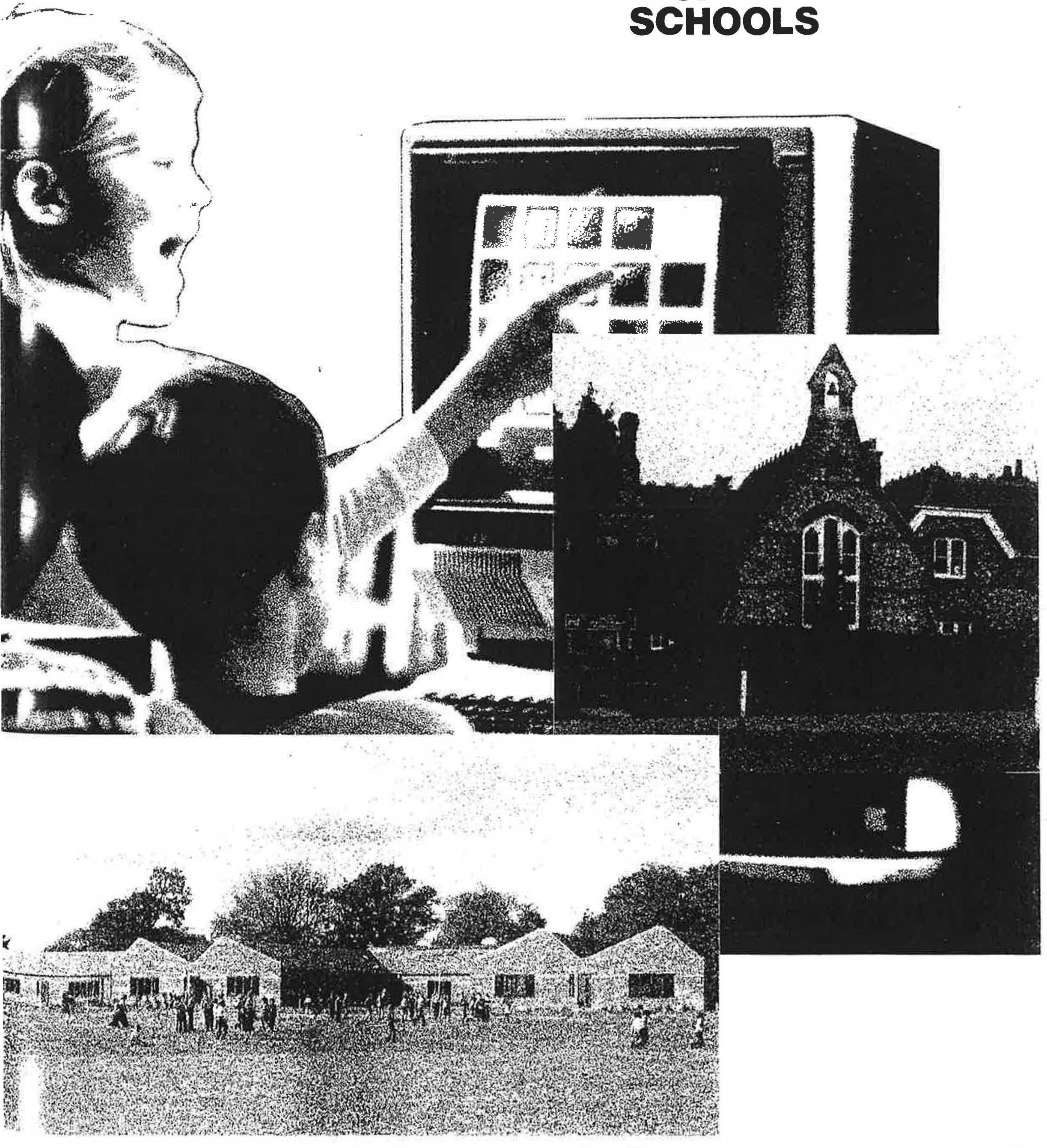
Energy Efficiency in Buildings

How to bring down energy costs in SCHOOLS



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Energy Efficiency in Buildings: Schools

The Energy Efficiency Office

Get more from your energy. It's a simple enough message and it's not difficult to achieve it with the right kind of help and guidance. That's where the Energy Efficiency Office comes in.

The Energy Efficiency Office was set up in 1983 to co-ordinate the Government's campaign for improved energy efficiency throughout the British economy. The country's fuel bills could be reduced cost effectively by 20 per cent, worth £8 billion a year. That kind of saving wouldn't just mean a more prosperous Britain, it would mean better profitability and lower costs for hundreds of companies and organisations, including your own. The Energy Efficiency Office gratefully acknowledges the assistance given by the Building Services Research and Information Association in the preparation of this booklet and by the following organisations in providing information:

Audit Commission
Avon County Council
Berkshire County Coucil
Gwent County Council
Hertfordshire County Council
Lancashire County Council
Oxfordshire County Council
Suffolk County Council

These organisations are not responsible for the use made of information they have provided in the preparation of the energy performance indicators and in formulating the guidance set out in this publication.

Introduction

Energy efficiency is important. Most buildings need energy to provide heating, hot water and lighting. The energy used for these purposes accounts for a staggering £17 billion every year. Wasteful buildings, whether poorly designed or badly run, can use many times more energy than similar efficient buildings. Many local education authorities have already recognised that energy efficiency in schools is important because school buildings account for approximately 70 per cent of their total energy bill.

This booklet is intended for head teachers, bursars, caretakers and other staff involved in the day-to-day running of schools in both the private and public sectors. It is designed to help in assessing the energy performance of primary, junior and secondary schools. Valuable savings will be achieved by carrying out the simple steps shown here, releasing money which could be used for educational resources that all schools need. This booklet explains how to compare an individual school's energy consumption with those of a representative sample of similar schools. This comparison will indicate whether your school is energy efficient or if significant improvements are possible. This booklet also describes the kind of measures that can be undertaken to save money. Many of these measures cost nothing to implement and can do much to enhance the conditions in which the school's staff and pupils work.

Not only do schools represent a significant potential for savings in the national energy requirement but they are also in a unique position to demonstrate energy awareness in the education of children. By doing this we are ensuring that future generations will come to regard energy as a valuable and important resource.

