Energy

The kitchen

This are of the school is the second biggest user of water; it is also more complex a scene than the bathroom. It is as well therefore to remind ourselves that a major component for reducing or eliminating the waste of resources is human behaviour. The most innovative technology available can be purchased but if it is not installed, maintained and used correctly, savings will not be achieved and potentially more resources can be wasted. Correctly certified, skilled labour must be used to install systems and their performance and maintenance should be monitored – water systems can be monitored by sophisticated information systems or by checking the water meter regularly for unexpected increases. Staff should be trained on workable best practice and the financial as well as environmental consequences of bad practice explained i.e. an open chill door can cost you at least £2 an hour and a deep-freeze £6 an hour (The Carbon Trust publication GIL129).

KITCHEN SINK

A tap left running for 10 minutes can use nearly 100 litres of water. When possible put the plug in and let the sink fill rather than running the tap continuously when peeling vegetables or washing up pans. Again taps should be fitted with aerator valves and have a single mixing mechanism.

DISHWASHER

The most effective method of ensuring efficiency of water and energy use is for dishwashers to be stacked correctly and to capacity. The same amount of water and heat will be used whether the machine is a quarter, half, or three quarters full, so staff should be trained accordingly to ensure the dishwashers are fully loaded. When purchasing a new commercial dishwasher, look out for those using a booster-heating devices; these ensure that the water temperatures are raised to the necessary levels (over 82 degrees for rinsing) when required but are allowed to drop down during periods of inactivity to c.60 degrees rather than maintain a constant 82 degrees or more. When purchasing a new dishwasher for domestic scale use (i.e. in boarding houses or staff accommodation), look at the energy rating which is mandatory for domestic but not commercial machines and also check the water consumption volumes for the most resource efficient.

OVENS

Warm up times should be prominently displayed so equipment is turned on for the minimum time necessary. Gas produces half the carbon emissions of electricity, however if the electricity is sourced from non-fossil fuels this choice is more evenly balanced. Domestic electric ovens are rated for energy efficiency from A to G, domestic gas ovens and commercial ovens of either type are not rated. Increased efficiency can be achieved by making the best use of the cooking space within the oven and opening the door as infrequently as possible, which is aided by having double glazed viewing windows. If the oven is electric, it is possible to turn the power off ten minutes before the final cooking time and the heat will be retained for the remainder as long as the door is not opened. Seals should be checked regularly.

HOBS

Again, gas should be the preferred option. If equipment is being replaced, consider automatic equipment such as pan sensors.

FRIDGES AND FREEZERS

These should be located away from the hobs, ovens, dishwashers and direct light sources. They should be filled but not to overcapacity so less air is lost each time the door is opened. These actions will ensure that the machines will not have to work harder than necessary to maintain the correct temperatures. Seals should be checked regularly and good ventilation maintained. The Energy Technology List (at http://www.eca.gov.uk/energy) identifies approved energy efficient products (which may allow a business to qualify for a tax break). The CE mark and EN 441 do not necessarily indicate greater resource efficiency but merely that the item adheres to minimum safety and quality standards.

Laundry

WASHING MACHINES

Domestic washing machines and drying machines are currently rated according to their energy consumption from A to G. In May 2010 the European Energy Labelling Directive was recast to include commercial and industrial appliances in the future. Products which will be labelled in the near future include commercial refrigerators and vending machines. Dishwashers, washing machines, water heaters, boilers, and air-conditioners and televisions for the household sector are planned for adoption by the Commission this year.

The Commission will adopt delegated regulations for each product after the Energy Labelling Directive is published in the Official Journal of the European Union (OJ). The new label will be mandatory for products placed on the market from 12 months after the delegated regulation has been published in the OJ.

In the meantime, comparisons are more difficult but, as energy and water use varies significantly, proper research is worthwhile. Some major manufacturers, notably Miele and Bosch are keen to show their technological advances. The same considerations obtain in purchasing drying equipment.

DETERGENTS

Obviously, if using conventional powders, concentrates are preferable but their use demands careful monitoring as the tendency is to use too much and to disbelieve the very small quantities that the instructions demand. Again, it is in the practice, not the technology that most affects the carbon footprint.

Eco-detergents have been disappointing in use but they are now improving and do reduce the environmental damage associated with conventional detergents. It is worth testing them against the standard products and use them if they are satisfactory.

