RENEWABLE ENERGY 4 DEVON

Bradworthy School Options Analysis

1.0 Summary

If funding can be secured then a PV array would be the best way to reduce electrical costs. For replacement of the two old Propane boilers the most suitable renewable option would be a pellet or grain boiler. Solar hot water could also be installed to help meet hot water demand in the kitchen.

2.0 Sector

Education

3.0 Location

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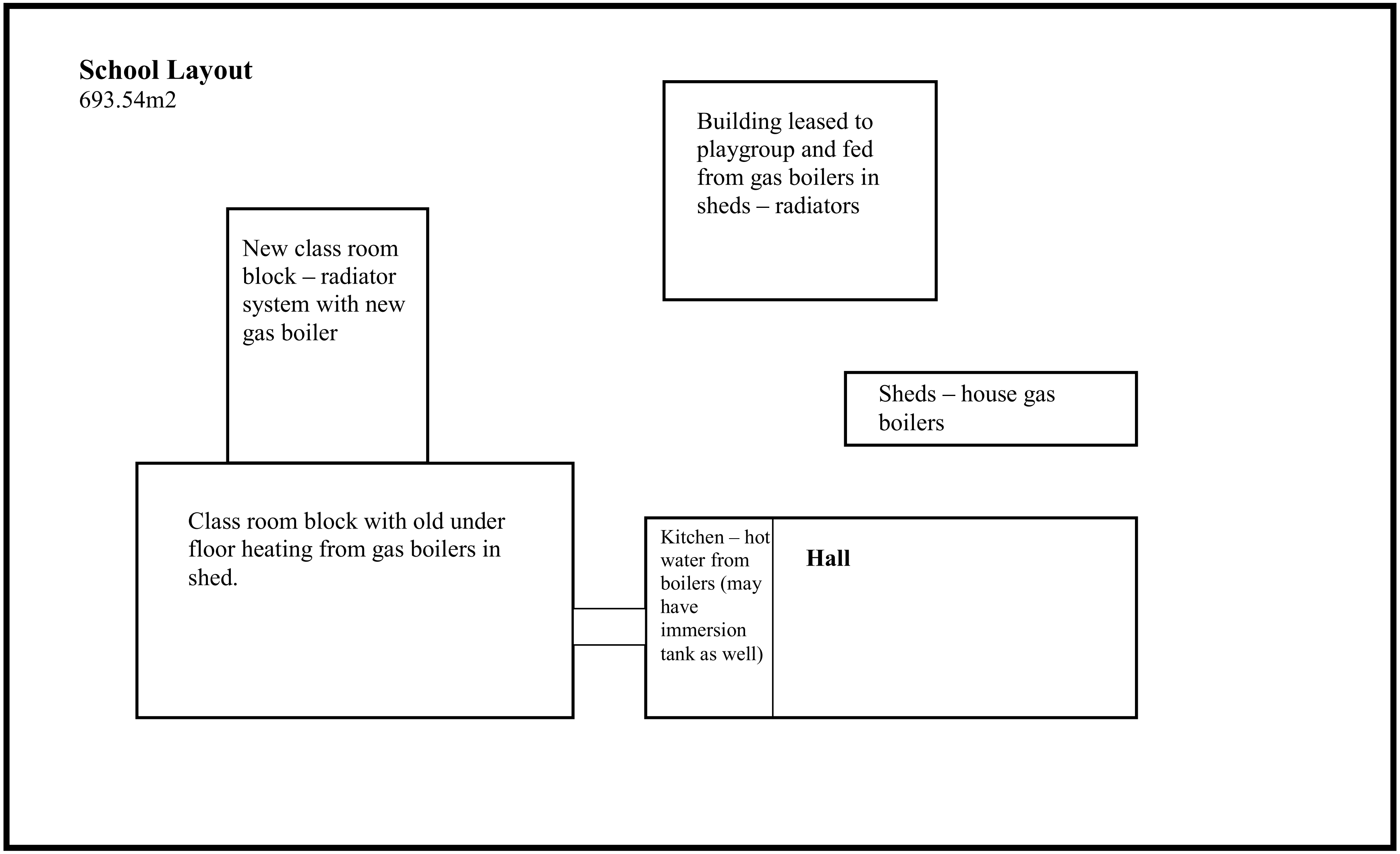
4.0 Overview

Bradworthy School is a primary school with 140 students based in Bradworthy, Devon. The school is a mixture of old and new buildings with various heating systems. The school is 793.5m2.

