Introduction to Energy Efficiency in Schools

BEST PRACTICE PROGRAMME

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

CONTENTS

1

INTRODUCTION

1.1 Who this guide is intended for

This guide is aimed at headteachers, governors or school board members, caretakers and others who have responsibility for energy use in schools. It should also be of interest to energy managers in local authorities.

It is intended to introduce the steps that anyone responsible for energy needs to take in order to control and reduce energy consumption in schools. It shows how to gain an understanding of energy is use in schools and indicates the methods by which savings are likely to be made.

1.2 Use of the guide

This guide is one of a series for different types of building. A full list of titles is given in section 8.4; make sure that you have the guide most suited to your needs.

If you are unfamiliar with energy management, you should start with section 2, Energy Management, in order to get an overview of the subject.

The subsequent sections concern creating and following an action plan (section 3) and implementing measures to achieve energy savings (section 4). Sections 5 and 6 describe methods for assessing energy use in schools.

The case studies (section 7) give examples of schools where energy saving measures have been successfully implemented.
Section 8 lists further sources of help and information, including addresses for obtaining copies of the information referred to throughout the guide.

More experienced energy managers or consultants may wish to use the method for calculating performance indices described in section 6 and appendix 1.

Many of the guides referred to in the text are part of the Energy Efficiency Office's (EEO) Best Practice programme. These guides provide information on various aspects of energy management, tailored to the needs of specific individuals in the school energy team, such as headteachers, teachers and caretakers.

1.3 Environmental benefits of energy efficiency

Most of the energy used today originates from fossil fuels (gas, oil and coal). Burning fossil fuels emits pollutants, including gases that cause acid rain, and carbon dioxide. As carbon dioxide and other gases build up in the atmosphere, more of the sun's heat is trapped (the greenhouse effect). This could result in the earth becoming hotter (global warming) which may also increase the risk of storms, coastal flooding and drought. Using energy more efficiently is one of the most cost effective means of reducing emissions of carbon dioxide and also helps to conserve finite reserves of fossil fuels.

1.4 Financial benefits of energy efficiency

Energy is one of the largest controllable outgoings in running schools. Using simple and cost effective measures, fuel bills can often be reduced by about 20%. Further savings are possible in new construction and when buildings are refurbished or their services replaced.

Well designed and efficiently managed services not only result in energy savings, but also in an improved and more comfortable environment for pupils and staff. Efficiently run buildings also require less manpower to maintain and to service complaints, providing savings additional to the reduced costs of energy.

1.5 Energy efficiency and the curriculum

There are many areas of the curriculum in which energy and the environment are relevant. A learning environment in which energy is efficiently managed provides a positive educational benefit. It may also be possible to develop project work which involves assessing and improving a school's energy efficiency.

1.6 Acknowledgements

This guide was prepared for the Energy Efficiency Office (EEO) by Target Energy Services Ltd. The EEO gratefully acknowledges the assistance given by the following organisations in providing information:

Audit Commission

Biggin Hill School, Bransholme

Building Energy Solutions

Building Research Energy Conservation Support Unit (BRECSU)

Canons High School, Harrow

Department for Education

Greatfield Comprehensive, Hull

Havelock Comprehensive, Humberside

Malet Lambert School, Humberside

Parkside Middle School, Cullingworth.

2

ENERGY MANAGEMENT

2.1 Energy efficiency - a management issue

The aim of energy management is to ensure that energy use and energy costs are as low as possible while standards of comfort, service and productivity are maintained or improved. This requires somebody to be directly responsible for energy efficiency, even if this is only a part of their job:

- Each school should have someone responsible for energy management.
- Enthusiasm is more important than technical expertise, but you will need outside help when undertaking more complex energy saving measures. This could mean forming strong links with a local authority energy management unit or private energy consultants.

The duties and functions of the person responsible for energy management are discussed briefly here. Section 3 includes a suggested action plan which can be used to get things moving.

2.2 Actions and measures to save energy

One of your main activities should be to identify areas of energy waste and implement energy saving measures to reduce them. Some waste is simple to diagnose and to correct, for example lighting left on all night in unoccupied areas. Other waste may be more difficult to identify and take more expertise or resources to correct (see section 4).

Start with the easier energy saving measures and periodically identify more substantial measures through energy walk-rounds, and commission work to implement them (see section 4).

2.3 Controlling energy use

To control energy consumption and costs, regular and reliable records of energy use should be maintained. Such records will help to identify changes in energy costs and consumption. This is commonly called monitoring and targeting or M&T. The simplest arrangement is a form which can be filled in regularly for each fuel, recording monthly energy use. Alternatively, systems can be based on a computer spreadsheet.

An M&T system should:

- Record energy consumption and any other factors that affect energy use (building usage, weather, etc).
- Compare your energy use to previous years, to other schools, or to yardsticks representing typical or target energy performance.
- Alert you to sudden changes in energy use patterns as soon as possible, so that any increase can be investigated and corrected if appropriate.
- Produce regular summary reports, especially if there are many sites, to confirm performance and show savings achieved overall.

If fuel bills are not available or some are missing, then duplicates can usually be obtained on request from the relevant fuel supply company.

Meters should be checked every few months to ensure the bills are correct. A caretaker might be an appropriate person to record meter readings.

For further information see:

EEO Practical Energy Saving Guide For Smaller Businesses.

Example recording of monthly electricity use

Period: *JAN-DEC 92* Completed by: *NJK* Date: *10.2.93*

Meter Reading Date	kWh Used	Cost £
8.1.92	*39,700*	*2756.29*
5.2.92	*38,700*	*2653.65*
5.3.92	*31,500*	*2200.35*
9.4.92	*25,000*	*1584.02*

2.4 Getting on the right tariffs

Making sure that fossil fuels and electricity are purchased at the cheapest rates is increasingly important. Considerable cost savings are sometimes possible by changing to more suitable tariffs for electricity, or by making alternative supply arrangements.

Tariff savings usually incur little or no initial cost and may be used to help finance measures to reduce energy costs further. Reviewing tariffs should therefore be one of your first actions. You may be able to obtain help and advice from your local authority energy management unit, if available. Alternatively:

- Seek alternative electricity tariffs from your existing supplier.
- Consider using other electricity suppliers in the contract market when the supply is for more than 100 kW (representing a bill of around £30,000 a year).
- Consider a different supplier for oil, or for gas supplies over 70,000 kWh a year (representing a bill of around £1,000 a year).
- For large sites with complicated tariffs and load patterns, it may be worth employing a tariff consultant, although be aware of consultants' costs (contact the Energy Systems Trade Association (ESTA) or the Major Energy Users' Council, see section 8.8).

For further information see:

Fuel Efficiency Booklet 9 - Economic use of electricity in buildings.

2.5 Motivating occupants and staff

The greatest possible savings can only be achieved with the cooperation of staff and pupils. Foster their support and give them every chance to participate in initiatives. Feed back information to staff and pupils on the results of these initiatives.

Activities could include:

- Providing information about why energy conservation is important, describing practical and environmental benefits.
- Stressing that most energy is used by all occupants - for lighting, equipment and for maintaining comfortable conditions.
- Encouraging staff and pupils to switch off equipment and lights when they are not needed. This could include staff suggestion schemes, stickers, posters and articles in school newsletters and magazines.
- Relating energy use at school to energy use at home.

Incorporating energy education into the school curriculum is very important and will help to raise awareness amongst pupils, for example by making a school project out of an energy walk-round.

It may be worth appointing energy monitors throughout the school to help achieve savings by turning off lights and closing windows.

The caretaker is a key figure in any school energy campaign and should be involved to ensure that plant is managed and maintained as effectively as possible.

If there are significant kitchen facilities at the school then you should work closely with the person responsible for the kitchens to ensure that those facilities are used efficiently.

You should be aware of the savings achieved and publicise them to help motivate staff, pupils and governors or school board members. Obtaining capital investment for future energy efficiency measures may depend on demonstrating the cost effectiveness and environmental benefits of measures that have already been completed.

