and challenges and the value or burden of these should be quantified through detailed discussion. Specific merits/ challenges include:

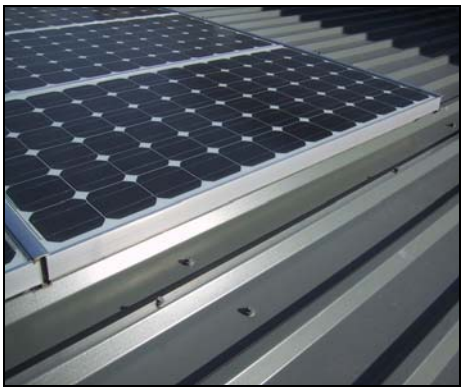
1. **Cost** - certain solutions are more cost effective than others in terms of energy produced per pound sterling spent.

Annexes

10.2 Solar Photovoltaics (PV)

Solar photovoltaics

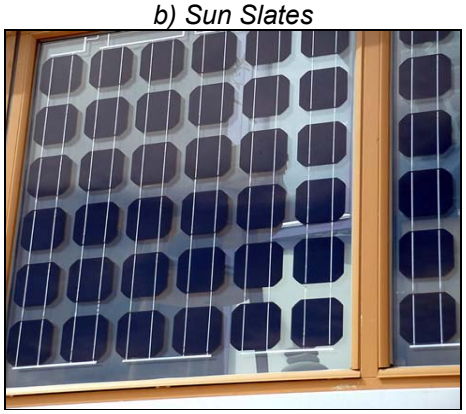
Product information



a) Standard 'bolt-on' modules

b) Sun Slates

c) C21e



d) Glass-glass laminate

Source: solarcentury.com and BioRegional

Annex Figure 1: Solar products

Technology	Electricity generated [kWh/kWp/yr]	Roof area required [m^2/kWp]	Carbon savings [kg CO_2//kWp/yr]	Guideline cost[4] [£/kWp]	Guideline cost[4] [£/m^2]
Bolt-on modules, monocrystalline	830	7	88	6,000	820
Sun slates	830	10	88	8,200	820
C21e tiles	830	8	88	7,000	900
Glass-glass laminates	830	9	88	9,800	1,090

Source: solarcentury.com

Annex Table 1: Outputs of solar photovoltaic products

[4] Cost includes supply and installation for >20kWp. Price per kWp will increase as system size decreases (by up to 20%). Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

Solar photovoltaics

Technical details

- PV panels convert light from the sun directly into electricity.

Energy generating capacity

- An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Annex Table 1. As with wind energy, any electricity that is not consumed at the point of generation can be exported to the National Grid.

Environmental requirements

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

Building design requirements

- **Roof-type**: PV panels should ideally be mounted at tilt angle of 30 to 40 degrees to maximise solar gain throughout the year (see **Error! Reference source not found.** and Annex Figure 3 for more details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.
- **Roof orientation**: the roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation, especially if other technologies could be used instead.
- **Area required**: with the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame.
- PV panels can be mounted in landscape or portrait orientation to maximise the roof space.
- On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Maintenance

- Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient.
- Isolators can be used in order to automatically highlight any problems that the system encounters.

Auxiliary equipment required

- A-frames (if required)
- If excess energy is to be sold back to the Grid, an export meter s required.
- An inverter is always required for a Grid connection.

Installation and planning issues

- With the range of PV products available, it is possible for PV to be integrated into the design of a building, minimising planning issues. Installation of PV is reasonably straightforward.
- Planning permission is not normally required for building mounted PV if it does not project significantly beyond the roof slope. However, exceptions may apply for systems on listed buildings, in conservation areas or areas of outstanding natural beauty.

Solar photovoltaics

Health and Safety issues

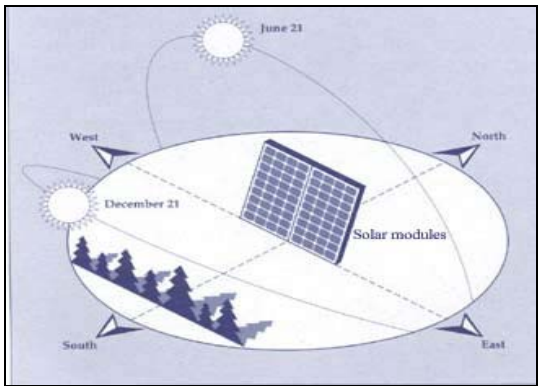
- No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

Estimated costs

- The capital cost of PV is relatively high compared to other renewable technologies. By installing PV in a new-build development, the cost of some building materials may be offset.
- As well as directly offsetting electricity costs on the site and reducing the Climate Change Levy contribution, where applicable, income can be generated through exporting excess electricity or trading ROCs.