Recognising the Benefits

The Role of the Energy Manager

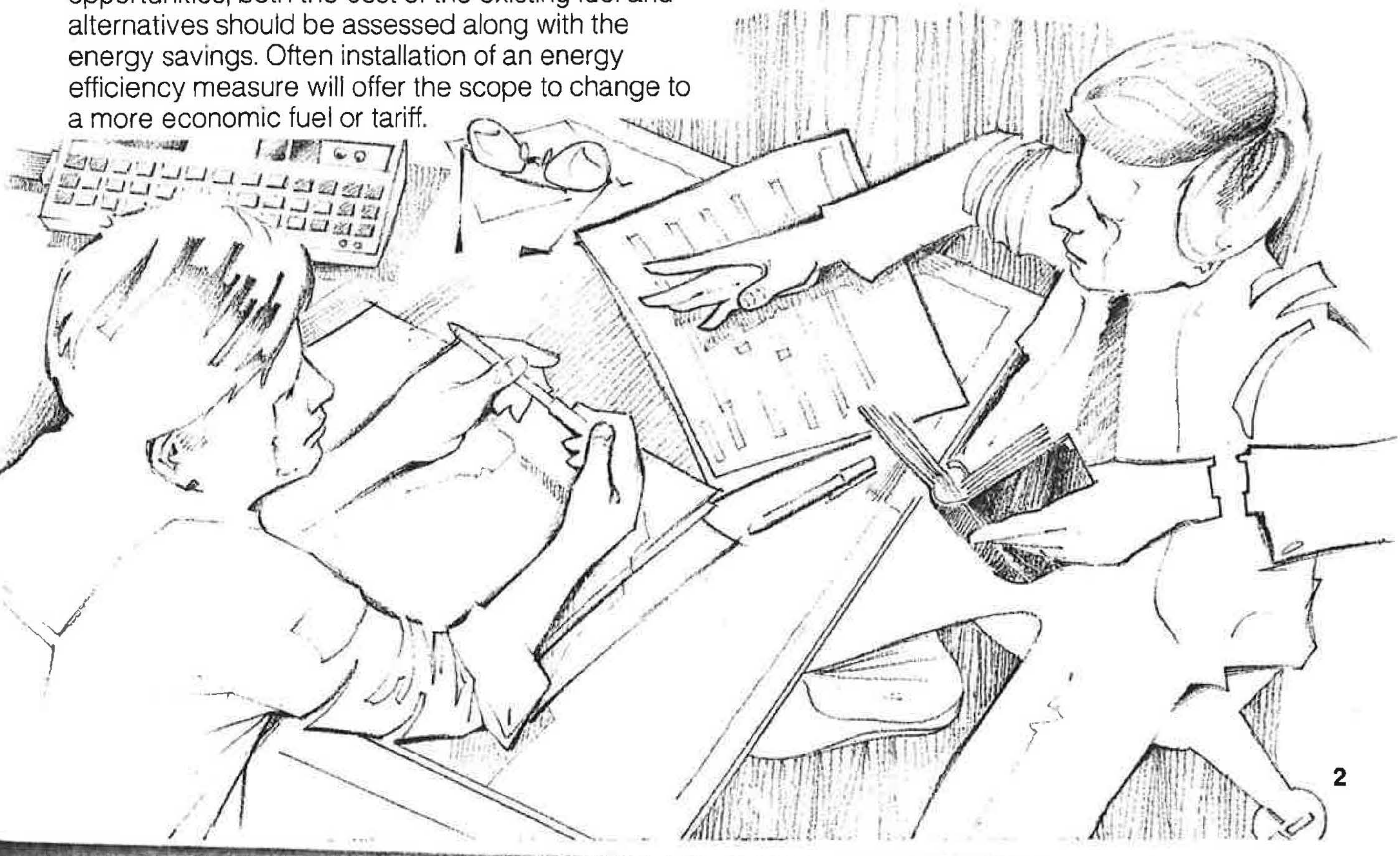
All buildings have someone to take responsibility for the energy used in them. This person (sometimes called an 'energy manager') will generally be a member of the teaching or administrative staff. He or she will need to examine on a regular basis the performance of the building in order to ensure that nothing has gone seriously amiss with the plant or the way the building is used. Where the energy manager does not have direct responsibility for maintenance or capital expenditure, a well reasoned and researched argument, supported with the techniques outlined in this booklet, can be a powerful submission to higher management.
Staff must provide the initiative if good housekeeping and other low-cost/no-cost measures are to be taken seriously by those working in the school. It is essential to develop and maintain good communications at all levels and to take positive action to remedy faults. Providing incentives and encouraging a general enthusiasm for energy-efficient behaviour is an integral part of the task. These can by themselves contribute to more overall savings than many 'high tech' capital-intensive solutions.
When considering enegy efficiency investment opportunities, both the cost of the existing fuel and alternatives should be assessed along with the energy savings. Often installation of an energy efficiency measure will offer the scope to change to a more economic fuel or tariff.

Who gets the benefit?

- **The staff and pupils.**
An efficiently controlled environment gives comfortable working conditions. Many local authorities are now running schemes to reward individual schools that improve their utilisation of energy. This is often done by implementing targeting schemes where a percentage of saving is returned as a capitation allowance.

- **Local authorities or boards of governors.**
Efficiently run buildings are less time-consuming to administer, requiring less manpower to service complaints. These savings are additional to the reduced revenue costs of energy. The reduced costs of operation can release valuable resources that can be better employed in improving or expanding facilities.

- **The nation.**
Fossil energy resources are finite and diminishing. Energy efficiency is the key to ensure that these valuable resources are not squandered. This is true of course for all sectors, including the domestic one, and an awareness in schools will have enormous long-term benefits through pupils carrying the message into future generations.



Types of Building Discussed in this Booklet

This booklet covers school buildings ranging from nursery schools up to secondary schools within the private and public education sectors. Higher Education buildings are dealt with in another booklet. The stock of school buildings is very wide, ranging from early nineteenth century solid brick construction, through the system-built schools of the sixties, to the low-energy schools increasingly built today.

In this booklet we have grouped schools into functional categories.

Within these groups, distinctions are made between schools with and without swimming pools.

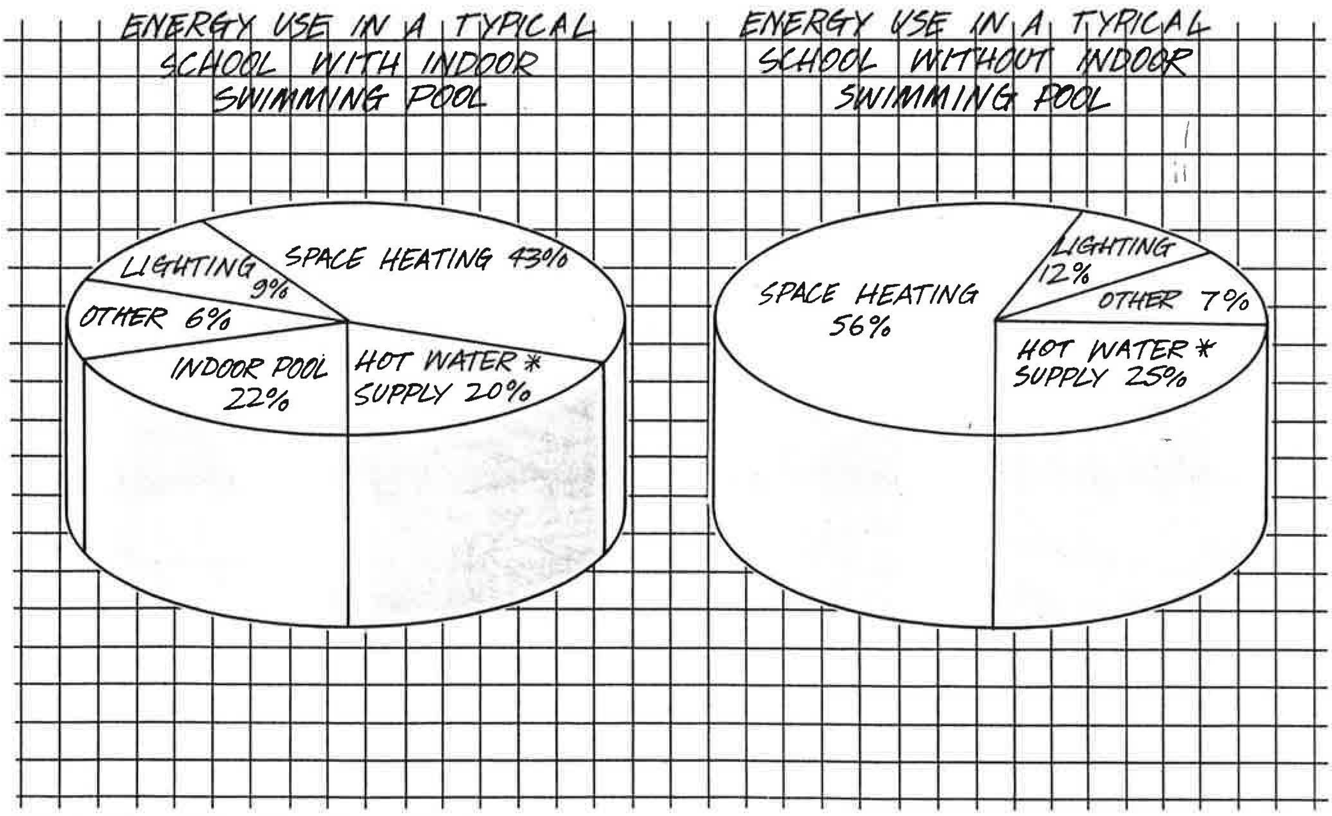
Secondary schools with sports facilities open to the public are also treated separately.

