DOCUMENT RESUME

ED 453 648 EF 005 945

| | |
|---|---|
| TITLE | Saving Energy. Managing School Facilities, Guide 3. |
| INSTITUTION | Department for Education and Employment, London (England). Architects and Building Branch. |
| ISBN | ISBN-0-11-270880-3 |
| PUB DATE | 1995-00-00 |
| NOTE | 27p.; Researched and written by DSC Associates Ltd. |
| AVAILABLE FROM | The Stationary Office, P.o. Box 29, St. Crispins House, Duke Street, Norwich NR3 1PD England (3.95 British pounds). Tel: 0870-600-5522; Fax: 0870-600-5533; e-mail: customer.services@theso.uk; Web site: http://www.clicktso.com. |
| PUB TYPE | Guides - Non-Classroom (055) |
| EDRS PRICE | MF01/PC02 Plus Postage. |
| DESCRIPTORS | *Educational Facilities; Elementary Secondary Education; *Energy Conservation; Foreign Countries; *Guidelines; Public Schools |
| IDENTIFIERS | *Cost Containment; United Kingdom |

ABSTRACT

This guide offers information on how schools can implement an energy saving action plan to reduce their energy costs. Various low-cost energy-saving measures are recommended covering heating levels and heating systems, electricity demand reduction and lighting, ventilation, hot water usage, and swimming pool energy management. Additional recommendations on maintenance solutions to preventing energy waste are highlighted as are advice on education and training, and energy conservation when subletting school facilities. A management action plan checklist is included. (GR)

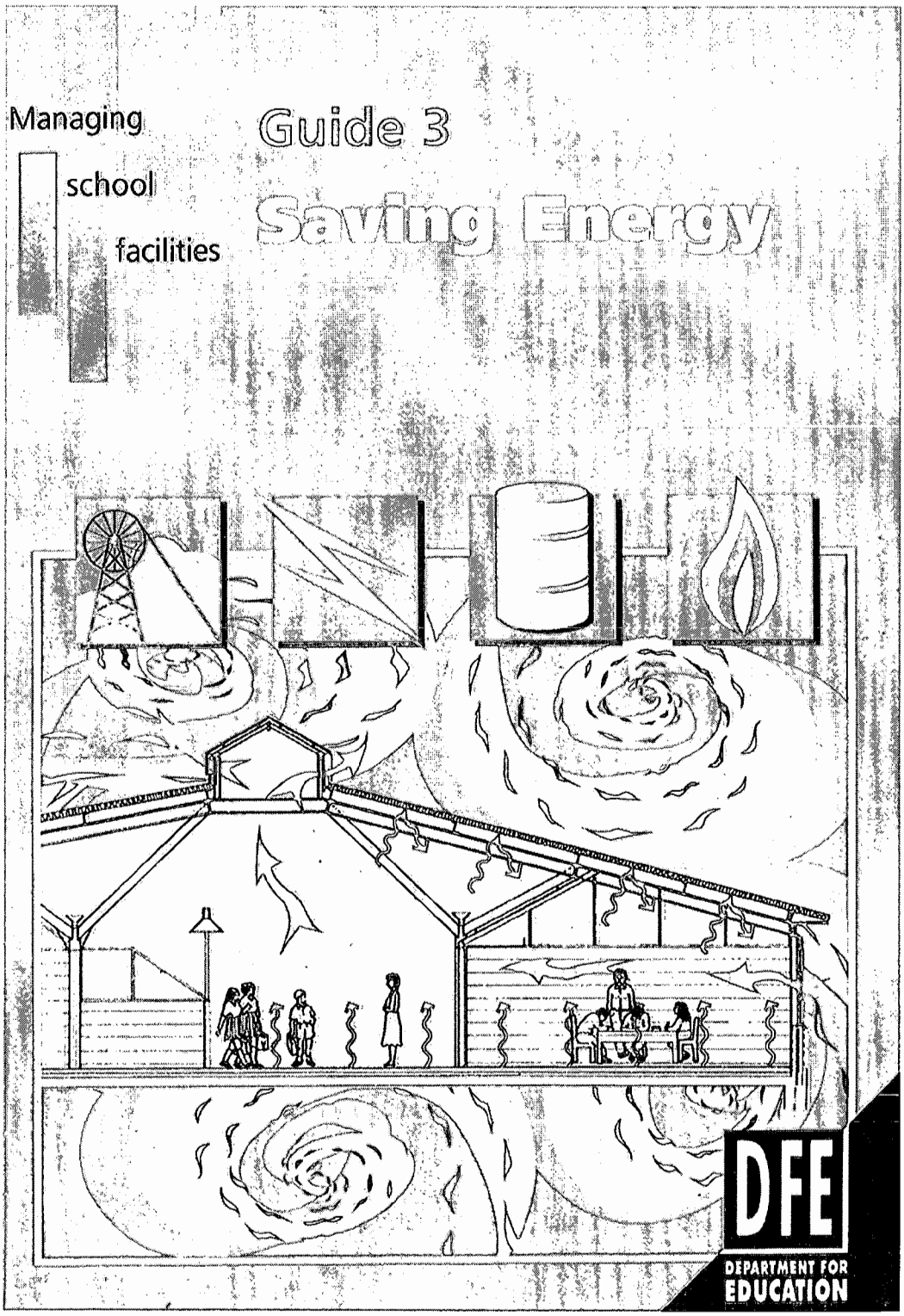
Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 453 648