The school is located in the village and space is very limited. The surrounding area is urban. The school has two old Propane fired boilers that they are looking to replace.


School Layout
693.54m2
Building leased to playgroup and fed from gas boilers in sheds – radiators
New class room block – radiator system with new gas boiler
Sheds – house gas boilers
Class room block with old under floor heating from gas boilers in shed.
Kitchen – hot water from boilers (may have immersion tank as well)
Hall

5.0 Energy Efficiency

Loft Insulation: Insulation depth varies. Deeper in new build section.
Cavity Wall Insulation: Yes in new extension
EE Light Bulbs: Most lights are fluorescent tubes
Thermostatic Controls on Radiators: Main part of school is old under floor heating – most radiators in older sections are old wall units.
Glazing: Some double glazing.
Any other info:

Energy Efficiency measures to be considered: Higher levels of insulation in older sections of school.

Example of older radiator in the main school.

An example of the radiators in the main hall of the school.

6.0 Current Energy System and Usage:

Electrical: £3591.03 P/A = 44887kWhs = 19302 kgs of CO_2– the usage has grown markedly since the computer suite has been installed. The school are keen to offset this if possible.
Grid Connection: single phase
Heating: £5255.03 P/A gas = 210201 kWhs = 52550kgs of CO_2 – this is the totals of the gas boiler in the sheds and the new gas boiler in the new class rooms. The gas is Propane Gas.

The new gas boiler in the new class rooms.

There are two 29.3 kW Propane Gas boilers in the sheds which heat the under floor heating and radiators in the older section of the school. The school is looking to replace the boilers.

7.0 Renewable Energy Options Analysis

7.1 Biomass

Biomass can be an effective means of heating a wide range of sites. If sourced locally, the fuel can be deemed sustainable. Devon has a large biomass resource, with lots of managed and unmanaged woodland. Buying heating fuel from local markets will help to stimulate the local economy, be more sustainable in terms of carbon footprint and also be less susceptible to international fossil fuel price increases.

The types of biomass heating that are suitable for this site can be summarised as follows:

- *Pellet/grain boilers* - Use small pellets formed from clean/dry material or grain. This provides a versatile fuel that flows easily and provides a high calorific value. Its processed nature (pellets) does however mean a higher cost for the fuel itself (see below). The system requires room for the boiler itself and also the hopper unit. Pellet boilers can cope with domestic scale installations (15kW+) up to larger installations (80kW).

- Boilers can be designed with an integral hot water energy storage tank or accumulator tank that stores water up to 90C, enabling the supply of heat to be further decoupled from the combustion of the fuel. This is particularly helpful with log boilers where systems operate at full load and the matching of demand with load is performed by the accumulator.

The only type of boiler system that would work at this school site would be a pellet or grain boiler. Space and access is limited and unless a new boiler room was built the only boiler system that would have chance of fitting in the present sheds would be a pellet type system. Fuel could then be blown into a hopper from the road. The sheds would have to be converted to accommodate the boiler and hopper system needed for a pellet boiler, but there should be just enough space.

Pellets would not be hugely cheaper than the current gas, but it would be more sustainable (especially as supply increases in the South West). Pellet is also much more flexible than a chip system in that the fuel can be feed via an auger or blown into the boiler, meaning the hopper can be sited more easily. A grain boiler might be cheaper to install and the fuel is also cheaper. Quotes could be obtained on both systems.

The mentor has taken some video footage of the shed area and this will be included in any information sent to installers.