As a general guide the pie charts below indicate where energy goes in a normal school building without catering or special sports facilities.

Indoor swimming pools are a big consumer of energy and can increase the average annual energy consumption of a school by 30 per cent. More detailed information on energy factors for swimming pools is contained in another booklet in this series.

Kitchens used for preparing school meals on the premises will be an additional source of energy use, particularly if the kitchen provides a central catering service for other schools in the area.

The relative importance of energy costs may differ considerably from the energy use. For example, lighting often accounts for 40 per cent annual energy costs in school buildings because daytime electricity is a comparatively expensive form of energy.



*including Boiler Standings Losses

Assessing Current Building Performance

Steps to assessing performance

This section shows how to calculate a number that indicates the energy performance of your school. It is designed to give an equivalent 'miles per gallon' number that can be used to compare your own school with other similar schools. If your building compares badly then urgent measures should be taken; if it compares well then take the opportunity to seek further ways of improving performance, and in particular make sure that you have a method of checking that the situation does not deteriorate in the future.

What you will need to know

- **The annual energy consumption of your school building.**

This information is most conveniently obtained from past bills, but take care that the figures collected represent actual energy consumed through a full year and are not 'estimated' by the utility. It may be helpful to look at more than one year's bills, provided 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: natural gas, bottled gas, kerosene, oil, solid fuel and electricity.

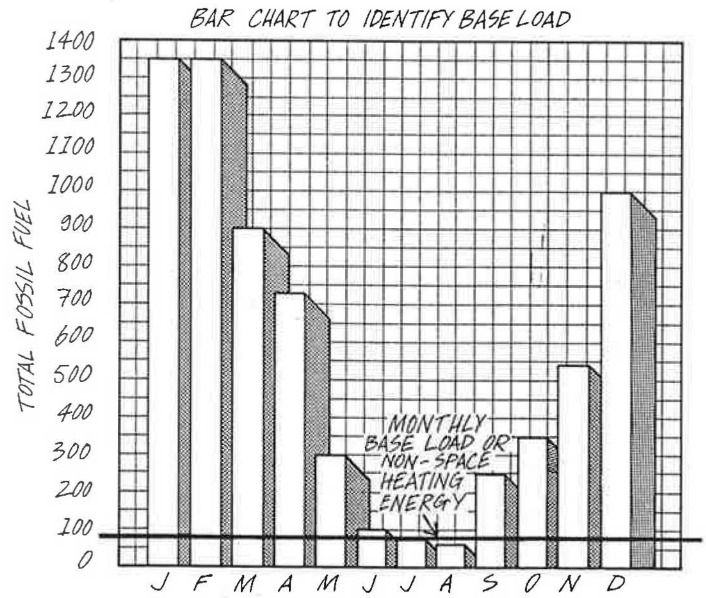
- **The floor area of the school.**

This should be the floor area of the parts of the building which are directly or indirectly heated, and includes corridors, toilets, and storage spaces. Take the total internal floor area of each storey bounded by the external walls, but exclude completely unused and unheated areas such as basements. It is common practice for the 'cleaning area' to be available. If only this data is available then as a general rule of thumb you will need to add 10 per cent to take account of areas not accessible to cleaners. Note what the units of measurement are.

- **The energy used for space heating**

This is a difficult figure to obtain, unless separate heaters or boilers are used to provide hot water and these are metered separately. If no data is available an approximate assessment of space heating energy can be obtained by taking 75% of the fossil fuel consumed by a combined space heating and hot water system. Alternatively the procedure outlined below may be adopted to assess energy used for space heating.

Examine the records of fossil fuel and electricity consumption for several successive years and plot bar charts of total consumption against each month. The consumption during the summer months when space heating is normally switched off, will give the base load which is not weather-dependent. The load can subsequently be subtracted from the total annual consumption to give the consumption attributable to space heating.



- **The total number of hours that the building is occupied during the year.**

Calculate this as follows: multiply the number of school days in the year by the number of hours each day for which the school is normally occupied. Add an allowance for the number of extra hours in a year for which the school is used for extra-curricular activities and meetings, but exclude cleaning time.

The Normalised Performance Indicator

In order to compare the consumption of different school buildings, it is important to account for several factors that contribute to additional fuel usage. In this way, schools with different exposures and of differing size can be compared on the same basis.
The yardsticks given in these booklets are based on average annual energy consumptions from as wide a sample as available at the time of publication and take account of:

Floor area
Local weather information
Exposure
Hours of use

Before the energy consumption of the building can be compared with the yardsticks provided on page 9, it is necessary to normalise for the above factors.

Calculating the NPI

The following notes will help you to carry out the calculation for the first time. You may find it convenient to enter the figures on the form provided on page 8.

Step 1 Convert energy units to kWh

Obtain the energy consumption for each fuel over a one-year period from your quarterly bills. The table below shows the conversion factors that you should use to convert most fuel types into units of kilowatt hours. If you use a fuel type not listed here then you should obtain this factor from one of the sources listed at the end of this publication.

Fuel Type	Billed Units	to get kWh multiply by
Natural gas	Therms	29.31
	Cubic feet	0.303
Gas oil (35 sec)	Litres	10.6
Light fuel oil (290 sec)	Litres	11.2
Medium fuel oil (950 sec)	Litres	11.3
Heavy fuel oil (3500 sec)	Litres	11.4
*Coal	Tonnes	7600
*Anthracite	Tonnes	9200
Liquid petroleum gas	Litres	7
(LPG)	Tonnes	13900

*The calorific value of solid fuel is subject to local variation. A more accurate figure may be available from your supplier.

Step 2 Find the energy used for space heating

Space-heating energy should include electicity consumed in heating temporary classrooms and for supplementary heating in specific areas. These figures are often difficult to determine and in these cases will have to be omitted from the weather correction process. Where central plant provides both space heating and domestic hot water then you will need to calculate the energy used for space heating from the total fuel used by this plant. If space heating energy is not metered separately, adopt the estimation procedure outlined on page 4. If this is not possible a good guide for schools is to take 75 per cent of the total fossil fuel used by combined space heating and hot water plant. The remaining 25 per cent is due to boiler losses and hot water service which are not primarily dependent on prevailing weather. For schools with electric space heating and hot water take 75 per cent of the total energy consumption as being for space heating.

Step 3 Modify the space-heating energy to account for weather

When the weather is severe a building will use more energy. In order that a reasonable comparison can be made with data from different years, a correction factor is applied. This correction factor is derived from 'Degree Day' infomation that is available from a number of different sources:

- **Regional Energy Efficiency Officers.** They can advise you in a wide variety of cases and will have the data you require. **See page 18**
- **'Energy Management',** a monthly publication by the EEO, available free. **See page 19.**

The concept of Degree Days is fairly simple. There is an outside temperature, called the base temperature, above which heating is not necessary because the occupants of a building will be warm enough due to lighting, sunshine through windows and their own body heat. Degree Days indicate both the amount of time and the temperature below this base temperature, taken to be **15.5°C.** As an example, if for one week the avarage outside air temperature was **12.5°C**, this would represent a severity of **(15.5-12.5) x 7= 21** Degree Days.