In all cases, it is the temperature at which washing takes place that will contribute significantly to the carbon footprint. Keeping assiduously to the Manufacturers recommendations, using the lower setting wherever possible, and loading machines fully and correctly can make a huge reduction in the carbon impact.

ELECTRICAL EQUIPMENT

Where possible upgrade existing computers, replace old monitors with LCD flat screens and use “thin client” technology which does not require individual CD-ROM players and disk drives. When replacing old equipment, ensure that the specifications for the new equipment include the highest energy star rating.

Lap tops are significantly less energy intensive than PCs. Every new generation of equipment improves the use of energy and really up to date information is essential. A year is a long time in computer development.

Systems that ensure that equipment is turned off when not in use rather than relying on exhortation will make for great savings. Automatic shut down systems can be instigated that turns off equipment at an agreed time ie 8pm when equipment is unlikely to be required. A warning message should be sent out at a suitable interval before the system shuts down to forewarn any late workers. 1E's NightWatchman software (http://www.1e.com/softwareproducts/nightwatchman/index.aspx) shuts down PCs and Macs according to a centrally controlled schedule and also reports on the PC's energy consumption, allowing those monitoring usage to identify trends and unexpected activity, and appropriate strategies for reduction. Other systems include Verdiem's Surveyor (available through http://www.it-energy.co.uk) and Data Synergy's PowerMAN (http://www.datasynergy.co.uk).
Turning monitors, TVs and DVD players off fully is essential. A single monitor left on standby overnight uses the equivalent amount of energy as is required to print 800 sheets of A4.

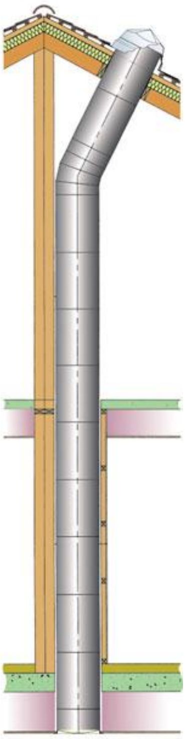
Behavioural change is crucial and should be encouraged through active campaigns by the Sustainability Committee, pupil groups, classroom champions. Modern TVs and DVD players often do not have standby buttons, leaving the standby light glowing but without the option to turn it off on the display terminal; these should be turned off at the socket. Oneclick (http://www.oneclickpower.com) is an example of a useful technology that can be used in conjunction with encouraging behavioural change. Computer 'peripherals" such as printers and whiteboard projectors are plugged into the multi socket unit or 'intelli panel' and the system automatically powers on or off as the desktop / laptop are switched on or off.
ICT equipment generates a great deal of heat. The temperature needs to be monitored and regulated to ensure the longevity of equipment and the maintenance of the ideal temperature for a productive working environment.

Questions to ask

- How has the design for the school kitchen incorporated sustainability best practice?
- Is all electrical equipment being procured with due consideration to the energy rating standards?
- Is new ICT equipment required or can it be upgraded?
- How is the old ICT equipment being disposed?
- What powering down strategies for powering down electrical equipment are being implemented?

Lighting

Daylight



It is often felt that natural daylight may not provide sufficient levels of illumination for the classroom so electrical lights are turned on at all times just to make sure the room is bright enough. Daylight has slid down the list of priorities in design so far that there are even some architectural schools where the incorporation of daylight into a scheme is not taught. However studies undertaken in UK, USA and Liberia have all reached the same conclusion, that students perform better in rooms lit by daylight rather than purely electrical light. The Heschong Mahone Group (HMG) looked at 21,000 children in 1,000 classrooms in three school districts in the

USA and determined that well daylighted classrooms in the 1999 study population correlated to a 20 percent increase in student maths scores and a 26 percent increase in reading scores over non-daylighted classrooms. http://www.nwpublichealth.org/docs/nph/s2005/loveland_s2005.pdf].

It is therefore essential that when undertaking a new build project, particular attention is paid to the design of the classrooms to ensure maximum use is made of this free resource. For refurbishment projects, consideration should be given to the installation of sunpipes. These quite simply are tubes that transfer light from the outside to the desired destination. Due to their innovative design, dust, moisture and heat are not transferred. http://www.monodraught.com have a range of Sunpipes which are made using over 90% recycled aluminium and can produce effective systems over a depth of up to 8m from the exterior of the building. Targetti Poulsen is working on using fibre optic cabling to transfer daylight over greater distances, into the depths of buildings. The importance of daylight is moving up the agenda and there are tried and tested options that have a strong track record as well as new innovations that are being developed to overcome traditional hurdles such as distance from the source. The level of light is measured in lux – in full daylight the lux is c.10 000 lux and an overcast day c.1000 lux. For general study in a library or at a PC, the recommended levels are c.500 lux, supermarkets are often c.750 lux and for detailed drawing work 1 000 lux is recommended.