For further information see:

Good Practice Guide 40. Saving Energy in Schools. A Guide for School Energy Managers

Good Practice Guide 29. Good Housekeeping in Schools. A Guide for School Staff, Pupils and Governors

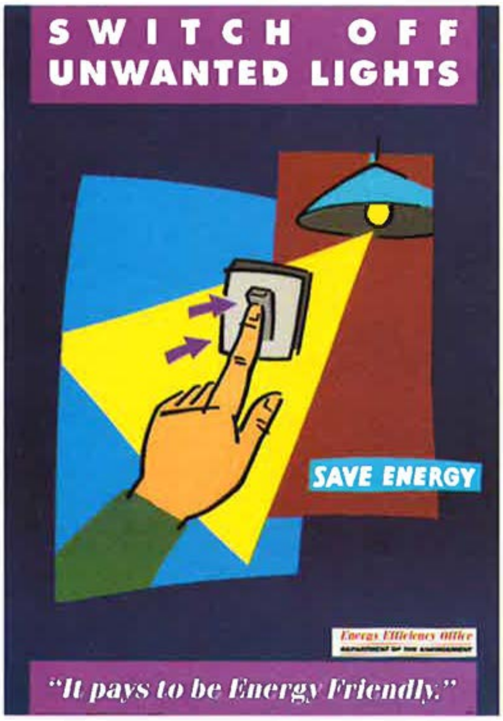
Good Practice Guide 39. Managing Energy in Schools. A Guide for Headteachers and Governors.

2.6 Hours of use

Extending the hours of use by only two hours per day in a school is likely to increase energy costs by about 10%. It is therefore important to consider this when deciding whether to increase the use of buildings.

If the set up of the heating system allows, heating should be confined to those buildings that are used out of normal hours. On days that the buildings are not required outside normal hours, the heating controls should be set for normal daytime use only.

Energy Efficiency Poster



Refurbishment offers a relatively rare opportunity to incorporate many energy measures

These principles can also be used to advantage during holiday periods. Heating all the school buildings to full temperature for small numbers of staff will waste energy. It may be possible to turn off domestic hot water systems during these periods.

2.7 School cleaning

Whenever possible, cleaning should be carried out immediately before or after the school is occupied, when the pre-heating or residual heat can be used to provide adequate background heating. During the heating season, if cleaning has to be done at other times, it can prove expensive to heat the whole building for a small number of people.

Cleaning staff should be asked to keep windows and doors closed at all times. This is particularly important if cleaning is done during the pre-heating period when the system is bringing room temperatures up to comfort level. Cleaning staff should be asked to limit their use of electricity by switching lights on and off as they move from room to room.

2.8 New and refurbished property

Energy efficiency measures are most cost effective when installed in new or refurbished buildings, or while replacing equipment which is at the end of its normal life. New items of equipment which are required anyway should be as efficient as possible. Additional items to improve energy efficiency can be installed most cheaply during other building work. These special opportunities to incorporate energy efficient design are relatively rare and should not be missed.

You should be involved in decisions about new or refurbished property and should not just be brought in to correct high energy use following decisions made by others. Your knowledge of how the building is used should be drawn on when specifying appropriate levels of services and controls.

When refurbishing school premises or adding new buildings, take the opportunity to select or specify:

- Energy targets
- Systems which are simple and within the capabilities of staff to manage
- High efficiency of major plant and equipment such as boilers or main lighting systems
- Good levels of insulation, particularly where less substantial pre-fabricated buildings are concerned
- Appropriate controls for the anticipated pattern of use
- Suitable metering and monitoring facilities
- Information, advice and training for staff in the use of new systems.

For further information see:

EEO Good Practice Guide 56 - Saving Energy in School Swimming Pools

EEO Good Practice Guide 41- Opportunities for Energy Efficiency During Refurbishment of Schools

Department for Education. Building Bulletin 73. A Guide to Energy Efficient Refurbishment. HMSO

Department for Education. Design Note 17. Guidelines for Environmental Design and Fuel Conservation in Educational Buildings. HMSO.

2.9 Getting help

Sources of further information are described and listed in section 8. In particular, the EEO's Good Practice Guides provide information on energy efficiency techniques and measures. Many savings can be made with little or no investment through 'good housekeeping'.

To obtain further information about possible energy saving measures (see section 4), contact your local authority, if available. They may have a specialist energy management unit. Alternatively, contact relevant manufacturers, installers or service providers who will advise you of the features of their products. Make sure that these features are relevant and appropriate to your requirements. Gas and electricity suppliers can also offer advice.

If you are considering making large investments, it may be worth hiring a professional consultant to provide advice or to conduct an energy survey.

If the availability of finance and management time is a problem for opportunities requiring substantial investment, contract energy management (CEM) organisations may provide a solution - they offer a comprehensive energy saving service including finance and management responsibility. ESTA can provide a list of companies (see section 8.8).

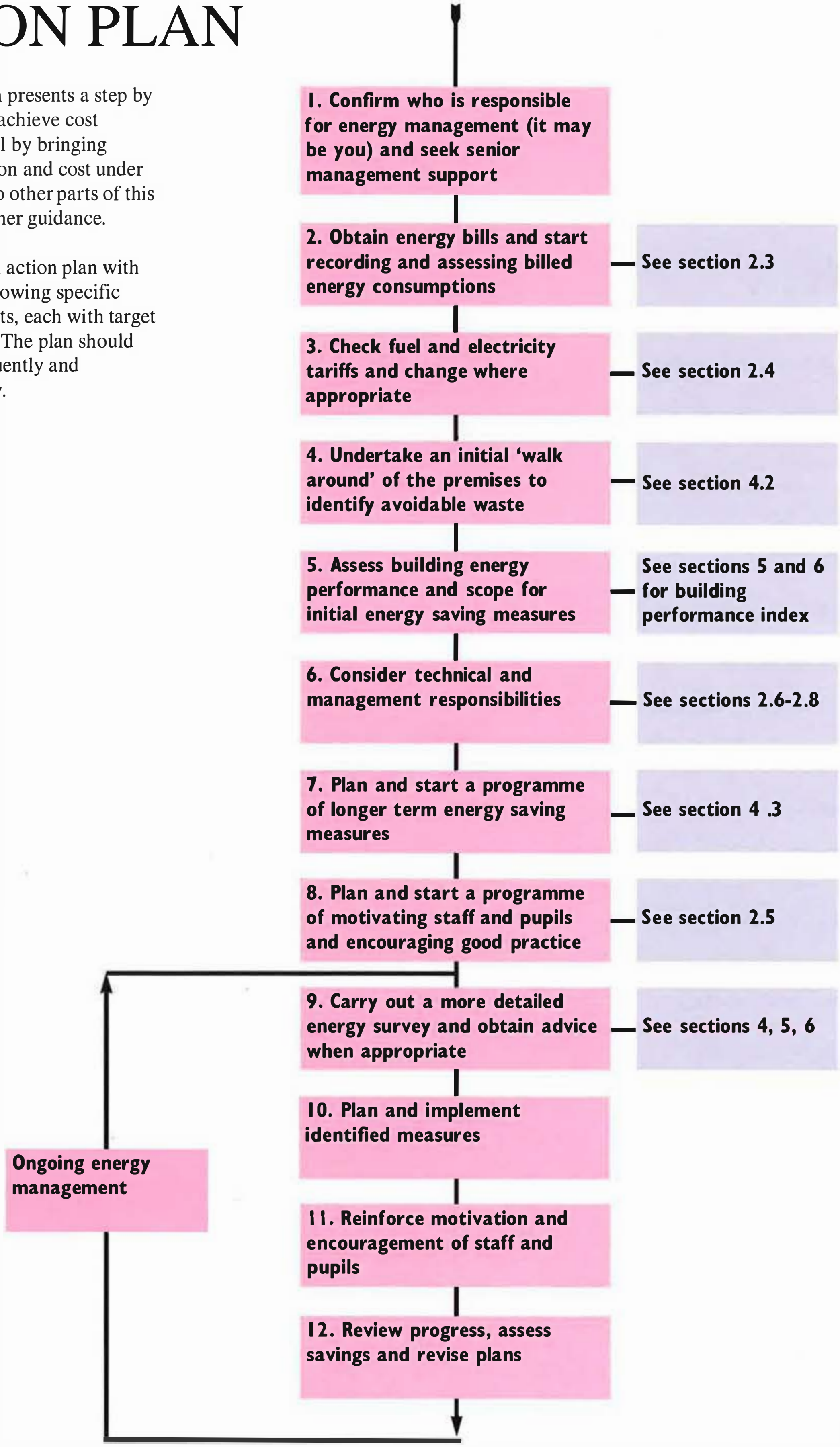
For further information see:

Choosing an Energy Efficiency Consultant (EEO).