For more detailed explanation of Degree Days, **Fuel Efficiency Booklet No 7** is available from the EEO whose address is given on **page18.** In order to calculate the weather correction factor, the total Degree Days for a 'standard year' are divided by the Degree Days for the year in which the energy data is to be considered. The standard year is taken to be 1976 which conveniently has characteristics that are typical of the last 20 years' average and had 2462 Degree Days in it.

$$\text{Weather correction factor} = \frac{\text{Standard Degree Days (2462)}}{\text{Degree Days for energy data year}}$$

Because both figures are similar in most cases the number will be close to the value 1. If weather data cannot be obtained, the value 1 will have to be assumed, but this will result in a loss of accuracy of the final NPI. You have at this point to multiply the annual space heating energy obtained in step 2 by the weather correction factor.

Step 4 Modify the space heating energy to account for exposure

Part of the heat loss of a building is due to air leaking into and out of the windows and doors. In areas of high exposure it is natural that a building will use more energy to maintain the same internal conditions. Similarly, a well-sheltered building should use less. To account for this an exposure factor is used in a similar manner to the weather correction factor.

From the table below choose the description of location that most closely describes your own site and multiply the space heating energy by the factor shown.

Exposure Factors

Description of location	Factor
Sheltered. The building is in a built-up area with other buildings of similar height or greater surrounding it. This would apply to most city-centre locations.	1.1
Normal. The building is on level ground in urban and 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
Note: The majority of buildings should be in the normal category.	

At the completion of this stage you have made all the corrections required to the space-heating energy and it is said to be normalised.

Step 5 Add non-heating energy use

All of the other energy use in the building should now be added to the corrected space-heating energy obtained previously. It is not necessary to normalise non-space-heating data, since it is not significantly dependent on weather or exposure. Remember to add all energy used, including separately metered supplies for areas that may have been added to the original building but which were included in your area assessment.

Add the domestic hot water use, if this is not already included above. (This is the data that you separated in step 2 from the space-heating energy use.)

Step 6 Hours of use factor

Not all schools are used for the same length of time in a year. To overcome this difficulty a correction can be made to the annual energy consumption.

This works in a manner similar to the Degree Day correction and is calculated by reference to the following table.

Standard hours of use per year for schools

School type	Hours of use
Nursery schools	2290
Primary school, no indoor pool	1480
Primary school with indoor pool	1480
Secondary school, no indoor pool	1660
Secondary school with indoor pool	2000
Secondary school with sports centre	3690
Special school, non-residential	1570
Special school, residential	8760

From the table choose the building type that describes your own school and note the 'standard hours' alongside. This figure must then be divided by the number of hours for your own building as follows:

$$\text{Hours of use factor} = \frac{\text{Standard number of hours}}{\text{Number of hours for your school}}$$

As with the other factors the result should be fairly close to 1. If it is greater than 1.33 or less than 0.67 then you should recheck your calculation. If on rechecking the number still lies outside this range then use the appropriate upper or lower limit. In these cases the Calculated NPI should be compared with the appropriate yardstick with some caution as no comparitive data is available.

Step 7 Convert the floor area into units of square metres (m^2)

The conversion factors given below shoud be used for this purpose.

To convert from	multiply by to get m^2
Square feet ft^2	0.0929
Square yards yd^2	0.836

Step 8 Calculate the Normalised Performance Indicator (NPI)

You now have the information required to calculate the NPI. Simply divide the corrected annual energy use, obtained in step 6, by the area in square metres from the step above.

$$\text{NPI} = \frac{\text{Corrected Annual Energy Consumption}}{\text{Floor Area}}$$

This calculation provides you with the amount of energy consumed within your building under standard conditions, which can now be used to compare the performance of your building with a sample of similar buildings.

NPI Calculation Form

1. Convert your energy use into kWh units

Add your quarterly or monthly use over one year for each fuel and enter below

Natural gas	Therms	x 29.31	=	kWh	
	Cubic feet	x 0.303	=	kWh	
Gas oil (35 sec)	Litres	x 10.6	=	kWh	
Light fuel oil (290 sec)	Litres	x 11.2	=	kWh	
Medium fuel oil (950 sec)	Litres	x 11.3	=	kWh	
Heavy fuel oil (3500 sec)	Litres	x 11.4	=	kWh	
Coal	Tonnes	x 7600	=	kWh	
Anthracite	Tonnes	x 9200	=	kWh	
Liquid petroleum gas (LPG)	Litres	x 7	=	kWh	
	Tonnes	x 13900	=	kWh	
Electricity	kWh	x 1	=	kWh	
Total energy use for the year			=	kWh	A

2. Find your space-heating energy use

If you can identify any of the fuels above used only for space heating, enter the total energy use in kWh.

1.
2.
3.

Add these to give total				kWh	B

For fuels used for space heating and hot water, where these are not separately metered, take 75% of energy used. This figure may also be used for all electrically heated buildings.

1.
2.

Total		x 0.75	=	kWh	C
Annual space-heating energy		B or C	=	kWh	D
Annual non-space-heating energy		A – D	=	kWh	E

3. Adjust the space-heating energy to account for weather

Find the Degree Days for the energy data year		=		F
The weather correction factor = $\frac{2462}{F} = \frac{2462}{\quad}$		=		G
Adjust the space-heating energy to standard conditions	D x G	=	kWh	H

4. Adjust the space-heating energy to account for exposure

Obtain the exposure factor from this booklet to suit the location of the building		=		J
Adjusted space-heating energy	H x J	=	kWh	K

5. Find normalised annual energy use

	E + K	=	kWh	L

6. Correct for hours of use of building

Obtain standard hours of use from this booklet		=		M
Calculate the annual hours of use for your building		=		N
Hours of use factor $\frac{M}{N}$ =		=		P
Annual energy use for standard hours	P x L	=	kWh	Q

7. Find floor area in square metres

		=	m^2	R

8. Find the Normalised Performance Indicator (NPI)

NPI = $\frac{Q}{R}$ =	=	kWh/m^2	

Comparing your Normalised Performance Indicator with other buildings

The table below gives an energy efficient rating for different types of school buildings.

Good Buildings falling in this category have good controls and energy management procedures, but further energy savings are often still possible.

Fair Buildings in this band have some controls and energy management procedures. However, significant energy savings should be achievable.

Poor Buildings in this band have unnecessarily high consumption and urgent action should be taken to remedy the situation. Substantial energy savings should result from the introduction of energy efficiency measures. There may be valid reasons why energy consumption is this high, eg extensive use of electric pottery kilns.

Performance Yardsticks for Schools (kWh/m^2 per year)

Energy Efficiency Rating	Good	Fair	Poor
Type of school			
Nursery	less than 370	370-430	more than 430
Primary, no indoor pool	less than 180	180-240	more than 240
Primary with indoor pool	less than 230	230-310	more than 310
Secondary, no indoor pool	less than 190	190-240	more than 240
Secondary with indoor pool	less than 250	250-310	more than 310
Secondary with sports centre	less than 250	250-280	more than 280
Special, non-residential	less than 250	250-340	more than 340
Special, residential	less than 380	380-500	more than 500

Note: These values include schools with and without their own kitchen for providing meals on the premises. Schools with central catering facilities serving several other schools in the area are not covered, and this factor should be allowed for separately.

The following section 'How savings can be achieved' (page 10) will help you decide on ways to improve the energy efficiency irrespective of the NPI but will be part of particular assistance to buildings with a high NPI.

How Savings can be Achieved

Savings can be achieved in five main ways:

1. By altering the physical construction of a building to reduce its heat loss characteristics.
2. By replacing or upgrading the energy consuming equipment and controls to make it more efficient.
3. By changing or modifying energy consuming equipment to use a less expensive form of energy or more adventageous tariff.
4. By continuous assesment of consumption. This can be used to check that both the plant and controls continue to operate as intended, and also ensure that the occupants behaviour is not unnecessarily affecting energy use. This is often known as good housekeeping.
5. By installing, where a suitable electricity and heat requirement exists, combined heat and power (CHP) plant to meet building electricity and space heating/hot water needs.