Managing school facilities

# Guide 3

# Saving Energy



DFE

DEPARTMENT FOR EDUCATION

EF 005 945

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

John Birch

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

BEST COPY AVAILABLE

**ACKNOWLEDGEMENTS**

This guide has been produced by the Architects and Building Division of Schools Organisation Branch at the DFE.

It was written and researched by DSC Associates Ltd, 13 Fieldhouse Lane, DURHAM, DH1 4LT

DFE Project Team: Chief Engineer M Patel
Principal Architect C Bissell
Senior Engineer R Daniels

Designed by HMSO Graphic Design

Edited by DFE Information Branch

© *Crown copyright 1995*
Applications for reproduction should be made to HMSO

Printed in the United Kingdom for HMSO
DoI 298331 C20 3/95 559/1 59226

ISBN 0 11 270880 3

# Saving energy

## CONTENTS

Introduction

Energy management

Action plan

Monitoring

Low cost measures

- Heating
- The classroom
- The heating system
- Electricity and lighting
- Maximum demand
- Ventilation
- Hot water
- Swimming pools

Maintenance

Long term savings

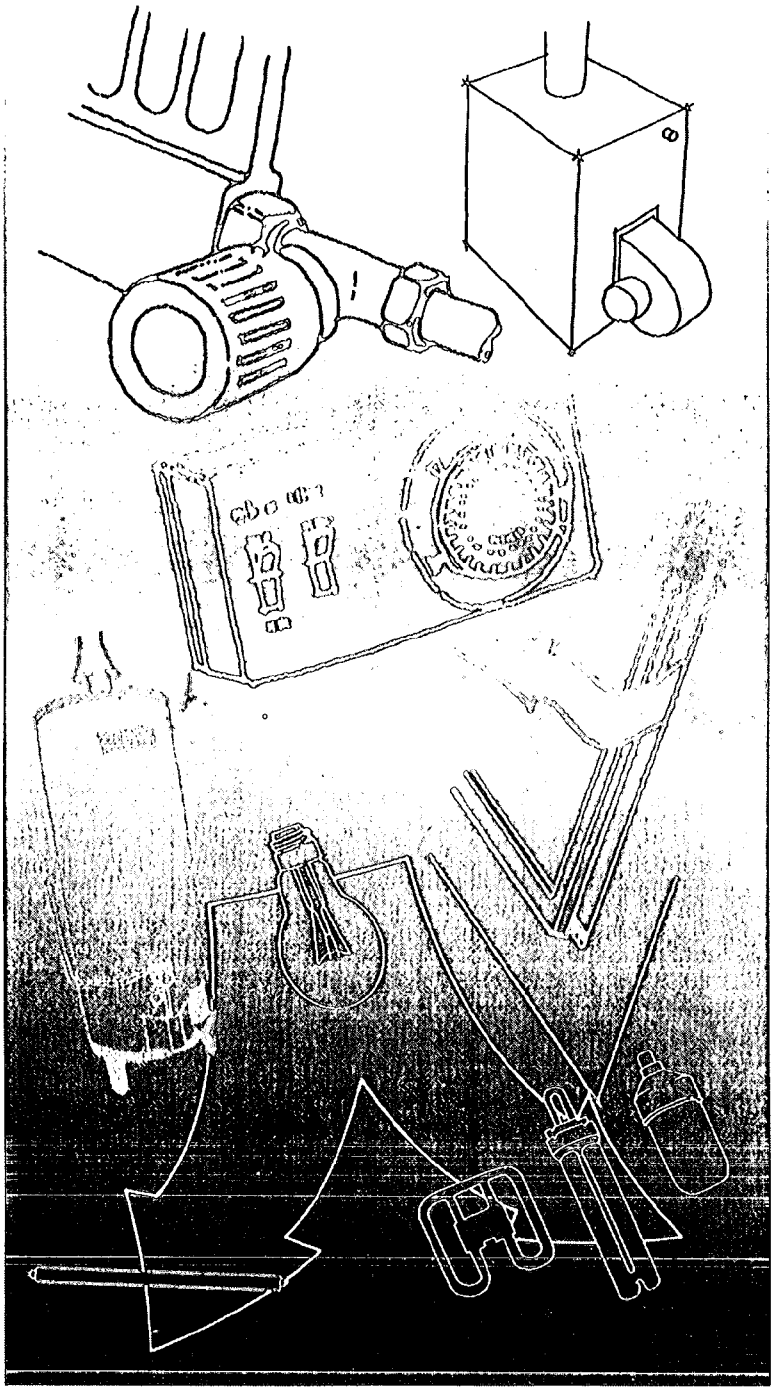
Lettings and shared use

Surplus accommodation

Education and training

... and finally

Management action plan checklist



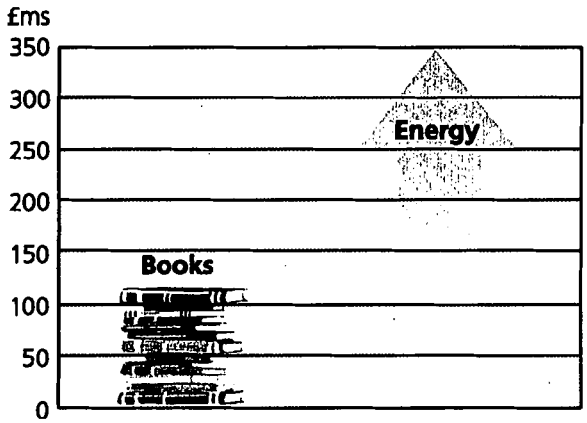
2

# Saving energy

## Introduction

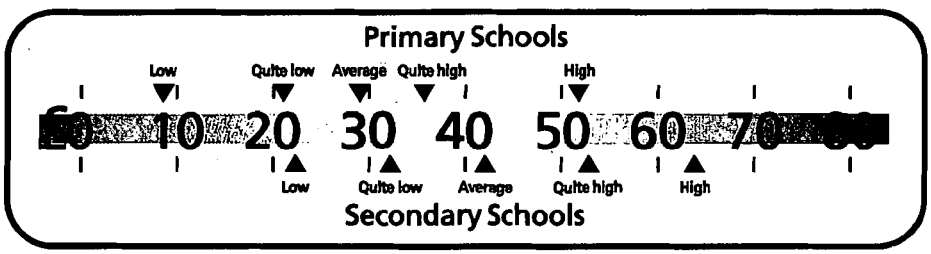
Energy is big business: schools use 25,000 million kilowatt hours of energy every year. It takes up a quarter of their non-staff costs and, in 1992, schools in England and Wales spent three times as much on heating and lighting as they did on books.