ACTION PLAN

This flow diagram presents a step by step procedure to achieve cost savings in a school by bringing energy consumption and cost under control. It refers to other parts of this document for further guidance.

Produce your own action plan with these headings, showing specific actions and projects, each with target completion dates. The plan should be consulted frequently and reviewed annually.



4

MEASURES TO ACHIEVE ENERGY SAVINGS

4.1 Introduction

Savings in energy use and cost can be achieved through 'good housekeeping' and improvements in standards of fabric and plant efficiency. The main areas for savings, starting with the most cost effective, are:

- Management and control procedures
- Control systems
- Lighting and office equipment
- Heating and hot water
- Building fabric.

Care is required in deciding which measures to implement and the most effective way of carrying them through. In the first instance, measures should be undertaken which have as many of the following features as possible:

- Worthwhile energy and cost savings
- No or low capital cost
- Short period to repay initial cost
- Little technical knowledge required
- Little or no extra maintenance
- Little or no disruption to normal operations.

4.2 Good housekeeping

In most schools, it is possible to make some savings by using the existing building and equipment as efficiently as possible. No financial investment is needed; instead, a check on how the building is being used may reveal areas where equipment can be turned off when it is not needed, or where the level of service can be reduced without affecting the comfort of staff or pupils.

Some opportunities may be easy to identify and implement, such as altering thermostats or timeclocks. Others, such as turning lights off when rooms are not being used, may require the co-operation of staff and pupils. Motivating everybody in the school to help is therefore important, although a long term task.

Guidance on good housekeeping measures and motivation is contained in other Best Practice publications.

For further information see:

EEO Good Practice Guide 29. Good Housekeeping in Schools. A Guide for School Staff, Governors and Pupils

EEO Good Practice Guide 39. Managing Energy In Schools. A Guide for Headteachers and Governors

EEO Good Practice Guide 45. Managing Energy in Schools. A Guide for School Caretakers

EEO Good Practice Guide 55. Good Housekeeping in School Swimming Pools

EEO Good Practice Guide 57. Conducting an energy walk-round.

4.3 Maintenance

Regular maintenance is a prerequisite to controlling energy costs and is also essential for maintaining a healthy environment in schools. A maintenance programme should include:

- Check plant operation and controls regularly
- Ensure that all motorised valves and dampers fully open and close without sticking
- Check that thermostats are accurate
- Check calibration of controls
- Service the boiler plant and check combustion efficiency regularly
- Look for water leaks and carry out repairs where necessary
- Clean windows to maximise daylighting
- Replace 38mm diameter fluorescent tubes in switch start fittings with 26mm diameter high efficiency triphosphor tubes as the former expire (see diagrams on page 10)
- Clean lamps and luminaires regularly and replace at the manufacturer's recommended intervals.

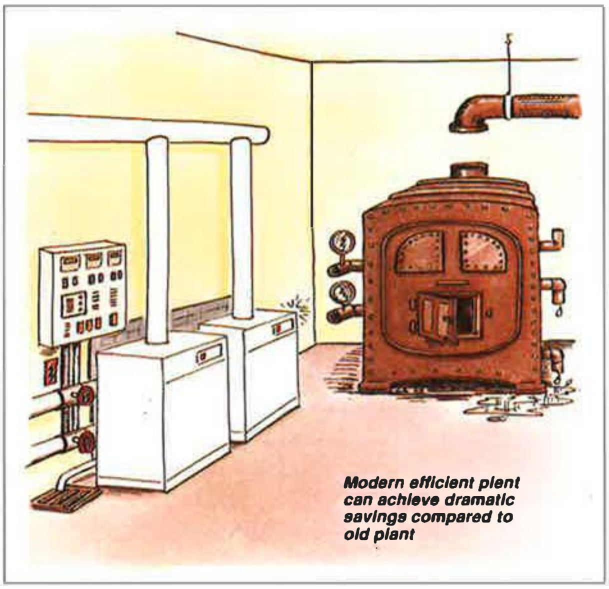
4.4 Investment in energy efficiency measures

There will almost certainly be items of equipment or insulation which could be replaced with more energy efficient alternatives. To identify opportunities you will need to have some understanding of how energy is supplied and used in your school.

Heating System

The cost of providing heat for space heating or hot water depends on the cost of the fuel used, the efficiency of conversion of fuel to heat, and the extent of the distribution losses in supplying the heat when and where it is needed.

Fossil fuels such as gas, oil or coal are usually burnt in a boiler and the heat is transferred to a heating system. Boilers have varying seasonal efficiencies - old boilers may convert less than 50% of the energy content of the fuel into heat in the heating system, while the most efficient gas condensing boilers may achieve seasonal efficiencies of over 90%. Condensing boilers can be used with most existing heating systems



Modern efficient plant can achieve dramatic savings compared to old plant

and ought to be considered whenever boilers are replaced.

Heat is lost from the heating system through ductwork, pipework, valves and hot water storage tanks. Pipe runs should therefore be short, and all parts of the system well insulated. Heat should only be supplied to a space or to produce hot water where and when it is needed. Where possible, large boilers should not be operated to meet small loads, as the efficiency will be very low.

Luminaires, left to right: recessed mirrored reflector with louvres, batten fittings, opal, prismatic diffusers.

Photographs below supplied by Philips and Fitzgerald

Figure 4.1 Typical relative energy consumption

lamp type	typical energy consumption relative to tungsten bulbs for similar levels of lighting (%)
tungsten filament bulb	100
tungsten halogen spotlight	70
compact fluorescent with electronic ballast	18
metal halide (MBI)	15
high pressure sodium	11
Fluorescent tubes:	
(1) choke & starter control gear with 38mm diameter tubes	18
(2) as 1), but 26mm diameter high efficiency triphosphor tubes	16.5
(3) as 2), but with electronic ballast	13

EFFECTIVE HEATING CONTROLS ARE ESSENTIAL. TYPES OF CONTROL INCLUDE:

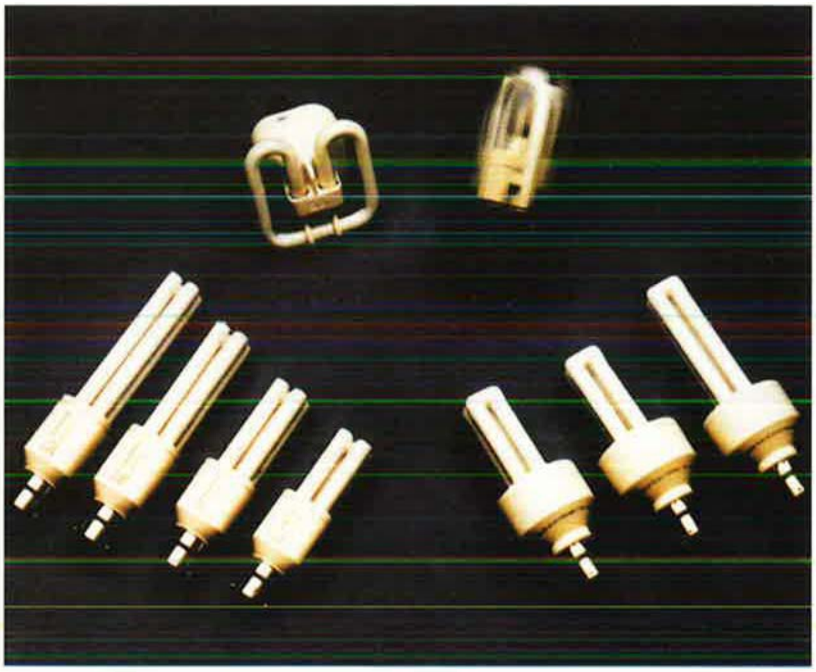
- Simple time control: a time switch that turns heating on and off at a fixed time each day - seven day time switches allow for variable occupancy during the week
- Optimum start control: switches the heating on so that the building reaches the desired temperature just in time for occupation
- Weather compensation: varies the heating according to the outside temperature
- Thermostatic radiator valves (TRVs): regulate the flow of hot water through the radiators in a room in order to maintain a local temperature
- Room thermostat: keeps the temperature in a room to a required level
- Boiler sequence control: enables only the number of boilers required to meet the system demand.

BUILDING FABRIC

Simple roof insulation and draught proofing are usually cost effective at any time, but most other building fabric measures are most cost effective when they form part of general maintenance or refurbishment.