7.11 Costs

It is best used when replacing older systems or in build/refurbishments. Although biomass boilers are more expensive than traditional systems, cheaper fuel (especially in the case of local wood chip/log), and a long guaranteed lifetime, means payback on the systems can be very short.
As a comparison of running costs, see the following table:

Fuel Type:	**Tariff:**	**Cost of Fuel (p / kWh):**	**Useful Heat (p / kWh):**
Logs (50% MC)	£40 / tonne	1.79	2.24
Logs (25% MC)	£70 / tonne	1.89	2.36
Wood-chip (50% MC)	£30 / tonne	1.35	1.68
Wood-chip (30% MC)	£50 / tonne	1.47	1.83
Wood-pellet (bagged)	£150 / tonne	3.09	3.86
Wood-pellet (bulk)	£115 / tonne	2.37	2.96
Oil	£0.23 / litre	2.46	3.07
Electricity	Standard	6.90	6.90
Electricity	Unit-E standard	7.83	7.83
LPG	£0.23 / litre	3.30	4.12
Mains-gas	£0.016 / kWh	1.62	2.03

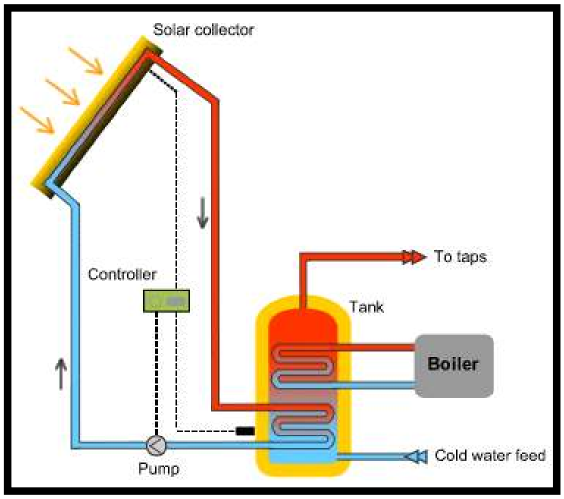
Figures sourced from Powys Energy Agency (2003), based on varying boiler efficiencies – figures should be checked for most recent price fluctuations.

Note, since this table was produced, the situation has improved even further for biomass fuel, as the prices of electricity, gas and oil have all increased; with LPG now in the region of £0.29 / litre and oil generally in excess of £0.36 / litre; whereas log, wood-chip and wood-pellet costs are generally the same. By the end of this decade, when oil, gas and electricity prices have risen even further, and wood-fuel prices will have remained largely static (or reduced in the case of wood-pellet, as regional production increases), significant savings on central-heating running costs will be made each year, accelerating the rate of system pay-back.

It is also important to note that delivery costs can vary depending on distance the fuel has to travel and also the actual delivery area/system. If a delivery system is designed badly then this can add £5-10 on to the cost of wood chip per tonne.

7.2 Solar Water Heating

Solar hot water could be mounted on south facing roof space near to the hot water tank. It is most efficient in the summer months, and would provide 50-70% of hot water demand annually if sited and sized correctly.



A basic solar hot water system. South facing roof space is the best location for the panels. The panel would feed water into either an existing hot-water tank, or a new large capacity thermal-store, either located in the loft (space permitting), or in another suitable location. Normal combi boilers can not take water at temps other than that from mains water, however some modern ones may have an adjusting flame in which case, in principle, they should be compatible, however the boiler manufacturers may not guarantee their use with SHW systems.

There are two types of solar water heating. Flat plate solar panels use copper filaments to harness solar radiation and transfer it to a liquid (either water or anti freeze). Evacuated tubes work in much the same way as a thermos flask and can have higher efficiencies than flat plate but can also be a little less robust.

An example of a small flat plate solar hot water installation.

Evacuated tube solar hot water array.

For areas that are liable to periods of freezing temperatures, either a drain back or a closed loop system is used, where an intermediary (anti-freeze) fluid and a heat exchange system heat the water in the tank indirectly. Other systems circulate and heat the water directly in the panels. Some systems require a pump to move the fluid through the systems, while others use gravity. Active systems are usually easier to fit but they may be more expensive.

The use of modern multi-source thermal-stores / accumulator tanks is an important consideration, as a tank of significant capacity (200 litres+) could store all of a solar–thermal system's output during the day, on until the following morning if well insulated. Modern thermal-stores are quite sophisticated, becoming effectively the brains of a building's heating system – linking a solar-thermal array to other systems, (e.g., a boiler, maybe with back-up electric immersion elements), to mix and match the systems' outputs; and the heat distribution network.

At this school site the solar hot water could be mounted on south facing roof near to the kitchen to provide hot water and offset Propane consumption. During the site visit is was not possible to get up into the roof void to check if there was a separate immersion tank for the kitchen. It may be that it is necessary to install a hot water tank in the space above the kitchen into which the boiler system and solar array would feed.