Saving energy is not difficult. It only takes enthusiasm and leader-ship. The enthusiasm comes from having a clear vision of your goal and good leadership makes sure everyone is striving towards the same goal.




On energy resources, at 1992 prices, a primary school will spend around £30 per pupil per year and a secondary school £40 a pupil. Swimming pools add another £10 a head.

*Energy costs per pupil*




3

The Audit Commission reckons that the right housekeeping measures can cut fuel bills by 10%. A well thought out action plan can double this figure. These are not one-off savings. Energy conservation can, with the correct attention, produce savings year-after-year.

It is also a powerful contribution to a greener world and Britain's sustainable development strategy. This is the environmental action plan for the next twenty years that grew out of the Rio Earth Summit and by using less energy schools will help to:

- Create a healthier working environment.
- Reduce demand on the world's finite energy sources.
- Cut pollution. Every year the energy used to heat and light each classroom produces four tonnes of carbon dioxide.

It makes energy conservation praiseworthy as well as profitable.

## Energy management

Cutting costs does not mean cold, dark schools. A comfortable temperature means striking the right balance between temperature and air movement. Good lighting does not mean having all the lights on all the time.

Even when the type of fuel, floor area, numbers on roll, hours of use and age and condition of the buildings are taken into account, energy costs at similar schools can vary by over £30 per pupil. The difference is the price paid for poor energy management.

Some schools will have more scope for savings than others but there is always room for improvement. Even new schools with the very latest energy management systems will incur avoidable expenditure if they do not manage their energy use wisely.

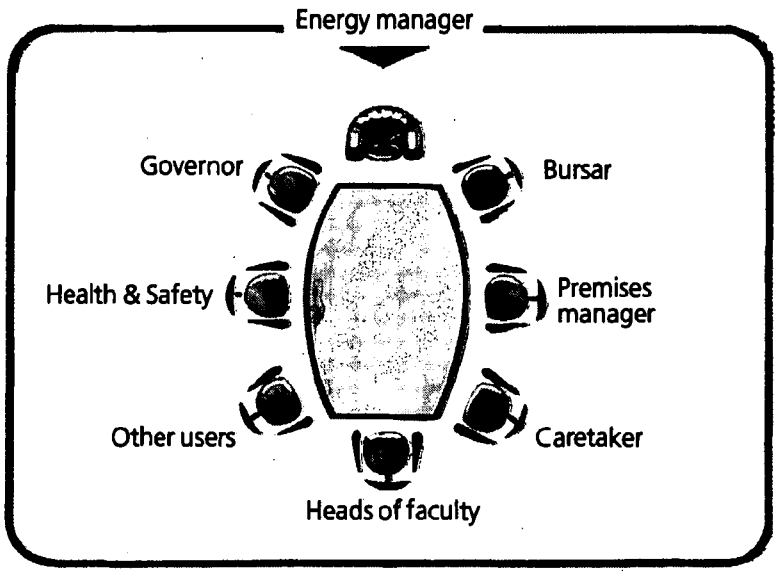
This guide gives you a simple step by step guide to energy efficiency and saving money.

## Action plan

The head teacher and the governing body should make a general overview of the school's energy use and agree a realistic target for

savings with the school energy manager. In many schools 15% to 20% of the annual energy bill is a reasonable and attainable target.

The energy manager, responsible for day to day energy management should be a senior member of staff. It could be part of the premises manager's duties but in smaller schools the job may be given to the head teacher or deputy. It is not a post that needs specialised knowledge: commitment is more important than technical expertise.




The energy manager's first task is to prepare an action plan. This will include:

- MONITORING to show the current pattern and costs of energy use.
- EVALUATING areas of possible savings and deciding how they may be best introduced.
- IMPLEMENTING no-cost and low cost energy saving measures.
- RATIONALISING the use of accommodation for its most energy and cost effective use.
- MAINTAINING the school's energy systems and related building

elements.