LIGHTING

Lighting is one of the largest energy costs in a school, and good savings can be achieved by ensuring that the lighting equipment and its controls and management are of a high standard.



Compact fluorescent lamps.

Typical levels of energy consumption of different types of lamp, expressed as a percentage relevant to tungsten lamps, are given in figure 4.1.

Other aspects of lighting are also important, particularly lighting controls. It should be possible for all lights to be turned off when they are not needed, particularly in areas such as corridors, where they tend to be left on. Automatic controls such as time controls, presence detectors or daylight detectors may be worth using in some areas.

For further information see:

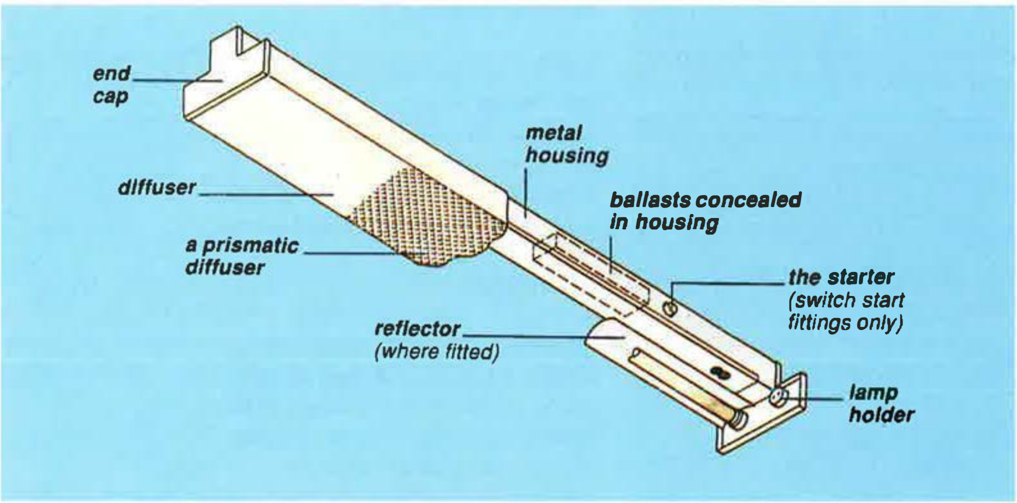
EEO Good Practice Guide 40. Saving Energy in Schools. A Guide for School Energy Managers

EEO Good Practice Guide 56. Saving Energy in School Swimming Pools. A Guide to Refurbishment and New Pool Design.

The energy used for lighting depends upon the energy consumption of the lamps and the hours of use. The most efficient systems are well designed, and have efficient lamps and fittings which provide the required level of illuminance (without over-lighting). They have controls which enable the lights to be switched off when they are not required, whether because a space is not being used or because there is sufficient daylight.

Some types of lamps, in order of increasing efficiency, are:

- 'Domestic' tungsten bulbs - very inefficient; should usually be replaced
- Compact fluorescent lamps - efficient replacement for tungsten bulbs, although not as efficient as modern tubular fluorescent lamps
- Fluorescent tubes
- Sodium discharge lamps - vary in efficiency, depending on type (most are more efficient than fluorescent tubes). Often used for external lighting.



The parts of a fluorescent light fitting

5

ENERGY USE IN SCHOOLS

5.1 Why analyse energy use?

Assessing the energy performance of a school allows you to:

1. Compare performance with standards to suggest the potential for energy saving in the building.

2. Compare with performance in previous years to monitor progress and to assess the effect of any changes or energy saving measures.

3. Consider the energy use in more depth to help understand where energy is used and wasted.

5.2 Types of school and their energy use patterns

Facilities vary considerably between different schools. In this guide three types are defined. These are: primary and middle schools, secondary schools without a swimming pool and secondary schools with a pool.

Energy costs per unit floor area in a typical secondary school are around 9% higher than those in a typical primary or middle school. This is mainly due to:

- More out of hours usage resulting in increased energy use in space heating and lighting
- More equipment, such as computers, experimental apparatus, televisions and videos resulting in increased electricity usage
- More substantial sports facilities resulting in higher hot water requirements.

A typical secondary school with a swimming pool uses around 8% more energy than a secondary school without a pool. This is due to:

- Heating of the air entering the pool hall
- Electricity consumed in running pumps and fans
- Heating of the pool water.

Figure 5.1 shows costs for typical schools. The good practice equivalents tend to use 20 to 30% less energy, mostly achieved by good management and simple measures. Still lower energy consumption is achievable in new buildings and major refurbishments.

A general understanding of what electricity and fuels are used for in schools helps to concentrate attention on priority areas, especially where the use of one of the fuels is particularly high.

Typical energy cost breakdowns for a secondary school with a pool and one without a pool are given in figures 5.2 and 5.3. The energy cost breakdown varies very little between primary and secondary schools, although some primary and middle schools may have catering facilities.

This breakdown is useful for identifying areas that you should concentrate on if one or both of the performance indices (see section 6) are high.

Note that the consumptions of energy for different end uses in any one school may be significantly different from the typical breakdowns given here.

Figure 5.1 Typical annual energy costs

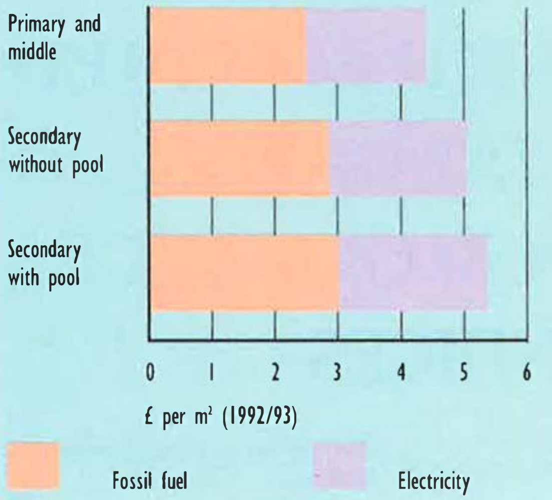


Figure 5.2
Typical energy cost breakdown in secondary school without swimming pool

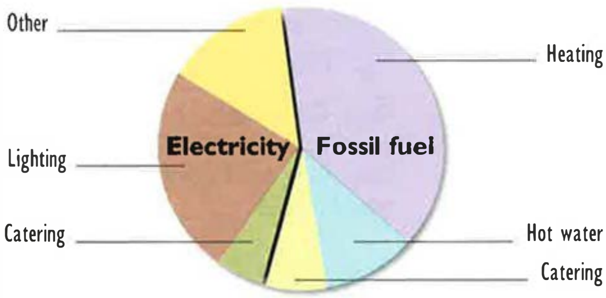
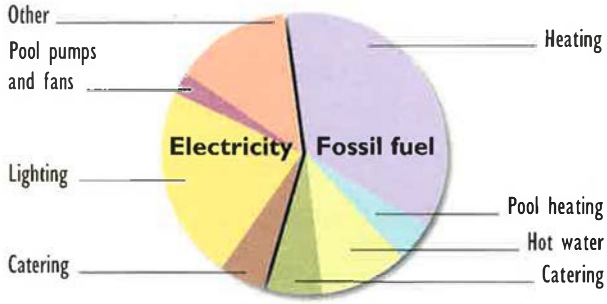


Figure 5.3
Typical energy cost breakdown in secondary school with swimming pool



For further information see:

Energy Consumption Guide 15. The Headteacher's and Governor's Guide to Energy Efficiency

Energy Consumption Guide 16. The 'School Energy Manager's' Guide to Energy Efficiency.

6

COMPARING WITH ACCEPTED STANDARDS - PERFORMANCE INDICES

6.1 Why use performance indices?

Performance indices give a measure of the energy use of a building which can be compared with yardsticks. They can indicate the potential for improvements and can be used to show progress over time.

6.2 Calculating the performance indices of a building and comparing to yardsticks

Two separate indices are calculated for the school, one for electricity and the other for fossil fuels. The separate indices should not be added together, because of the different cost and environmental impact of fossil fuels and electricity.

The performance indices are obtained by dividing the annual school energy use by the floor area of the school. Yardstick values for the different school types are given in figure 6.2, with electricity consumption and fossil fuel energy consumption shown separately.