A list of potential opportunities for reducing energy costs in schools is given below. This is followed by some typical case studies of energy efficiency programmes already successfully carried out in schools to illustrate the application of the basic principles described in this booklet.

Appropriate Energy Saving Measures for Schools

Improvement area	Aim	Measures
Building fabric	Reduce air infiltration	Draughtproof around windows and doors. Fit automatic door-closure devices Install draught lobbies.
	Improve thermal insulation	Insulate roof voids. Insulate flat felt roofs during refurbishment. Cavity wall insulation. Add internal insulation panels. Reduce excessive glazing area/fit insulated infill panels. Double glazing.
Boiler plant	Improve operating efficiency	Regular maintenance checks/maintenance contracts. Improve thermal insulation of boilers and pipework. Isolate inoperative boilers. Isolate space-heating circuits in summer months (combined heating and DHW plant). Replace old inefficient boilers.
	Avoid overheating	Check thermostats are set correctly. Turn off radiators in unused rooms. Use frost protection thermostats outside occupation periods. Install zone controls for areas of extended use. Install weather-compensating controls. Install more accurate thermostats (tamperproof type).
Space heating systems	Reduce operating periods	Fit time controls to eliminate out-of-hours heating. Ensure frost protection operates during holiday periods. Install optimum start control to reduce preheating times. Consider Building Energy Management Systems.
Provision of own on-site electricity and heat.	Reduce electricity and heating costs	Install Combined Heat and Power plant.

Appropriate Energy Saving Measures for Schools

Improvement area	Aim	Measures
Hot water service	Reduce heat losses	Insulate hot water storage tanks and pipework. Install point-of-use water heaters in place of central plant.
	Reduce hot water demand	Check hot water thermostat settings are correct*. Install spray taps.
Electrical services	Reduce costs	Check tarriffs and maximum demand ratings are still appropriate.
Lighting	Improve lighting efficiency	Regular maintenance and cleaning of lamps and luminaires. Install more efficient lighting source (e.g. fluorescent instead of tungsten lamps).
	Avoid unnecessary lighting	Switch off unnecessary lights manually. Install automatic lighting controls (time, daylight or occupant detection control).
Ventilation	Optimise operation	Switch off kitchen and toilet extraction fans out of hours. Switch off fume cupboard extracts after use. Fit time controls.
	Recover reject heat	Install heat recovery devices in ventilation exhaust system.
Swimming pools	Reduce pool losses	Fit swimming pool cover. Check whether pool water and air temperatures are correct or could be rduced.
	Reduce ventilation losses	Consider ventilation heat recovery systems.

Note: Adding insulation to flat roofs and walls could lead to condensation problems within the structure if incorrectly applied. Expert advice should be sought to avoid future problems.

**The minimum recommended hot water storage temperature is 55°C to avoid the risk of Legionaires Disease. The minimum temperature at point of draw should be 45°.*

Case Study 1

Reducing Energy Costs with an Energy Efficiency Package

Ryelands Junior Mixed Infants School in Hertfordshire is an early 1970s school with a floor area of 1200m². It has a gas-fired boiler for heating and hot water services, which also serves an outdoor swimming pool during summer weeks. The classrooms are heated by fan convectors fed from the low-pressure hot water system. These convector units were controlled by bi-metallic thermostats, which did not achieve a close control over room temperature. This led to demands by those using the building for a higher temperature setting than would have been necessary with closer control. Hertfordshire County Council decided to try more accurate thermostats in a number of schools.

The package

In 1982, electronic thermostates were fitted in each classroom at Ryelands School. During that time a package of other energy efficiency measures was adopted to reduce energy consumption. An optimum start control was fitted to the heating system to match the boiler operation more closely to the actual start of occupation of the building with the best preheat time.

A day-extension timer was added to regulate heating times outside normal school hours for meetings and evening classes. Zone controls were introduced to enable the school to reduce heating costs for the evening and weekend use. All windows and doors were draughtproofed and automatic closers were fitted to the doors.

The school had a great deal of full-height glazing, giving rise to excessive heat losses. The caretaker was provided with appropriate insulation materials and he constructed and fitted insulation panels on the inside of all low-level glazing.

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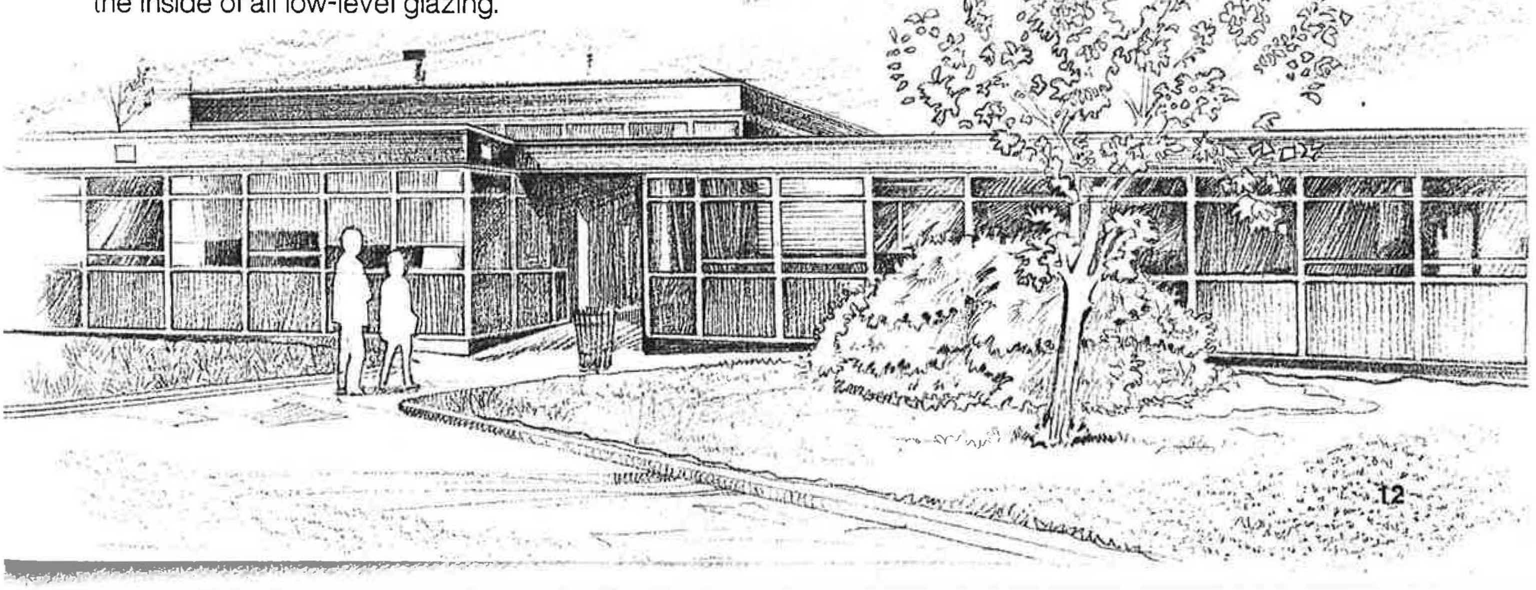
Improved NPI

Over the 6-year period prior to those improvements, the average annual energy use was equivalent to an NPI of 366 kWh/m². In the 3-year period 1983/86, since the energy efficiency measures were implemented, the average energy consumption has fallen to 241 kWh/m². This is a reduction of 34 per cent and has improved the energy efficiency rating from 'poor' to 'fair', allowing for the fact that some energy is used to heat the outdoor pool in the summer.

Caretaker

This substantial reduction in energy use is due in large part to the keen interest and efforts of the caretaker, who recognised the need to achieve better control over the school's heating system.