7.21 Costs

Costs vary due to a range of factors such as size of collector, type of roof, existing hot water system and geographic location. The typical installation costs for collectors is generally upwards of £3,000 and if hot water demand is high the expected payback period can be less than 10 years, especially if a Low Carbon Building Programme, or RE4D grant is used.

7.3 PV

Photovoltaic systems use cells to convert solar radiation into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers, causing electricity to flow. The greater the intensity of the light, the greater the flow of electricity.

The three main types of solar cells are:

- Monocrystalline: made from thin crystal of silicon. This has a typical 15 per cent.
- Polycrystalline: made from thin slices silicon crystals. This has a typical efficiency 12 per cent.
- Thin Film: made from a very thin atoms deposited on a glass or metal typical efficiency of 7 per cent.

Individual PV cells are connected together to form a module. Modules are then linked and sized to meet a particular load (need). The result is a PV array which supplies power to the building it is fitted on. If the building has mains electricity, any excess electricity can be exported to the national grid. Alternatively, when demand is high, extra electricity can be purchased from the national grid through the utility companies. Where there is no mains supply, PV arrays can be used to charge batteries.

PV arrays now come in a variety of shapes and colours, ranging from grey 'solar tiles' that look like roof tiles, to panels and transparent cells that you can use on conservatories and glass to provide shading as well as generating electricity.

PV panels.

The schools electrical costs have risen since the installation of a computer suite. To offset this through on site generation the only real option would be PV. Although this is expensive per kW installed the school could possibly obtain 100% funding. This would be made up of Low Carbon Building Grant (50% for PV) and possible funding from Eon or EDF green energy schemes.

This is some of the south facing roof of the school. There is a large area on the front of the school; however it would be directly visible from the road. This would have planning implications. Any potential array should be looked on favourable by planners under new guidance that is due to be published soon.

7.31 Costs

For the average small scale system, costs can be around £4,000- £9,000 per kW installed. Solar tiles cost more than conventional panels and panels that are integrated into a roof are more expensive than those that sit on top. If you intend to have major roof repairs carried out it may be worth exploring PV tiles as they can offset the cost of roof tiles. Systems connected to the national grid require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees has not become a problem.

If a 2 kW P.V. installation only produces on average 1,800 kWh of electricity a year (approximately half the average domestic property requirement), at £0.085 per unit of electricity (kWh), then the pay-back period (approx. 60 years) might not be tempting to a site owner with a limited project budget. This figure however can be reduced markedly by a successful application to a Low Carbon Building or RE4D grant, and if factored in to refurbishment or new build, PV can make a significant contribution to energy needs at a viable cost. As detailed above the school would be able to get a large amount of funding from various sources which would make the viability of the system that much greater.

8.0 Recommendations

The best way to offset the increased electrical costs of the school would be to try and install a PV array on the south facing roof of the school. This would involve getting suitable quotes, planning and also securing funding. The RE4D mentor can help with all of these aspects.

In regard to the heating system the easiest option to install would be some form of solar hot water for the kitchens. For the space heating system the only real option would be some form of pellet or grain fired boiler. This would require the internal space of the sheds to be modified. Again, the school could get high levels of funding for a biomass boiler from the Low Carbon Building Programme and Green Energy schemes such as EDF and Eon.

9.0 Planning Issues

Impact on local environment?

A PV array would be visible from the road. It would probably require planning consent. The biomass boiler would probably be permitted development as it would be going into an existing boiler house with existing flue. Solar hot water would also require planning.

National Park/AONB/SSSI etc?

No

Views of local residents/businesses?

Has a pre application enquiry been submitted?

No

Has a formal planning application been submitted?

10.0 Finance

The school has some funds which could be made available for a new heating system. They would however be seeking as much funding as possible from other sources.

11.0 Grant Eligibility

The low Carbon Building Programme has a grant scheme for schools to install RE. This is their Phase 2 funding.

http://www.lowcarbonbuildings.org.uk/home/

The EDF Green Energy Fund. Non profit or charitable organisations and or organisations involved in education and or work at community level. The green fund will not support projects that benefit businesses or individual householders. For details of how to apply please refer to this document.

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There is a similar scheme run by Eon for renewable energy schemes as well.

12.0 Any other info

Scorecard Rating: 43