The procedure is:

1. Enter the annual energy use for each fuel into column 1 of figure 6.1.
2. Multiply each fuel by the conversion factor in column 2 to get common units of energy (kWh is used for electricity and now for gas - conversion units are given in Appendix 2).
3. Enter the treated floor area of the building in column 4.
4. Divide the energy use of each fuel by the floor area to get energy use per unit area (kWh/m²) in column 5.
5. Add the fossil fuel figures together to get a fossil fuel index - the electricity figure can be used directly.
6. Compare the indices with yardsticks for the building type in figure 6.2 to give an energy performance assessment.

Note: this does not take account of the effect of weather on heating energy use (see section 6.4).

Floor area information.

The measure of floor area used to standardise energy consumption is treated area, defined as follows in relation to the more commonly available data on cleaning area:

Treated	The floor area of the parts of the building which are directly or indirectly heated, and including corridors, toilets, storage space. Take the total internal floor area of each storey bounded by the external walls, but exclude completely unused and unheated areas such as basements.
Cleaning	This is usually less than the treated area because of the areas that are inaccessible to cleaners.

The best available information on floor area should be entered as either ft² or preferably m² in the form below - the estimates of treated floor area can be obtained using typical ratios as shown in the form. If more than one estimate of treated area is then available, the most reliable should be used.

	ft²	÷ 10.76 = m²			Treated floor area	
Cleaning floor area			x 1.10	=		m²
Treated floor area			x 1.00	=		m²

Annual energy consumption of your building.

This is most conveniently obtained from past bills but take care that the figures collected represent a full year and are not "estimated" by the utility. It may be helpful to look at more than one year's bills providing that there have been no significant changes to the building or its use in that time. The numbers you require are the energy units consumed, not the money value. Include all fuels: solid fuel, bottled fuel, natural gas, oil and electricity.

Figure 6.1 Energy Performance Index Calculation

		Column 1 Annual Billed Units				Column 2 kWh* Conversion	Column 3 Annual kWh	Column 4 Treated floor area (m²) divide by	Column 5 Annual kWh/m²
Gas			kWh		x	1.0			
Oil type			litres		x				
Other Fossil fuel					x				
Total of fossil fuel									
Electricity			kWh		x	1.0			

Note * for kWh conversion factors see Appendix 2

Energy consumption per unit floor area also depends, amongst other things, on the size of school. Further information is given in Department for Education Design Note 17 (see section 8.7).

There may be exceptional reasons to explain high or low consumption. For example, a school may have a low consumption because it has no catering facilities, or a high consumption because it has a larger than normal sports facility. Even a building with a low consumption may have opportunities for cost-effective improvement.

The indices show which fuel requires the most attention. The description of typical energy use patterns in section 5 may help to ascertain which use of energy is most likely to offer potential for savings. The references given at the end of sections 4.2 and 4.4 show possible energy saving measures for each energy use. The next step is to select and progress suitable measures.

6.3 Alternative performance assessment

A quick first assessment to compare your school's energy costs with those of other schools is on a £/pupil basis. This is useful because it is simple, and also much school funding is based on £/pupil.

This index is calculated by dividing the total annual fuel bill (for fossil fuels and electricity) by the number of pupils at the school.

In the same way as before a performance assessment is obtained by comparing with yardsticks (see figure 6.3).

If possible use both the methods described above and compare the two performance assessments. If either of the assessments based on kWh/m² are worse than the assessment based on £/pupil then it may indicate above average utilisation of space.

Figure 6.2 Energy Consumption Yardsticks

Performance Assessment

	Low consumption / Medium consumption: Yardsticks in kWh/m²	Medium consumption / High consumption: Yardsticks in kWh/m²
	Low consumption Less than →	← **Medium consumption** Between → ← **High consumption** Greater than
Primary or middle school		
Fossil fuels	137	189
Electricity	20	27
Secondary school without swimming pool		
Fossil fuels	151	204
Electricity	22	31
Secondary school with swimming pool		
Fossil fuels	172	221
Electricity	26	33

Figure 6.3 Cost/pupil Yardsticks

Performance Assessment

	Low cost / Medium cost: Yardsticks *in £/pupil	Medium cost / High cost: Yardsticks *in £/pupil
	Low cost Less than →	← **Medium cost** Between → ← **High cost** Greater than
Primary or middle school	23	32
Secondary school without swimming pool	38	52
Secondary school with swimming pool	46	59

*Based on typical 1992 prices

6.4 Overall yardsticks and performance indices

Performance indices based on carbon dioxide (CO_2) emissions or cost of energy per m² of floor area can also be calculated. These can be used to prepare league tables for a group of schools or to assess buildings which have fuel supply arrangements which do not fit into the yardstick categories. This may occur, for example, in schools with electric heating.

Appendix 1 shows how to apply simple factors for CO_2 emissions or energy cost for each fuel type to calculate an overall performance index.

6.5 Refining the performance indices

If there is more information available, you may wish to assess your performance further in a number of ways as described in Appendix 1.

- If your school is used a lot outside of normal hours, or experiences unusual weather or exposure, you may want to know the likely effect.
- You can compare your building performance with the 'Normalised Performance Indicator' used in previous editions of these guides.

6.6 A closer look at energy consumption

It is possible to learn more about how energy is used in your school by looking more closely at your energy consumption data and relating it to factors such as weather and the types of heating system, lighting and equipment in the school. You can then make more informed decisions about where to direct resources to reduce energy costs most effectively. Guidance on how to do this is contained in other EEO Best Practice programme publications.

For further information see:

EEO Energy Consumption Guide 15. The Headteacher's and Governor's Guide to Energy Efficiency

EEO Energy Consumption Guide 16. The 'School Energy Manager's Guide' to Energy Efficiency

EEO Energy Consumption Guide 28. A Guide on Lighting and IT Equipment for Headteachers, Governors and School Staff

Department for Education Design Note 17. Guidelines for Environmental Design and Fuel Conservation in Educational Buildings.

CASE STUDIES

This section gives examples of buildings where energy saving measures have been implemented. These case studies are described more fully elsewhere.

For further information see:

EEO Good Practice Case Study 99. Energy Management by a School Governor

EEO Good Practice Case Study 184. A Head Teacher Speaks Out

EEO Good Practice Case Study 185. Out of Hours Use of Schools.

7.1 'Out of Hours' Use of Schools

Four examples of measures to deal with out-of-hours use which were taken by the Humberside County Council are given here.

Local electric heaters for Biggin Hill School

Biggin Hill School in Bransholme, Hull is a primary school with about 500 pupils. Two central gas boilers supply all the heating and hot water requirements.

In 1988, Humberside County Council installed local electric radiant heaters in school offices where it was recognised that there was a small local, but regular, out-of-hours heating requirement.

The hourly cost of heating the whole school was about £5.40. By contrast, if only one or two offices were required these could be heated locally with the electric heaters for around £0.20/hour each. Thus the few offices in use could be heated for less than 5% of the cost of heating the whole school.

Zoned heating control at Greatfield Comprehensive

In 1989, the Assembly Hall at Greatfield Comprehensive was converted into a public library to serve the local community. While this change of use was a success, the heating system was not designed to cope with partial occupancy. The opening times of the library extended beyond school hours, and existing controls did not allow the library to be heated without the school being heated as well.

To overcome this problem and provide greater control over the heating, Humberside County Council funded from its energy budget the installation of local isolating valves to provide zone control so that the library could be heated on its own when the school was not occupied.

Zone controls at Malet Lambert School

The school's heating system had no local controls, so the whole building had to be heated to ensure that adequate temperatures were maintained when selected areas were used out of hours.

The heating system was split into four zones. Control was provided from the council's energy management system (EMS).

To provide heating for any extra use of a particular area of the building, the school contacts County Hall who make the necessary adjustments to the centrally controlled EMS. The EMS then reverts back to its previous actions until another change is required.

Local boiler installation for sports facilities at Havelock Comprehensive School

Havelock Comprehensive School is a large school in Grimsby, South Humberside. It has its own sports hall and swimming pool that are also used by the local community in the evenings and at weekends. The only drawback with this arrangement was the large fuel bills which resulted from having to heat the main school building in order to heat the pool and sports hall.

It was not possible to split the heating system into separate zones, so two gas fired boilers with an overall capacity of 545kW were installed to meet the heating and hot water needs of the sports block. Within the sports block, the boilers were connected into the existing hot water distribution mains, and the original supply pipework was capped off.