Electrical light

Once the maximum use of natural daylight is incorporated into the design, we turn to electric lighting. There is a great deal of mythology about lighting. People believe that it is not very costly and hold to the fiction that turning lights on and off use a lot of electricity – so it's best to leave them on. Actually both views are false and traditional lighting systems are very expensive to run.

There are however four rules that can help guide a sustainable outcome.

1. Take it seriously. Good lighting is important and there are serious savings to be made.
2. Behaviour, as well technology, can contribute real savings. Therefore design and arrangement to make it easier to behave properly and harder to do the wasteful thing is worth real attention.
3. There is much that can be done to improve current performance even without major refurbishment.
4. Major refurbishment or new build gives a real opportunity to make major savings.

LED lights

Everyone has understood the importance of energy saving bulbs. Most of us think they are ugly. Perversely, it can be argued that the investment that the manufacturers have made in their production and development has made them determined to get their money back in profits and therefore they have delayed the widespread introduction of better technology while they maximise the return on their investment! The basic rule is to use LED lighting wherever that is possible as it is significantly cheaper in running costs. Often lighting experts will tell you that there are only limited functions where such lighting can be used. In fact the range widens all the time and if a Head encounters difficulties it is worthwhile contacting a firm like Greengage (http://www.greengagelighting.com) who will tell you truthfully what is available. Energy savings of up to 85% are possible so it is really worth pressing architects and electricians to find a means of using this system.

Ecolight (http://www.ecolitetechnology.co.uk/) have produced a comprehensive range of LED lights that are compatible with most existing fixtures. They can also advise on bespoke installations, will undertake a complimentary survey of the site, provide an estimated carbon saving compared to the existing system and an estimated payback period for the investment.

Motion sensors

Lights should be activated on entry and turned off automatically on exit. In suitable circumstances secondary lighting will be activated on use of lavatory or shower cubicles and the nature of the layout should allow for this. Different levels of lighting are required depending on the purpose of the space – the requirements for areas for technical drawing contrast starkly with those of queuing for lunch. Poorly lit corridors and stairwells should also be avoided, but they only need to be lit during times of use.

B.E.G. UK Ltd (http://www.luxomat.com/en) offer a range of motion and occupancy detectors the settings for which can be controlled centrally, managed on a room by room basis or by individual unit.
The key thing is to encourage good behaviour. Exhortation is simply not going to work. All young people will lecture their seniors on the threat to the Rain Forests but will still not, themselves, turn off the lights. Their seniors may not care a damn about the Rain Forests but they pay the bills! That's why automatic lighting actioned by body heat or beams is so useful. We are not trying to instil morality in all this but to save carbon emissions - so make it easy to do the right thing and difficult to do wrong.

Employing LED wherever possible and recognising that new developments are coming on to the market all the time and that the employment of a really good lighting expert early in the development of plans for refurbishment and new build can be very cost effective.

Questions to ask

- To what degree is the lighting system plan incorporating sustainability measures?

Power

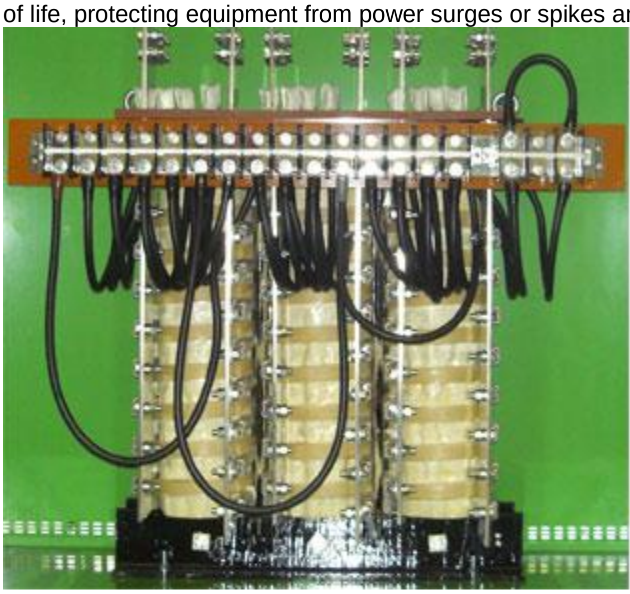
Where possible all lights and equipment should be turned off when not in use. Timed automatic power down features should be enabled and "switch off" behaviour encouraged – it is simply not true that turning a light on and off and on again uses more power than leaving it on continuously.