The cost of the new controls at 1986 prices was £1200 and the insulation materials cost a further £500. The reduction in the school's annual fuel bill amounted to £1900, so that the measures have paid for themselves within one year. Complaints about the school heating have also been greatly reduced.



Case Study 2.

More Books from Energy Cost Savings

Hawes Side School is a large infants and junior school, with some 550 pupils and 44 teaching and ancillary staff. It was built in the 1930s and is typical of many schools erected in the interwar years, being of single-storey brick construction. The building is square in plan with a large internal quadrangle. Lancashire County Council had already implemented a number of basic energy efficiency measures at the school, including insulation of the roof voids, renewal of the original boiler, and replacments of tungsten lighting by flourescent fittings.

Half savings retained by school

As a result of these improvements, the annual energy consumption of the school in 1984/85 was equivalent to an NPI of 228 kWh/m^2, which is 'fair' for this type of school. The Council decided to introduce an incentive scheme on a pilot basis to encourage further savings, and the idea was enthusiastically taken up by the staff at Hawes Side. It was agreed that half of the savings achieved, after allowing for capitalisation of the initial investment, would be given to the school in the form of an increase in their capitation allowance. An energy target was set based on the average of the weather-corrected performance for the previous four years.

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Energy monitors

Following an energy survey and prior to the start of the trial year, the cavity walls were insulated with blown glass fibre and timeswitches were fitted to the direct-fired gas convector heaters in temporary buildings. From the start of the trial period a series of meetings was held involving the headteacher and staff, the school governors, and technical officers of the authority's Property Services Department. These meetings were used to review energy use against previous years' performance and to decide on further actions and improvements to be made. An important contribution was also made by the pupils themselves, some of whom were appointed as Energy Monitors. These pupils assisted in the implementation of good housekeeping by switching off unnecessary lights, closing doors and turning off radiators.

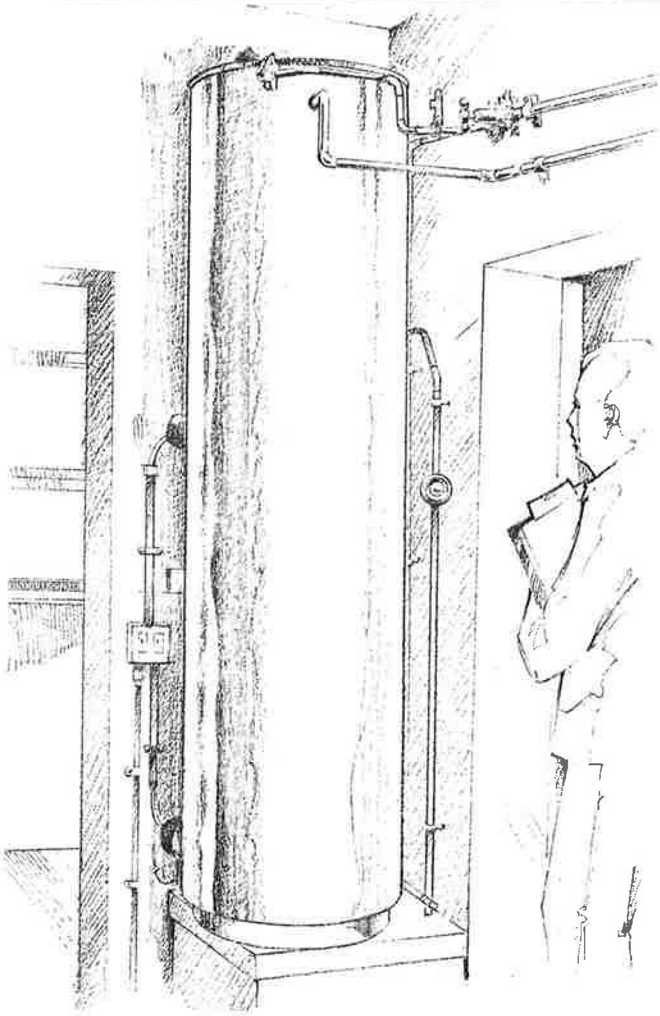
Improved NPI

The energy consumption for the trial year 1985/86 gave an NPI of 177 kWh/m^2, a reduction of 22 per cent relative to 1984/85 and 31 per cent below the target assessed from the average of the previous four years. The energy efficiency rating of the school was improved to 'good'. The financial savings for the year on energy costs were £3430. After deducting a fifth of the improvement costs for capitalisation, the school obtained an increase in its capitation allowance of £1550. The school decided that they would use the extra money to equip a new library facility.

This study demonstrates the effective participation of the school users in implementing and monitoring an energy efficiency programme. Arising out of staff recommendations, further improvements have been initiated and the school intends to use its share of the anticipated savings to increase their stock of books.

Case Study 3

Separate Space and Water Heating Systems Save Costs



Point-of-use electric water heating

Causton County Primary School, Felixstowe, was originally built in the 1950s with extensions added in the 1960s and it now has 257 pupils and staff. It is a mainly brick construction single-storey building with a flat roof, and is situated in a fairly exposed position near the coast. The school originally relied on a central oil-fired boiler for heating and hot water, but the extensive pipework system gave rise to high heat losses, making the system expensive to run. With this system it was also difficult to meet the varying requirements for hot water temperature in the kitchen and other parts of the school, giving rise to concern for the children's safety.

New heating systems

In 1984/85, the County Architect replaced the combined space and water heating system with a new gas-fired boiler to supply space heating and individual electric water heaters for hot water. There are 25 point-of-use water heaters, varying in size from 227 litres in the school kitchen to smaller units in toilets and cleaners' rooms. These heaters are fitted with both off-peak and on-peak electric elements to allow the school to use the cheaper night-rate electricity tariff as far as possible. The cost of the new water heaters was £6600.

20 per cent reduction in energy consumption

The conversion has been very successful, not least in reducing the total energy consumption of the school by nearly 25 per cent. Prior to the conversion the NPI was 192 kWh/m^2, a "satisfactory" energy efficiency rating for this type of school. The new hot water system and replacement of boilers have reduced this figure to 145 kWh/m^2 for 1985/86 and the school is now in the "good" category. The County Architect calculated that the point-of-use water heaters have reduced the energy bill by £1300 a year at 1985/86 fuel prices, so that the conversion will pay for itself in five years. Following the success of the scheme, the authority have now initiated six other similar projects in primary schools in their area and intend to extend the programme to other types of school in the future.

Example Calculation. Before Improvements

NPI Calculation Form Causton C.P. School 1983 – 1984.

1. Convert your energy use into kWh units

Add your quarterly or monthly use over one year for each fuel and enter below

Natural gas		Therms	x 29.31	=		kWh	
		Cubic feet	x 0.303	=		kWh	
Gas oil (35 sec)	46827	Litres	x 10.6	=	496366	kWh	
Light fuel oil (290 sec)		Litres	x 11.2	=		kWh	
Medium fuel oil (950 sec)		Litres	x 11.3	=		kWh	
Heavy fuel oil (3500 sec)		Litres	x 11.4	=		kWh	
Coal		Tonnes	x 7600	=		kWh	
Anthracite		Tonnes	x 9200	=		kWh	
Liquid petroleum gas (LPG)		Litres	x 7	=		kWh	
		Tonnes	x 13900	=		kWh	
Electricity	14462	kWh	x 1	=	14462	kWh	
Total energy use for the year				=	510828	kWh	A

2. Find your space-heating energy use

If you can identify any of the fuels above used only for space heating, enter the total energy use in kWh.

1.
2.
3.

Add these to give total				kWh	B

For fuels used for space heating and hot water, where these are not separately metered, take 75% of energy used. This figure may also be used for all electrically heated buildings.

1. 496366
2.