The sports hall and swimming pool at Havelock Comprehensive School have been provided with separate boilers to avoid unnecessary heating of the main school building.

Radiant electric heaters were fitted in the headteacher's office and other rooms identified as having an out-of-hours heating requirement at Biggin Hill School.

Cost savings

	Capital Cost (£)	Savings (£)	Payback Time (years)
Zoned heating control at Greatfield Comprehensive	6,000	3,619	1.7
Zone controls at Malet Lambert School	12,000	4,490	2.7
Local boiler installation at Havelock School	22,300	13,700	1.6

7.2 Energy Saving by a School Governor at Parkside Middle School

Parkside Middle School, in Cullingworth, near Bradford, is attended by 430 children. One of the governors volunteered to take responsibility for its energy management. His strategy centred on involving the caretaker and teaching staff in a good housekeeping campaign which could be implemented at no capital cost.

The school is poorly insulated, giving it a high overall energy consumption. Two coal fired boilers supply heating and hot water for the school during the heating season. In summer, the coal fired boilers are shut down and hot water is provided by a much smaller gas boiler.

Strategy for savings

Using previous fuel bills the Performance Index (normalised for weather and exposure) was calculated. The school had a Performance Index of 296 kWh/m² for fossil fuel consumption and 36 kWh/m² for electricity consumption, which placed it in the high consumption category for both types of fuel. This indicated that there was considerable scope for energy savings in electricity, gas and coal usage.

Raising awareness

The support and enthusiasm of the head teacher, teachers, pupils and ancillary staff were recognised as essential to the success of the campaign. The caretaker was encouraged to take regular meter readings as a way of monitoring fuel consumption and increasing his general awareness of how energy was being used in the school. Posters and stickers from the Energy Efficiency Office were displayed throughout the school to make staff and pupils aware of the need to save energy.

The governor gave a talk to all members of staff on the benefits of improved energy efficiency which was well received.

Energy saving measures

- Existing contracts for the maintenance of the heating system, checking of controls, cleaning of filters and maintenance of lighting were reviewed, and the contractors were informed that the 'Governor Responsible For Energy' was taking an active interest in the standard of their work.

- Time clocks and thermostats were checked and adjusted as necessary. Time clock periods were then gradually reduced to establish optimum settings. The caretaker was put in charge of checking at regular intervals to make sure settings were correctly maintained at 18°C to 19°C.

- The main change, also supervised by the caretaker, related to how the boilers were used. The gas boiler, which provides hot water in summer, was being used into the autumn term when one of the coal fired boilers was providing a small amount of heating. The gas boiler is now turned off as soon as the coal-fired boiler is in use. As well as saving gas, this makes the coal-fired boiler operate more efficiently, because producing heating and hot water together uses more of its total heating capacity.

- Care was taken by all building occupiers to turn off unnecessary lights.

- Water consumption was also reduced by 45%. The resulting savings, worth £1,290 per annum, have been re-invested to enable a programme of switching to energy efficient lighting to proceed.

Cost savings

	Total consumption 1990/91 kWh	Percentage energy saving over previous year	Total cost 1990/91 £	Cost savings over previous year £
Electricity on-peak	65,801	17%	6,409	(221)
Electricity off-peak	16,329	15%		
Gas	158,333	39%	2,392	1,105
Coal	473,480	13%	4,362	497
Total	**713,943**		**13,163**	**1,381**

Monitoring and feedback

The governor obtained electricity, gas and coal bills for the previous two financial years so that consumption could be monitored and compared.

Savings were calculated and the results passed on at regular meetings with the caretaker and head teacher. He also regularly reported energy use as a specific item to the Board of Governors and the Building Sub-committee. Other staff were kept informed through teacher and governor representatives.

All the building users accepted the adjustment to the operation of the heating system and no drop in comfort levels was reported.

After six months it was clear that significant savings were being made across all the fuel bills. The caretaker's job of monitoring and trouble shooting was the key to achieving and maintaining savings.

The table shows that cost savings of 10% were achieved.

7.3 Canons High School, Harrow

A series of measures have been undertaken to reduce energy consumption at Canons High School, which has 520 pupils. Four main approaches were taken to reduce energy costs. These were:

- Understanding the energy bills
- Examining ways of reducing energy consumption and service requirements
- Using incentives to encourage students and staff to be energy conscious
- Taking advice from and working with the energy efficiency staff from the Borough.

Heating

Heating is the greatest single non payroll cost. The school's main strategy for improving the cost efficiency of heating has been to maximise utilisation of the premises. For example, if one area of the school is being let then an effort is made to let other areas that have to be heated too.

Left, Corridor showing lagged pipes and new lights.

The boilers are new with a fairly sophisticated optimiser/compensator system. The compensator notes the outside temperature and measures the inside temperature in a particular location. If it is cold outside and cold inside the compensator makes the system work harder. At night during a cold spell, the optimum start/stop control will turn the heating on earlier for the next day.

Building fabric and insulation

There are very long pipe runs in the school, many of which were uninsulated. Accessible piping was lagged and the cost of the insulation was recovered in three heating months.

As part of an external redecoration the gaps between all the window and door frames and the walls were sealed with mastic.

Lighting

The following straight-forward measures were carried out without the need for much technical expertise, mostly by the caretaker.

- An effort was made to turn off unused lights.
- Large diameter (38mm) fluorescent tubes were replaced with higher efficiency narrow diameter (26mm) tubes. (Direct replacement is possible with newer fittings that have starters).

Other lighting measures carried out were as follows:

- High efficiency sodium lamps were installed for outside security lighting, equipped with light sensors. The resulting improved security was thought to be a major benefit.
- Occupancy sensors were installed in the assembly hall, sports hall, the gym and the science labs.

Electricity tariffs

With help from the council an effort was made to understand the electricity bills and the way the tariffs work.

Having understood that a large percentage of the bill during the winter months is dependent on the maximum demand requirement (the maximum electrical power that is consumed at any one time during a given month) the school first of all checked that their actual maximum demand corresponded to that on the monthly bills and then sought ways to reduce it.

Water heating

Hot water is supplied from central tanks kept hot all year with long pipe runs to taps. The school is moving over to instantaneous heaters, especially where there is a gas supply.

Incentives

Half of the savings made on energy go to school funds which are spent by the School Council, largely made up of pupils. This is a good incentive for them and gives motivation for saving.

The future

At the time of writing all the heating was provided by one set of boilers situated in a boiler house, with long underground pipe runs to each of the blocks which make up the school. Scorched grass along these pipe runs indicated high heat losses.

As the pipes are lagged with asbestos bearing material, pipe replacement would be costly and perhaps dangerous. Each of the blocks already has its own boiler for generating domestic hot water. Since there is already a gas supply to each of the blocks and there are existing fluing arrangements the school is considering installing heating boilers into each of the blocks. This will remove the need for expensive pipe replacement and also provide zoning. For example, the science block and main hall will not need to be heated when heating is only required in the gym.

8

ADVICE AND HELP

8.1 The Energy Efficiency Office

The Energy Efficiency Office (EEO) is part of the Department of the Environment.

The EEO currently aims to achieve environmental and economic benefits by promoting cost effective energy efficiency measures in the industrial, commercial, domestic and public sectors of the economy by:

- Raising awareness
- Identifying and overcoming barriers to action
- Providing financial incentives where appropriate
- Regulation where necessary
- Providing technical advice.

8.2 Best Practice Programme

The EEO's Best Practice programme gathers and disseminates authoritative information on cost effective energy saving measures. The Best Practice programme for buildings is managed on behalf of the EEO by the Building Research Energy Conservation Support Unit (BRECSU) and for industry by the Energy Technology Support Unit (ETSU). The programme is also supported by the Department for Education.

A range of publications is available under the Best Practice programme, normally free of charge. Relevant titles for schools are listed here.

Energy Consumption Guides give data on the way in which energy is currently used in specific building types and industrial processes, enabling organisations to compare their current energy usage with others in their sector or occupying similar building types.