There are a number of options for schools looking to source electricity from a "green energy" supplier. The main utility companies offer "green" packages, and two companies in particular specialise in renewable energy:

Ecotricty [http://www.ecotricity.co.uk]
They invest in their own renewable energy sources such as wind farms. Their energy is sourced 45% from renewable sources and 55% from brown energy (natural gas, coal, nuclear, other). Two tariffs are offered, either 100% from renewable sources or 50%.

Green Energy UK [http://www.greenenergy.uk.com]
Energy is sourced from CHP 54%, waste 27%, biomass 11%, hydro 6%, wind 1% (other less than 1%). No brown energy is used. Two tariffs are available: *Deep Green* - 100% of the electricity that is used with a supply from renewable power or *Pale Green* which is a hybrid tariff made up from 17.5% renewable electricity and 82.5% green electricity sourced from good quality combined heat and power (CHP) from accredited generators.

POWER VOLTAGE OPIMISATION is a technology that requires no behavioural change in order to achieve reductions in electricity consumption. The mains electricity supply has a voltage of between 207V and 253V; the optimum voltage for electrical equipment in the UK is 220V. Power Voltage Optimisation does exactly that, the technology ensures that three phase power is provided at the optimum level for the equipment, enhancing length of life, protecting equipment from power surges or spikes and reducing costs as less energy is being used.



An example of a recent success is at the Department of Energy and Climate Change, where electricity savings of 11% during the working week (projected annual savings of £19,000) was achieved by the installation of powerPerfector technology (http://www.powerperfector.com).
Read the Treorchy Comprehensive School Case Study

ENERGY DISPLAY

Example display of energy use, courtesy of Ecodriver.

Monitoring and recording consumption levels is essential, however enabling energy users to see in real time the amount of energy a site is using, in term so carbon dioxide emissions, units and the universally comprehensible measure, pounds sterling, makes it all real. It is possible to easily and clearly display the impact of the sustainability measures that have been announced, discussed and even fundraised for, for the benefit of the school bursar, the Year 10 geography class or a visiting parent.

EcoDriver is an application that can monitor and record energy, water and waste consumption and production on site. It has been designed for use in the classroom, allowing pupils to see the real impact of their actions and be engaged in the school's sustainability programme. Display screens can be provided for communal areas for the greatest visibility. (http://www.ecodriver.co.uk)

Questions to ask

- What is the current agreement with the energy supplier and when was it last renegotiated?
- Is the current usage regularly monitored?
- What are the supplier options in terms of cost and sustainability?

Onsite generation

There are no standardised figures for educational or commercial use but a reasonably accurate assessment of costs can be calculated from the domestic comparisons which are used here.

SOLAR ENERGY – PHOTOVOLTAIC CELLS

Photovoltaic cells on the roof of Larmenier School. Image courtesy of Solar Century.

Photovoltaic (PV) cells generate electricity from the sun. They come in a range of colours and shapes. They can be imbedded into your roof or sit on top; it is more expensive to embed them however it is worth considering if the roof is undergoing significant repair or it is a new building. There are even transparent cells available. PV cells must be kept clean and clear of debris and significant arboreal overhang.

There are no fuel costs as sunlight is free and if you are producing more electricity than required at a certain time, it is possible to sell it back to the grid (see Feed in Tariffs below). Solar energy does not release carbon dioxide thus the carbon footprint for the building is reduced. A typical (home) PV system could save around 1000-1200 kg of CO_2 per year, approximately 30 tonnes over its lifetime. A typical home PV system can produce around 40% of the electricity a household uses in a year.