Total 496366	x 0.75	=	372275	kWh	C
Annual space-heating energy	B or C	=	372275	kWh	D
Annual non-space-heating energy	A – D	=	138553	kWh	E

3. Adjust the space-heating energy to account for weather

Find the Degree Days for the energy data year		=	2538		F
The weather correction factor $= \frac{2462}{F} = \frac{2462}{2538}$		=	0·97		G
Adjust the space-heating energy to standard conditions	D x G	=	361107	kWh	H

4. Adjust the space-heating energy to account for exposure

Obtain the exposure factor from this booklet to suit the location of the building		=	0·9		J
Adjusted space-heating energy	H x J	=	324996	kWh	K

5. Find normalised annual energy use

	E + K	=	463549	kWh	L

6. Correct for hours of use of building

Obtain standard hours of use from this booklet		=	1480		M
Calculate the annual hours of use for your building		=	1337		N
Hours of use factor $\frac{M}{N} = \frac{1480}{1337}$		=	1·11		P
Annual energy use for standard hours	P x L	=	514539	kWh	Q

7. Find floor area in square metres

	=	2682	m^2	R

8. Find the Normalised Performance Indicator (NPI)

$NPI = \frac{Q}{R} = \frac{54539}{2682}$	=	192	kWh/m^2

Action Plan

How to implement a course of action

1. Appoint a person who will carry ultimate responsibility for energy management and who is answerable to the person in overall charge of the building. It is important that this person's duties and authority are clearly established. In state schools you will need to liaise closely with the local authority's energy manager who will have overall responsibility for energy consumption in schools in the area. In this case make sure you know whom to contact.

2. Set up a monitoring system. This can prove to be a most cost-effective exercise in itself, by the created energy awareness. Obtained invoices and bills from the previous 12 months in order to initiate the system and provide a basis for comparison. On prepared forms, record the monitored consumptions for each fuel in a standard unit, i.e. kWh.
Aim to install as much individual monitoring as possible to identify large users and to establish the energy consumption for space heating as distinct from other forms of energy use.

3. Prepare and use checklists. These are the principal instruments in good housekeeping. An example checklist is shown at the end of this Action Plan.

4. Conduct an energy survey. Break down the site into buildings and the buildings into zones. Break down building services systems into energy-consuming units. Energy surveys should be carried out regularly.

5. Identify waste. Analyse the survey results and look for abnormal consumptions. Establish the reasons for any abnormally high consumption.

6. Obtain assistance. Seek specialist advice on technical aspects of the measures described, particulary where these involve physical alterations of the building fabric or plant. Have an energy survey carried out by an independant consultant. Seek advice from your Regional Energy Efficiency Officer whose name and address is on page 18.

Example Checklist

Measurements and records

Measure and record fuel consumption and hours of use (particularly additional use for evening activities).
Examine records to highlight any radical changes in energy consumption.
Obtain monthly Degree Days.
Keep a record of total fuel consumption for space-heating against total monthly Degree Days.
Carry out regular combustion efficiency tests.

Planning and training

Plan shortterm actions - mainly good housekeeping. Prepare long-term programme.
Estimate capital
requirement and identify projected savings.
Appoint someone to be responsible for energy use in the school.
Ensure the school caretaker is fully trained to operate the boiler and controls. Send the person responsible for energy use to meetings of the local energy manager's group.

Publicity and curriculum impact

Organise an annual essay competition among the pupils.
Organise a competition to design energy efficiency posters and stickers.
Ensure staff are aware of the benefits of increased comfort and resources from improved energy efficiency.
Display an energy performance progress chart in a prominent place, next to a record of outside and inside temperatures.

Good housekeeping

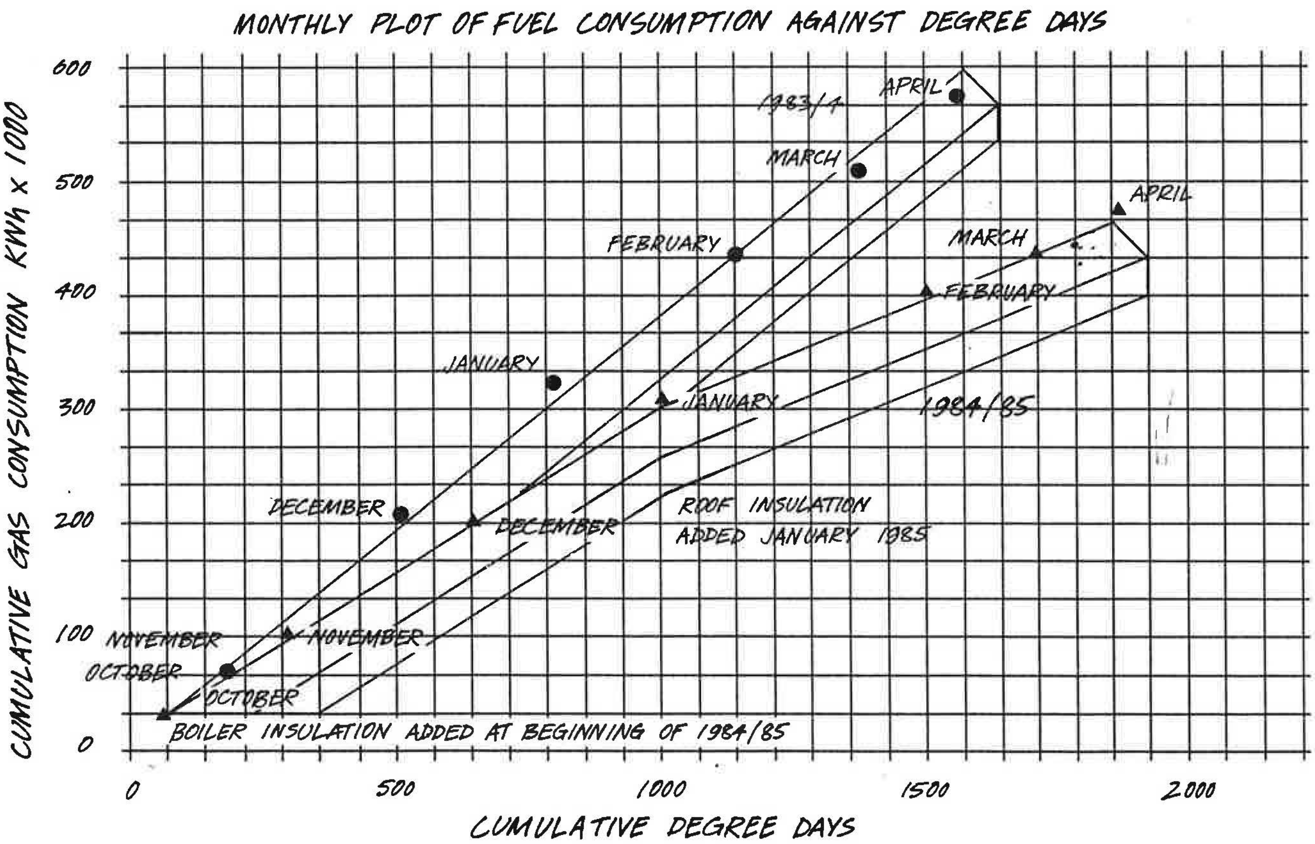
Close windows and doors in cold weather.
Check thermostat and time control settings.
Check hot water temperatures and reduce if necessary.
Check heating systems are free from air locks.
Replace worn washers on taps.
Inspect washrooms to ensure taps are not left running.
Attend to leaks promptly.
Discourage the use of unauthorised heaters by ensuring heating systems are correctly balanced and controls operate correctly.

How to Assess Results

A good way to display the results of energy saving measures month by month is to maintain a plot of cumulative space-heating energy against corresponding accumulated monthly Degree Days totals. Since they are in direct proportion, the slope of the straight line plot will yield a running efficiency figure for the previous year. A significant energy saving will be reflected in a reduction in the number of kWh per Degree Day.
At the end of the financial year, the overall energy efficiency of the building can be found from the Normalised Performance Indicator, calculated as described on page 5- 7.