15 The Headteacher's and Governor's Guide to Energy Efficiency

16 The 'School Energy Manager's' Guide to Energy Efficiency

17 The Local Authority Chief Officer's Guide to Energy Efficiency

28 A Guide on Lighting and IT Equipment for Headteachers, Governors and School Staff.

Good Practice Guides give advice on how to implement energy saving measures. Titles available relating to schools are as follows:

29 Good Housekeeping in Schools. A Guide for School Staff, Governors and Pupils

39 Managing Energy in Schools. A Guide for Headteachers and Governors

40 Saving Energy in Schools. A Guide for School Energy Managers

41 Opportunities for Energy Efficiency During Refurbishment of Schools

45 Managing Energy in Schools. A Guide for School Caretakers

55 Good Housekeeping in School Swimming Pools. A Guide for School Staff

56 Saving Energy in School Swimming Pools. A Guide to Refurbishment and New Pool Design for Headteachers, Governors, and Local Authorities

57 Conducting an Energy Walk-Round. A Guide for School Energy Managers, Headteachers and Governors.

General Information Leaflets and Reports also give advice on how to implement energy saving measures. General Information Leaflets relating to schools are as follows:

1 The Success of Condensing Boilers in Non-Domestic Buildings. A User Study.

4 Opportunities for Saving Energy in Schools

7 Energy Efficiency In Schools And Colleges: Experience in 20 Case Studies.

Information on energy management is contained in these General Information Reports:

12 Organisational Aspects of Energy Management

13 Reviewing Energy Management

14 Energy Management of Buildings Including a Review of Some Case Studies.

Good Practice Case Studies provide examples of proven techniques which are already enabling the better energy users to be more energy efficient. Titles available relating to schools are as follows:

38 Condensing Gas Boilers

99 Energy Management by a School Governor

184 Energy Efficiency in Schools. A Head Teacher Speaks Out

185 Out Of Hours Use of Schools.

Fuel Efficiency Booklets are working manuals which provide detailed technical guidance on specific areas of energy use in buildings and industry. Relevant booklets are:

1 Energy audits for buildings
7 Degree days
8 The economic thickness of insulation for hot pipes
9 Economic use of electricity in buildings
10 Controls and energy savings
12 Energy management and good lighting practices.

In addition, a wide range of events is organised to promote the results of the Best Practice programme. These include seminars, workshops and site visits and are targeted at different sectors and professionals.

Details of publications and events can be obtained from:

BRECSU (for buildings)
Building Research Establishment
Garston
Watford WD2 7JR
Tel: 0923 664258
Fax: 0923 664097

ETSU (for industrial sectors)
Harwell
Didcot
Oxon OX11 ORA
Tel: 0235 436747
Fax: 0235 432923.

8.3 Other publications available from BRECSU

Energy Efficient Lighting in Schools (1993). A THERMIE Maxibrochure.

8.4 Free Publications From the EEO

The Introduction to Energy Efficiency series. There are 13 Guides in this series of which this is one:

Catering establishments
Entertainment buildings
Factories and warehouses
Further and higher education
Health care buildings
Hotels
Libraries, museums, galleries and churches
Offices
Post Offices, banks and agencies
Prisons, emergency buildings and courts
Schools
Shops
Sports and recreation centres.

Choosing an Energy Efficiency Consultant (EMAS 2)

Practical Energy Saving Guide for Smaller Businesses (ACBE 1)

Guidelines for Local Authority Shared Savings Energy Performance Contracts (IIB10).

The above are all available from:
Department of the Environment
Blackhorse Rd
London SE99 6TT
Tel: 081 691 9000

The 'Energy Management' journal. Published bi-monthly and available free in the UK from the EEO (Tel: 071 276 6200).

8.5 Other Programmes

Energy Design Advice Scheme

The Energy Design Advice Scheme is a Department of Trade and Industry discretionary initiative aimed at improving the energy and environmental performance of the building stock by making low energy building design expertise more accessible for the energy efficient design and refurbishment of buildings. The scheme offers support, via a number of Regional Centres, to design teams or clients in the energy aspects of design of new buildings or refurbishment projects.

Further information can be obtained from the following Regional Centres:

For Scotland
Tel: 031 228 4414

For South East England
Tel: 071 916 3891

For Northern England
Tel: 0742 721 140

For Northern Ireland
Tel: 0232 364 090

EU Programmes

Several EU programmes are aimed at demonstrating energy efficiency measures and encouraging energy efficiency R&D. Details of these programmes are announced periodically. For further information contact BRECSU for buildings and ETSU for industry.

8.6 Sources of Free Advice and Information

Regional Energy Efficiency Officers

11 Regional Energy Efficiency Officers (REEOs) around the UK can provide copies of all the EEO's literature and give specific advice on:

- opportunities for better energy efficiency in your organisation
- technologies and management techniques you should be thinking about
- appropriate sources of specialist advice and assistance in the private sector
- EEO programmes
- regional energy managers' groups.

REEO Northern Region
Wellbar House
Gallowgate
Newcastle Upon Tyne NE1 4TD
Tel: 091 201 3343

REEO Yorkshire and Humberside
City House
New Station Street
Leeds LS1 4JD
Tel: 0532 836 376

REEO North West
Sunley Tower
Piccadilly Plaza
Manchester M1 4BA
Tel: 061 838 5335

REEO East Midlands
Cranbrook House
Cranbrook Street
Nottingham
Nottinghamshire NG1 1EY
Tel: 0602 350 602

REEO West Midlands
Five Ways Tower
Frederick Road
Birmingham B15 1SJ
Tel: 021 626 2222

REEO Eastern
Heron House
49-53 Goldington Road
Bedford MK40 3LL
Tel: 0234 276 194

REEO South West
Tollgate House
Houlton Street
Bristol BS2 9DJ
Tel: 0272 218 665

REEO South East
Charles House
Room 565
375 Kensington High St
London W14 8QH
Tel: 071 605 9160

REEO Scotland
New St Andrews House
Edinburgh
Scotland EH1 3TG
Tel: 031 244 1200

REEO Wales
Cathays Park
Cardiff
Wales CF1 1NQ
Tel: 0222 823 126

REEO Northern Ireland
Dept of Economic Development
Netherleigh House
Massey Avenue
Belfast
N Ireland BT4 2JT
Tel: 0232 529900.

8.7 Other Publications

Department for Education (DFE):

Design Note 17. Guidelines for Environmental Design and Fuel Conservation in Educational Buildings - free.

Broadsheet 29. Energy Use in Educational Buildings - free.

DFE publications are available from:
DFE Publication Centre
PO Box 2193
London E15 2EW
Tel: 081 533 2000
Fax: 071 533 7700

Building Bulletin 73. A Guide to Energy Efficient Refurbishment - HMSO

Managing School Facilities Guide 1 - Saving Water - HMSO

HMSO publications are available from HMSO shops
Tel: 071 873 9090
Fax: 071 873 8200.

Chartered Institution of Building Services Engineers (CIBSE):

CIBSE Applications Manual, AM 5:1991, Energy Audits and Surveys

CIBSE Applications Manual, AM 6:1991, Contract Energy Management

CIBSE Code for Interior Lighting (1984)

Available from:

CIBSE, 222 Balham High Rd,
Balham,
London SW12 9BS.
Tel: 081 675 5211
Fax: 081 675 5449.

Heating and Ventilating Contractors Association (HVCA):

Standard Specification for Maintenance of Building Services. Volumes 1 - 5. 1990 - 1992.

Available from:

HVCA Publications, Old Mansion House, Earmont Bridge, Cumbria, CA10 2BX
Tel: 0768 64771.

8.8 Other Useful Addresses

Centre for Research, Education and Training in Energy (CREATE)
Tel: 0942 322 271

Energy Systems Trade Association Ltd (ESTA)
PO Box 16, Stroud, Gloucestershire
GL5 5EB
Tel: 0453 886776
Fax: 0453 885226

Major Energy Users' Council
10 Audley Road
London W5 3ET
Tel: 081 997 2561/3854
Fax: 081 566 7073.

APPENDIX 1

Development of Building Performance Indices (PI)

Introduction

This section outlines how to calculate environmental and cost indices for the energy used in your school. It describes the effect of weather, building occupancy and exposure on the performance of a building, with a method to allow for these factors if required.

Adjustments of the PI for these factors produces a 'Normalised Performance Index' (NPI) which is compatible with earlier versions of this guide. For many purposes, the effect of these factors on performance indices is small enough to be ignored.

Overall performance indices

Overall performance indices provide a single measure of building performance, and can be expressed in terms of carbon dioxide (CO_2) emissions or energy cost. Overall energy indices are useful for comparing a stock of buildings or for assessing the performance of buildings with electric heating. However, separate fossil fuel and electricity performance indices are more useful to assist in deciding a course of action.