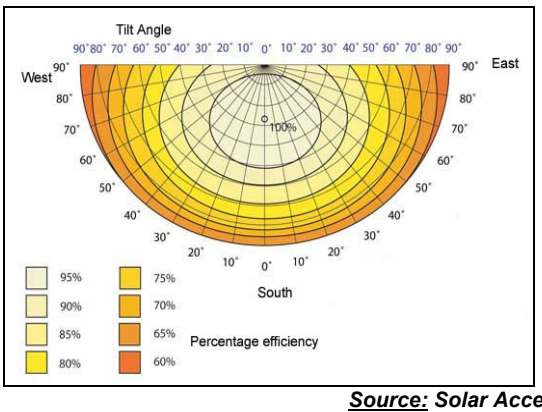
Additional Information

Annex Figure 2 demonstrates how the height of the sun changes throughout the year. Therefore it is important to position solar panels in such a way that they will give an output during the winter months. If a panel were almost horizontal, although the output would be high during the summer, it would receive almost no irradiation during the winter, as the sun is lower.



Source: NREL

Annex Figure 2: Solar variations throughout the year



***Source:* Solar Access**

Annex Figure 3: The reduction in output of a solar PV panel as the tilt angle and orientations change.

10.3 Financing low and zero carbon technologies

Financing low and zero carbon solutions
Certain technologies attract Enhanced Capital Allowance (ECA), enabling businesses to reap the economic benefits of the technologies within a shorter period. Please note that the calculations in Section 5 have assumed no grant funding or ECA. Therefore, if additional funding is applicable, the financial case for the technologies would be significantly more compelling.

Financing low and zero carbon solutions

Government Grants

The Client may apply to the Low Carbon Buildings Programme (LCBP) – Phase 1, Stream 2 and Phase 2, depending on which solution is selected. Stream 2 of the LCBP is split into two categories, both of which are competitive:

- **Stream 2A** – There is a maximum grant of £100k or 40-50% of total costs (excl. VAT). There will be quarterly deadlines for stream 2A applications.
- **Stream 2B** – There is a maximum grant of £1m or 40-50% of total costs (excl. VAT). Deadlines for applications will be twice a year.

Large commercial organisations including developers can apply for up to 40% of the total installation costs (excl. VAT). However, small to medium sized enterprises (SMEs) are entitled to an extra 10% uplift and can apply for up to 50% of the total installation costs (excl. VAT). To find out if your company qualifies as an SME, the LCBP regard them as follows:

An SME is an organisation that has fewer than 250 employees and that satisfies at least one of the following conditions: annual turnover not exceeding €50million; and/or annual balance sheet total not exceeding €43million.

Only one grant is available per installation location (incl. groups of buildings). Grants are available for projects across the UK, excluding the Channel Islands and the Isle of Man.

Phase 2 is a non-competitive funding stream that is only open to public sector organisations, installations have to be completed by framework installers and benchmark costs per kilogram of carbon saved apply. This would not be a suitable stream for a biomass boiler installation as only boilers under 45kW comply.

A number of energy efficiency measures must be undertaken in order to be eligible to apply for a low carbon buildings grant. These measures will ensure that energy requirements are minimised.

More information is available on http://www.lowcarbonbuildings.org.uk/home/

Alternatively if the Biomass option was chosen, the client could apply for a Bioenergy Capital Grant (a guaranteed 20 - 25%, though this cannot be taken in conjunction with any other government grant), which is available through UK installers that have successfully obtained BECG money to distribute to their customers directly.

ESCo Model

Energy service companies (ESCos) will undertake a more extensive service, managing the whole heating system and perhaps other services as well. An ESCo would be able to manage the monitoring and billing for heat and electricity to residents within the development.

Financing low and zero carbon solutions

Renewable Obligation Certificates

All energy producers are required to produce a certain proportion of their energy from renewable energy sources. For every unit of electricity produced in this way (normally measured in MWh), a credit is received, known as a Renewable Energy Obligation certificate (ROC). Producers that are unable to generate sufficient electricity from renewable sources are able to trade ROCs in order to gain the required amount, as specified in government legislation. Therefore any generator of electricity can benefit from this system. Usually, decentralised systems (e.g. roof-mounted PV panel system or small wind turbine) do not generate enough energy in order to become a ROC trader. However, some companies, such as Good Energy, will pay a sum per unit of energy generated to a number of 'small generators' in order to be able to trade ROCs. The tariff per unit of energy is normally very favourable in comparison with the value for which energy can be sold back to the Grid and the ROC system has the added benefit that all energy generated is included, not just excess production.

Climate Change Levy

Organisations that are required to pay Climate Change Levy (CCL) on fuel used can benefit from on-site generation of energy from mini CHP or renewable sources. The CCL does not apply to energy generated on site.