Summary

Now that you know how to assess the performance of your school, you should start your own Action Plan. An Action Plan for improving energy efficiency in your buildings will lead to reduced running costs, release valuable resources for other purposes, and provide a more comfortable environment.
Many of the actions described in this booklet could form the basis of projects for pupils in the school and will create a greater awareness of energy matters.



Obtaining Assistance

Organisations aiming to improve the energy efficiency of their premises can obtain advice and information through the Energy Efficiency Office and other organisations.

1 Free Advice and Information

Regional Energy Efficiency Officers

Within the Department of Trade and Industry's regional offices – and in the Welsh and Scottish Offices and the Northern Ireland Department of Economic Development - a specialist and senior member of staff is available to advise firms on all aspects of energy efficiency. Contact your local REEO at the address below:

NORTH EAST REGION
Arthur Hoare
Energy Efficiency Office
Stanegate House
2 Groat Market
Newcastle upon Tyne NE1 1YN
Tel: Newcastle (091) 232 47722

NORTH WEST REGION
John Mortimer
Energy Efficiency Office
Sunley Tower, Room 2104
Piccadilly Piaza
Manchester M1 4BA
Tel: Manchester (061) 236 2171 Ext. 5330

YORKSHIRE & HUMBERSIDE REGION
David Harrison
Energy Efficiency Office
25 Queen Street
Leeds LS1 2TW
Tel: Leeds (0532) 443171

WEST MIDLANDS REGION
Mike Russell
Energy Efficiency Office
Lady wood House
Stephenson Street
Birmingham B2 4DT
Tel: Birmingham (021) 631 6109

EAST MIDLANDS REGION
Ian Wright
Energy Efficiency Office
Severns House
20 Middle Pavement
Nottingham NG1 7DW
Tel: Nottingham (0602) 506181
Ext 360

LONDON REGION
Ken Tarrant
Room 214, Bridge Place
88/89 Eccleston Square
London SW1V 1PT
Tel: London (071) 215 0619

EASTERN REGION
Godfrey Smith
Room 215, Bridge Place
88/89 Eccleston Square
London SW1V 1PT
Tel: London (071) 215 0610

SOUTHERN REGION
Iain Ure
Room 216, Bridge Place
88/89 Eccleston Square
London SW1V 1PT
Tel: London (071) 215 0609

SOUTH WEST REGION
Rodney Youlton
Energy Efficiency Office
The Pithay
Bristol BS1 2PB
Tel: Bristol (0272) 272666 Ext. 437

SCOTLAND
Eddie Gowans
Industry Department for Scotland
Energy Division Room 6/41
New St Andrews House
St James Centre
Edinburgh EH1 3TA
Tel: Edinburgh (031) 244 4665

WALES
Jeff Wallington
Welsh Office
Industry Department
Cathys Park
Cardiff CF1 1NQ
Tel: Cardiff (0222) 823126

NORTHERN IRELAND
Jack Beattie
Department of Economic Development
Netherleigh
Massey Avenue
Belfast BT4 2JP
Tel: Belfast (0232) 63244 Ext. 437

Technical Advice

Buildings and buildings services (excluding heat pumps, small scale combined heat and power and building energy management systems)

Enquiries Bureau
Building Reasearch Energy Conservation Support Unit (BRECSU)
Building Reasearch Establishment
Garston
Watford
Herts WD2 7JR
Tel: 0923 894040

All other areas

Enquiries Bureau
Energy Technology Support Unit (ETSU)
Building 156
Harwell Laboratory
Didcot
Oxon OX11 0RA
Tel: 0235 821000 Ext. 3530

Technical Sales Data Service

Three separate Technical Sales Data Service modules are available, covering buildings, industrial processes and consultants. For further information contact the **Energy Information Centre, PO BOX 147, Grosvenor House, High Street, Newmarket CB8 9AL Tel: 0638 663030.**

2 Publications from the EEO

Energy Management

Published monthly and mailed to all those interested in energy economy, 'Energy Management' provides the latest information on cost-effective ways of reducing energy consumption. Every issue of 'Energy Management' contains a table of Degree Days giving regional temperature variations.

Fuel Efficiency Booklets

These give guidance on the efficient operation of building services and utilities, on insulation and on auditing energy use.

Please note that until 6 May 1990 London Telephone Numbers are prefixed 01

Energy Technology Series
This series examines the current state of particular technologies and outlines their potential use in encouraging the adoption of energy-efficient techniques.

These publications are available from:
Department of Energy
Energy Efficiency Office
Blackhorse Road
London SE99 6TT

3 Financial Support

Support for collaborative research
The exploitation of successful research and development can be further assisted, in appropriate cases, through the Department of Trade and Industry's programme of support for collaborative research. The assistance can apply to both general and advanced technology programmes.

For further information contact your nearest DTI Regional Office, or the Scottish or Welsh Office.

4 Monitoring and Targeting

Monitoring and targeting (M&T) is a structured and disciplined approach to the management of energy. The E.E.O. has sponsored, often through trade associations, the development of M&T systems for all major sectors of industry. For more information about M &T, contact your Regional Energy Efficiency Officer.

Other Sources of Help

1. **The Businessman's Energy Saver:** the complete guide to energy efficiency by NIFES. Published by Formecon Services Limited.
2. **Energy Conservation in Educational Buildings:** Bulletin 55. Published by the Department of Education and Science.
3. **Design Note 16:** Energy Conservation in two Oxfordshire Schools, 1978. Department of Education and Science.
4. **Design Note 17:** Guidelines for Environmental Design by Fuel Conservation in Educational Buildings. Published by the Department of Education and Science, 1981.
5. **Broadsheet 24:** Saving Energy in Schools. Three case studies in Nottinghamshire, 1987. Published by the Department of Education and Science.
6. **Independent Energy Consultants Group**
Energy Systems Trade Association Ltd., P.O. Box 16, Stroud, Gloucestershire GL5 5EB.
Tel: 045 387 3568
7. **The Building Services Research and Information Association** (BSRIA), Old Bracknell Lane West, Bracknell, Berkshire RG12 4AH. Tel. 0344 426511. Provides extensive technical support and library facilities for member organisations and an information service to non members. The association caters for all aspects of energy use in buildings.

The Hevac Control Manufacturers Association, Automatic Controls Group (HEVAC), Sterling House, 6 Furlong Road, Bourne End, Bucks SL8 5DG (Tel: 06285 31186/7)

The Heating & Ventilating Contractors' Association (HVCA), Esca House, 34 Palace Court, London W2 4JG (Tel: 01-229 2488)

Glass & Glazing Federation (GGF), 44-48 Borough High Street, London SE1 1XP (Tel: 01-403 7177)

Cavity Foam Bureau, PO Box 79, Oldbury, Warley, West Midlands B69 4PW (Tel: 021 544 4949)

National Cavity Insulation Association (NCIA)
External Wall Insulation Association (EWIA)
National Association of Loft Insulation Contractors (NALIC)
Draughtproofing Advisory Association (DPAA)
PO Box 12, Haslemere, Surrey GU27 3AN (Tel: 0428 54011)

Builders Merchants Federation, 15 Soho Square, London W1V 5FB (Tel: 01-439 1753)

Association for the Conservation of Energy (ACE), 9 Sherlock Mews, London W1M 3RH (Tel: 01-935 1495)

Please note that until 6 May 1990 London Telephone numbers are prefixed 01

Energy Efficiency Office

DEPARTMENT OF ENERGY ELAND HOUSE,

STAG PLACE, LONDON SW1E 5DH TELEPHONE 071 273 3000

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