To calculate overall performance indices you need the annual energy use indices as obtained on page 12, figure 6.1 and conversion factors for each of the fuels - some of which are given in figures A1.1 and A1.2. The calculation procedure is to enter the kWh/m² figure in Column 1, and multiply by the relevant conversion factors in column 2 to get either the kg of CO_2 per m² or the cost per m² in column 3.

The conversion factors shown are broadly representative of the current fuels used in schools, and can be used if a consistent set of factors is required. CO_2 factors, particularly for electricity, may vary from this data. Cost factors will also vary over time and as a function of use. Energy unit costs in larger buildings tend to be cheaper than for smaller supplies. You may wish to use your own costs from your fuel bills instead of those given here.

Overall yardsticks for CO_2 emissions or energy costs can also be calculated, by inserting yardstick energy consumptions (given in figure 6.2) into column 1. These can be compared with the actual index for your building to give an overall assessment. CO_2 and cost yardsticks calculated on the basis that the fossil fuel is gas are given in figure A1.3.

Effect of weather on energy use

Weather changes from year to year for a given site cause variations in fossil/heating energy use of typically ±5% from the average values or ±10% in more extreme years. Weather differences across the country cause variation in heating requirements of typically ±10% from average values and ±20% in more extreme areas.

The effect on electricity use will be small unless electricity is used for space heating.

Exposure

If a building is very exposed (on an exposed hill for example), heating energy increases by 5-10% and likewise a completely protected building may use 5-10% less. In many cases steps will have been taken on exposed buildings to improve draught sealing which will offset the increase. Electricity use is largely unaffected except in electrically heated buildings.

Hours that the building is occupied (occupancy)

Occupancy affects schools' energy use in different ways for different systems. Heating energy in a heavy building varies very little with occupancy - say 5%. If a building is light weight, such as a prefabricated classroom, the heating energy may increase in more direct proportion to the occupied hours. This may give 20% variation or more from the typical occupancy.

Electricity consumption of a badly controlled school will be almost independent of the occupancy, owing to lights and services left on from early morning to last thing at night. For a well controlled school both lights and plant may operate in direct proportion to occupancy.

Figure A1.1
CO_2 Performance Index Calculation

	Column 1 Annual energy use kWh/m²	Column 2 CO_2 conversion* factors kg/kWh	Column 3 Annual CO_2 emissions kg/m²
Gas		x 0.20	
Oil		x 0.29	
Coal		x 0.32	
Electricity		x 0.70	
Total CO_2 emissions per m²			

*typical 1993 emission factors

Figure A1.2
Cost Performance Index Calculation

	Column 1 Annual energy use kWh/m²	Column 2 Cost conversion* factors £/kWh	Column 3 Annual cost £/m²
Gas		x 0.014	
Oil		x 0.012	
Coal		x 0.009	
Electricity		x 0.071	
Total energy cost per m²			

*typical 1992 prices

Figure A1.3 Carbon dioxide and cost yardsticks

CO_2 Performance Assessment

Low Emissions: Less than | Medium Emissions: Between | High Emissions: Greater than

School Type	Yardsticks in kg CO_2/m^2	Yardsticks in kg CO_2/m^2
1. Primary and middle schools	41	57
2. Secondary school without pool	46	63
3. Secondary school with pool	53	67

Cost Performance Assessment

Low Cost: Less than | Medium Cost: Between | High Cost: Greater than

School Type	Yardsticks in £/m²	Yardsticks in £/m²
1. Primary and middle schools	3.30	4.60
2. Secondary school without pool	3.70	5.10
3. Secondary school with pool	4.30	5.40

CO_2 and cost yardsticks are based on factors in figures A1.1 and A1.2

Normalised performance indices

It is possible to adjust (normalise) performance indices for weather, exposure and extended occupancy, but care is needed as incorrectly applied adjustments, or adjustments that are too simplistic, may introduce larger errors than the typical variations discussed above. For example, the effect of extended hours of use on energy consumption can easily be exaggerated, making the building performance seem better than is really the case.

Note also that while a normalised performance index is a better measure of a building's efficiency than an unnormalised index, the latter shows the building's actual performance. So a building with a low normalised performance index, but a high performance index before adjustment, is efficient, but since it is still a high user of energy, it may well offer good opportunities for cost effective energy saving.

The worksheet in figure A1.4 can be used to obtain performance indices which are normalised to standard conditions of weather, exposure and occupancy. This is useful if:

- You require normalised performance indices for compatibility with previous work
- Any of the factors cause significant errors (see above sub sections to evaluate this).

A normalised performance index based on overall CO_2 emissions or cost is obtained by using figure A1.1 & A1.2 and inserting the normalised index for each fuel into column 1. If more than one fuel is used for heating, calculate a separate normalised performance index for each fuel first and then use this procedure.

Performance indices - summary

- Simple performance indices are for initial energy assessments. Separate performance indices are calculated, one for fossil fuels and one for electricity use, and no adjustments are made.
- Overall performance indices, based on carbon dioxide (CO_2) or cost, are normally used when the energy supply arrangement is not typical or when a number of buildings are to be compared. Also, you may want to know the cost or the CO_2 performance for a single building.
- Normalised performance indices are used when more sensitive comparisons are required and the effect of factors such as weather and occupancy become significant. But if you choose to normalise, be aware of introducing errors.

Figure A.1.4 Normalised Performance Indices calculation

	Fossil fuel: Gas	Fossil fuel: Oil	Fossil fuel: Other		Total of Fossil Fuels	Electricity
Total energy consumption (kWh)				(A)		
Space heating energy (kWh)				*(B)		
Non space heating energy (kWh)				A-B = (C)		
Find the degree days for the energy data year				*(D)		
Weather correction factor = 2462 ÷ D =				(E)		
Obtain the exposure factor below				*(F)		
Obtain occupancy factor for heating energy use from below				*(G)		
Annual heating energy use for standard conditions				BxExFxG = (H)		
Obtain occupancy factor for non-heating energy from below				*(K)		
Annual non-heating energy use = C x K =				(L)		
Normalised energy use = H + L =				kWh (M)		
Find floor area				m² (N)		
Find the Normalised Performance Indices = M ÷ N =				kWh/m² (P)		

*Notes:
(B) Estimation of weather-dependent heating energy use is discussed in EEO Energy Consumption Guide 16.
(D) For degree day information, see Fuel Efficiency Booklet 7 - Degree Days. Monthly degree day figures are published in 'Energy Management' (see section 8.4).
(F) Exposure factors from figure A1.5.
(G) and (K) Occupancy factors from figure A1.6.

Figure A1.5 Exposure factor

	Factor
Sheltered. The building is in a built-up area with other buildings of similar or greater height surrounding it. This would apply to most city centre locations.	1.1
Normal. The building is on level ground in urban or rural surroundings. It would be usual to have some trees or adjacent buildings.	1.0
Exposed. Coastal and hilly sites with little or no adjacent screening.	0.9

Figure A1.6 Occupancy Factors

	Factor for heating energy (G)	Factor for non-heating energy (K)
Normal building occupancy: (5 days), 9 hours per day	1.00	1.00
Lightweight building Extended occupancy	0.85	0.80
Other buildings Extended occupancy	0.95	0.80

APPENDIX 2

Energy Conversion Factors

The unit of energy used in this guide is the kilowatt - hour (kWh). One kilowatt - hour is consumed by a typical one - bar electric fire in one hour. For fuels which are metered in other units, multiply the metered value by the relevant conversion factor from the following table to get the value in kWh.

Figure A2.1 Conversion to kWh

	kWh conversion
Light Fuel Oil	11.2 kWh/litre
Medium Fuel Oil	11.3 kWh/litre
Heavy Fuel Oil	11.4 kWh/litre
Gas Oil (35 second)	10.8 kWh/litre
Kerosene - burning oil 22 second	10.4 kWh/litre
Electricity	[Metered directly in kWh]
Natural gas	29.31 kWh/therm
Liquid Petroleum Gas (LPG) (Propane)	6.96 kWh/litre
Coal (washed shingles)	7,900 kWh/tonne
Coal (washed smalls)	7,800 kWh/tonne

BEST PRACTICE PROGRAMME

Energy Efficiency Office

DEPARTMENT OF THE ENVIRONMENT

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