According to analysis of different suppliers' charges by Oxford University's Environmental Change Institute, installation of a 1kWp system would cost around £7,000, and a 2kWp installation around £12,000 (although prices continue to fall). Sadly as of May 2010 there are no longer Low Carbon Buildings Programme government grants available. However there are a number of companies offering free installation of solar panels, with the costs recouped from the utility company through the savings made. These are new offerings to market and other innovations are sure to follow. Solarcentuary (http://www.solarcentuary.co.uk) has extensive experience of working with schools and has created a bespoke financial package with GE (Solar4Schools) which makes installing a solar panel system feasible. Herne Hill School, South East London's experience is documented in the case study at http://www.solarcentury.co.uk/Solar4Schools/

More information:
http://www.cabe.org.uk/sustainable-cities/advice/solar-technologies
http://www.energysavingtrust.org.uk/Generate-your-own-energy/Solar-electricity
http://www.yougen.co.uk/renewable-energy/Solar+Electricity/
Suppliers:
http://www.therenewableenergycentre.co.uk/power-from-the-sun-(photovoltaics)/pv-panel-manufacturers-and-suppliers/

WIND POWER

Small scale wind turbines are well suited to off grid, mobile and combined wind & photovoltaic (PV) applications. The PV/wind power combination is effective because wind power availability is highest in winter when available solar power is at its minimum and vice versa.

Small scale wind turbines vary in size with a range of models available, from less than 100 watts (W) up to 50 kilowatts (kW). Rooftop models vary from 0.5kW to 2.5kW in size.

A well sited 2.5kW turbine could result in a saving of around £380 a year from electricity bills and a saving of around 2.6tonnes of carbon dioxide per year (Domestic) (http://www.energysavingtrust.co.uk)
An array of schools have installed small wind turbines, such as Ladygrove Primary School, Borough of Telford & Wrekin, West Midlands (http://www.renewable-manifesto.com/small/cases.html) and Sandwich Technology School, Kent (http://www.eco-schools.org.uk/case-studies/case-study.aspx?ID=27)
Further information:
http://www.cabe.org.uk/sustainable-cities/advice/wind-power
http://www.therenewableenergycentre.co.uk/wind-power/
Wind power suppliers:
http://www.therenewableenergycentre.co.uk/wind-power/small-scale-wind-turbine-suppliers/

Comparison of costs

For average domestic power installation:

Type of power	Installation cost	Power production	CO_2 savings	Cost savings
* Assumes a 2kWp system with 50% on site consumption with excess exported to the grid on a typical export tariff				
Photovoltaic Cells	£5,000-8,000 per KWp	40% of average household's power per year (plus some exported to grid)	1,200kg per year (for average 2KW system)*	£200 per year off electricity bills (for average three bed

Type of power	Installation cost	Power production	CO_2savings	Cost savings
				house)
Wind Power	From £1,500 for roof mounted system (up to 2.5kw) to £19,000 for larger mast mounted windmill	Varies widely according to wind speeds – each site must be assessed individually: http://www.bwea.com/images/misc/noabl_c.gif	2,600kg per year (from well-sited 2.5KW system)	£380 per year from electricity bills (for average three bed house)

FEED IN TARIFFS
http://www.fitariffs.co.uk/
Anyone installing a renewable electricity system under 5 megawatts capacity after July 2009 is able to claim feed-in tariffs. This means that you will get paid for generating electricity that you then use, and bonus payments for any extra that is exported to the grid. Schools are eligible too.

If an average household, for example a three bedroom house, installed solar PV panels that generate electricity, the Feed-In Tariffs would provide the following benefits:

- The electricity generated would pay the homeowner £836 a year tax-free
- Remaining electricity costs would be reduced from £450 to £300: saving £150
- The total benefit would be £986 per year

This is based on an average use of 4,500kWh of electricity per year and the installation of 2.5kW of solar PV panels.

Since April 2010, the Feed-in Tariffs (FIT) has guaranteed an income for electricity generated from systems up to 5MW (which is quite a large system). The payments will be index-linked, and will continue for a 20 year period.

For microgeneration - systems below 50kW the major equipment and the installer need to be certified by the Microgeneration Certification Scheme (MCS) to ensure eligibility for the FIT.

Questions to ask

- Can PV cells be fitted to our roofs? What is the likely cost and return for installation?
- Do we have a suitable location for a wind turbine?
- What is the likely energy generation from the PV and wind turbines?
- What is the potential revenue from the Feed in Tariff?
- How can the Ecodriver display be incorporated in to the classroom activities and curriculum?

Heating

Very many schools are far too hot. Parents who will increasingly be controlling their own energy costs will become more critical of wastage at school. Again, although the technical advances in efficiency, both of generation and usage, can make a huge difference to the carbon footprint, the way energy is used and controlled is also vital. It is essential to keep systems as simple as possible, once installed they will need to be run and maintained by staff. The processes need to be as straightforward and user friendly as possible and more robust and minimal the equipment, the less there is to maintain and parts to replace.

Most schools have already recognised that the systems need to be flexible enough to be controlled from hour to hour and day to day rather than by mechanisms which used to bring the heating on in October and turn it off in April – whatever the weather. A building management system will allow discreet temperature control for different areas of the school, according to need. There is no need for the school to operate on the same thermostat; it is hugely inefficient in terms of energy and often unsatisfactory for those in the different areas. Trend Control Systems (http://www.trendcontrols.com) for example can create a system that regulate and monitors the heating, ventilation, airconditioning within the school. They can also incorporate the lighting. This gives you control of between 60 and 80% of the site's energy use. It is even possible to control it remotely, from off-site locations. Flexibility is not just about the seasons but also the time of day and the geography of usage. Where people sit will need to be hotter than the corridors along which people move. Areas not used after 19.00, should automatically turn to minimal or no heat, until it is time to raise the temperature for the next day.

Yet, even with careful design, the habits of energy saving are important. They start with appropriate clothing - the remark attributed to a long dead Duchess, 'No-one needs to be cold - except the poor and the vain.' is even more germane today. This generation of young people will need to minimise their personal energy demands as an essential life skill.

The extent of the personal challenge is illustrated by the comparison between the energy requirements for every American child – they need the energy produced by 120 men – as compared with 60 for the average European child, 8 for the average Chinese and 1 for the average Bangladeshi. The world of tomorrow will not be able to tolerate those vast inequalities. Technology will do much; fundamental change in construction, industry, and commerce will do more; a change in personal attitudes towards energy and water use is nonetheless imperative.

INTELLIGENT HEATING CONTROLS

Intelligent heating controls are available which monitor requirements for different areas of buildings and then interpret needs so that as little energy is wasted as possible. Systems are cheap and effective. E.g. Dataterm: http://www.warmworld.co.uk/index.php

SUPPLY

Reducing thermostats by 1°C can reduce heating costs by 8%. Thermostats should be set to the following levels:

18°C – normal teaching
15°C – corridors
21°C – areas of low physical activity; occupied by very young children or those with special needs

Controls should be installed to regulate the heating circuit and to react to the external weather conditions. Heating controls should have 7 day programming, ensuring heat generation is in line with the varying need. If boilers are being fitted, ensure they are correctly sized for the needs of the school.

Excellent levels of insulation should be insisted on and the actual heating requirement carefully assessed so the most appropriate form of generation can be chosen.

Combined Heat and Power

Combined Heat and Power (CHP) is the simultaneous generation of usable heat and power (usually electricity) in a single process. CHP is not necessarily renewable energy but can result in a much reduced carbon footprint. CHP systems are typically installed onsite, supplying customers with heat and power directly at the point of use, therefore helping avoid the significant losses which occur in transmitting electricity from large centralised plant to customer.

CHP systems make extensive use of the heat produced during the electricity generation process, therefore they can achieve overall efficiencies in excess of 70% at the point of use. By contrast, the efficiency of conventional coal-fired and gas-fired power stations, which discard this heat, is typically around 38% and 48% respectively at the power station, and even less at the point of use. Costs vary enormously but this is one system that should always be investigated as its advantages can be so significant in the right configuration.

Savings: CHP's high efficiency leads to a reduction in the use of primary energy. Precious fuels are used much more efficiently, so less is used. And less fuel used means significantly lower energy costs to the end user. Savings vary, but can be between 15% and 40% compared to imported electricity and on-site boilers. Less fuel burnt means reduced emissions of carbon dioxide and other products of combustion.
The main design criterion is that, to make the investment worthwhile, there must be a need for both the heat and electricity produced by the CHP unit.

Current information from the Carbon Trust study into Micro CHP can be found at
http://www.carbontrust.co.uk/emerging-technologies/current-focus-areas/pages/micro-combined-heat-power.aspx
More information:
http://www.yougen.co.uk/renewable-energy/Combined+Heat+'26+Power/
http://www.greenpeace.org.uk/climate/solutions/combined-heat-and-power-chp
Information on suppliers:
http://www.chpa.co.uk/
The University of Dundee used Mclellan (http://www.mclellan.co.uk) to create and install a CHP system to serve their university buildings (http://www.mclellan.co.uk/Cbspechp.php). Mclellan also installed the well publised Woking Town Centre CHP system, which has been used as a model for best practice in this area.

Biomass Boilers

A boiler burning pellets, logs or chips can be connected to a central heating and hot water system.

Biomass boilers are a low carbon option: the carbon dioxide emitted when wood fuel is burned is the same amount that was absorbed over the previous months and years as the plant was growing. As long as new plants continue to grow in place of those used for fuel, the process is sustainable. There are some carbon emissions caused by the cultivation, manufacture and transportation of the fuel, but as long as the fuel is sourced locally, these are much lower than the emissions from fossil fuels.

Cost: A typical automatically fed boiler (for a three bed semi detached property) costs around £9,000 including installation and installing a suitable flue. Manually fed log systems are slightly cheaper. Biomass boilers can however heat several buildings.
Savings: Savings in CO_2 emissions are significant - up to 9.6 tonnes per year when a wood boiler replaces a solid (coal) fired system.
Fuel savings are less significant, and if you replace a gas heating system with a wood burning system you may end up paying more for your fuel. But if you replace solid fuel or electricity you could save between £170 and £410 per year.

The most recent figures suggest that wood chips were the cheapest form of heating fuel at 2.3p per kWh generated according to Biomass Energy Centre. Mains gas and wood pellets both come in at 4.2p per kWh, with oil a bit more expensive at 4.5p. LPG and electricity are more expensive still at 7.1p and 14p per kWh respectively. Prices are around £225 per tonne for wood pellets and £80 per tonne for wood chips. These figures will depend on geography, as prices for wood pellets and chips vary considerably.

Wood costs often depend on the distance from your home to a wood supplier and whether you can buy and store wood in large quantities. If you have your own supply of wood fuel then this can significantly reduce your costs.

Example of schools using wood fuel:
http://www.ashdenawards.org/files/reports/Nottinghamshire_CC_2007_Technical_report.pdf
Torre Church of England School, Torquay installed a £72,000 45KW biomass boiler (www.torbay.gov.uk/pr2702.doc)
Information about Biomass Boilers:
http://www.yougen.co.uk/renewable-energy/Biomass+Boilers/
Suppliers:
http://www.therenewableenergycentre.co.uk/biomass-and-biofuel/wood-burning-stoves-and-boilers/
http://www.biomassenergycentre.org.uk/portal/page?_pageid=73,1&_dad=portal&_schema=PORTAL

Ground Source Heat Pumps

A Ground Source Heat Pump.

Ground source heat pumps use buried pipes to extract heat from the ground. This is usually used to heat water for radiators, under floor heating systems and hot water.

Beneath the surface, the ground stays at a constant temperature, so a ground source heat pump can be used throughout the year - even in the middle of winter.

Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the ground, air, or water is constantly being renewed naturally. The electricity they need to run can be provided by a renewable source e.g. wind/solar which would improve the environmental credentials of the system greatly.

The efficiency of a ground source heat pump is measured by a coefficient of performance (CoP) - the amount of heat it produces compared to the amount of electricity needed to run it. For example, a CoP of 3 would provide

3kW of useful heat output for every 1kW of electrical input. For a heat pump to be considered better than an efficient gas boiler in carbon emission terms it needs a CoP of around 3 or above. A typical CoP for a ground source heat pump is around 3.2 if used with under floor heating.

Ground source heat pumps work best when required to heat spaces to between 18 and 21 centigrade – warmer than this and the system becomes less efficient. Ground source heat pumps work best in well insulated buildings, and with either warm air convector heaters or underfloor heating because of the lower temperatures required. CO_2 emissions, compared to an oil boiler, for instance, would be 540kg less. If the heat pump is partly powered (the pump requires some electricity to function) by another renewable technology, such as solar electricity, emissions will fall even further.

Dafoss Heat Pumps (http://www.ecoheatpumps.co.uk/heat_pumps.htm) have a long history of installing a range of ground source heat pumps for schools, including Wormholt School, Shephard's Bush, London which was one of the first in the country to be heated by a ground source heat pump system concealed beneath the school playground. (http://www.ecoheatpumps.co.uk/school_heat_pumps.htm). The largest has been installed at Stockport Academy, designed by Buro Happold (http://www.burohappold.com/BH/Home.aspx) with a heating /cooling capacity of 360 kW.

Cost

The average capital costs for a ground source heat pump system would be between £800 and £2,750 per kW. This cost reflects the capital cost when applied to a Part L1a 2006 compliant home and is based on figures from the 2008 Communities and Local Government research. The same research also undertook an economic cost and benefit analysis of each technology. This found the value of saving in energy costs were £807 per tonne of CO2 saved. (http://www.cabe.org.uk/sustainable-cities/advice/ground-and-air-generated-heat)
Maintenance is minimal – it's often known as a 'fit and forget' technology.

A variant of ground source heating systems is interseasonal heat transfer (IHT). Pipes are placed below tarmac to heat or cool liquid. This can be effective as a tarmac surface in direct sunshine will often be 15° C warmer than the air temperature at the same time. The heat is then transferred to thermal banks below the building for release when needed. This enables transfer of heat (or cooling) between day and night and summer and winter. IHT may be effective in places where there are large areas of tarmac such as school playgrounds, car parks or roads.

Howe Dell School in Hertfordshire has been fitted with such a system and it is currently being monitored in use to judge effectiveness – see http://www.independent.co.uk/environment/green-living/too-cool-for-school-britains-most-ecofriendly-building-806892.html and http://www.icax.co.uk/howe_dell_school.html
More information:
http://www.energysavingtrust.org.uk/Generate-your-own-energy/Ground-source-heat-pumps
http://www.yougen.co.uk/renewable-energy/Heat+Pumps/
Suppliers:
http://www.heatpumps.org.uk/
http://www.gshp.org.uk/

Solar Water Heating

Solar water heating systems use free heat from the sun to warm domestic hot water. A conventional boiler or immersion heater is then used to make the water hotter, or to provide hot water when solar energy is unavailable.

Systems require a roof which faces east to west through south and receives direct sunlight for the main part of the day. The most benefit can be gained if they are mounted facing within 45 degrees of south, at an angle of around 30 degrees. They can be fixed to a frame on a flat roof.

The main types of solar water heating system used in the UK are flat plate collectors and evacuated glass heat tubes. Manufacturers' figures show that in London energy produced from solar water heating is an average of 401kWh/m^2/yr for flat plate collectors and 518kWh/m2/yr from an evacuated tube system.
Costs The average capital costs for a solar water heating system would be £850 per square metre.
http://www.cabe.org.uk/sustainable-cities/advice/solar-technologies
Savings - a solar water heating system can provide about a third of a household's hot water needs, reducing water heating bill by between £50 and £85 per year. It will also save up to 580kg of CO2 emissions, depending on what fuel you will be replacing.

Most have a lifetime of around 20-30 years. Ongoing maintenance costs are reasonably low since there are no moving parts. However, regular inspections of the inverter are necessary and panels require cleaning to eliminate deposited dust that reduces the efficiency of the system.

More information: http://www.yougen.co.uk/renewable-energy/Solar+Thermal/
Suppliers: http://www.therenewableenergycentre.co.uk/solar-heating/solar-compatible-boilers-and-heating-systems/
Comparison of costs for heating options: [based on a three bed house]

Method	**Installation cost**	**Average power supplied**	**CO_2 saving**	**Cost saving**
Solar Water Heating	£3,000-£5,000 (£850 per M^2 of heating)	50-70% of an average home's hot water	Up to 580kg, depending on what fuel is being replaced	£85-£50 pa, (equivalent to £2,324 per tonne of CO_2 saved)
Ground Source Heat	£800-£2,750 per KW (£7,000-£13,000)	100% of space heating, 50% of hot water	540kg less than an average oil boiler – up to 6tonnes if replacing electricity	15-40% of energy – equivalent to £807 per tonne of $C0_2$ saved
Biomass	£9,000 for average 3 bed house	Can supply all heat and hot water	e.g. 9.6 tonnes per year if replacing coal	Up to £400 per year if replacing solid fuel

RENEWABLE HEAT INCENTIVE

From April 2011, it will be possible to be paid for any heat that you generate and use. The Government is currently reviewing the tariffs and the levels are expected to be revised.

When you install a renewable heat generation system, such as solar thermal panels, heat pumps or a biomass boiler, an estimate will be made as to how much heat it will generate, and you will receive a fixed payment based on that estimate, over a fixed tariff period. For more information, see http://www.rhincentive.co.uk/