- PLANNING to identify the most suitable long term measures for inclusion in your building development plan.
- CALCULATING the economic energy costs of lettings and the shared or joint use of premises.
- EDUCATING and training staff and pupils in energy management and conservation.

## Monitoring

Electricity is metered in units equal to 1,000 watt hours or one kilowatt hour (kWh)

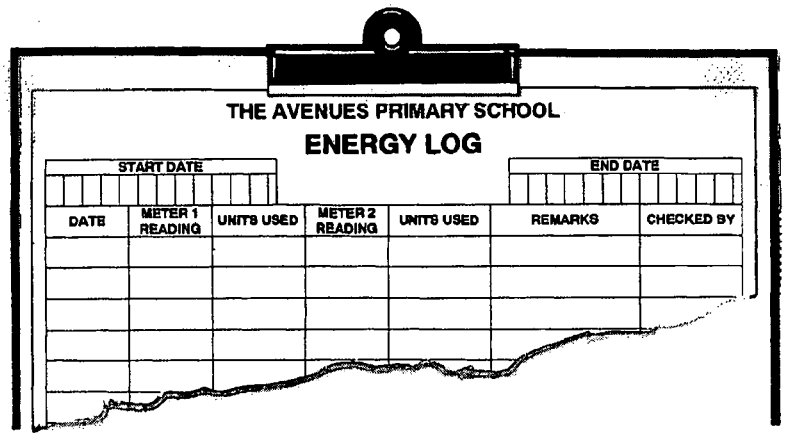
Gas is metered in volume but billed by its heat content, which is measured in therms.

With the information that regular monitoring provides it is possible to:

- Judge how energy is used and what it costs.
- Compare patterns of use. Today's pattern of energy use should be very similar to the same time last year and not that different from yesterday. Differences, good or bad, should be investigated.
- Estimate progress towards your energy saving objectives.

Every meter, including water meters, should be read at the same time each week. On Fridays at the end of school activities is a good time. A second check first thing on Monday morning gives weekend consumption.

Be sure that meters are read correctly. Utility companies normally use just one meter to prepare their bill. Check meters, like sub-stations, monitor consumption that has already appeared on the main meter. Multi-meter premises should ask the utility companies to identify and explain the purpose of each meter.



THE AVENUES PRIMARY SCHOOL

ENERGY LOG

START DATE | END DATE

| DATE | METER 1 READING | UNITS USED | METER 2 READING | UNITS USED | REMARKS | CHECKED BY |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Similar logs could be prepared to allow schools to keep track of the servicing and maintenance of energy systems and equipment including that used in craft, domestic science, kitchens etc.

Examine bills and delivery notes against the actual delivery and compare accounts with meter readings. Is the bill correct? Is energy being bought at the best price? Is it worthwhile moving into a different tariff band?

Check out alternative suppliers. This is possible for both gas and electricity. Fuel from private suppliers enters the national grid and private companies market their share directly to end users. Tariffs can vary by as much as a third and the only change the end users will notice is the name on the invoice.

Some companies will offer to monitor your school's energy consumption in return for a share of any savings. Before agreeing to such an arrangement seek independent professional advice from either a reputable consultant or your local authority energy management unit.

## Low cost measures

$$\text{The payback period in years} = \frac{\text{(capital cost of a measure)}}{\text{(resulting annual saving)}}$$

Any measure which has a payback period of two years (pays for itself in two years) or less is a low cost measure. Many low cost measures are cash-free. Some may require maintenance work but this should have already been picked up by the normal premises checks and charged to the maintenance budget. For payback periods longer than five years a

discounted cash flow (DCF) analysis should be carried out (DCF calculations are described in DFE Building Bulletin 73).

## Heating

The School Premises Regulations lay down a minimum temperature of 18°C for those parts of the school where there is a normal level of activity; 21°C for areas where the occupants are inactive or sick; and 15°C for other teaching accommodation, washrooms, sleeping accommodation and circulation areas.

Heating and hot water make up 60% of a school's energy budget. Small economies can bring big savings. Raising room temperatures by one degree increases fuel bills by at least 5% and sometimes by as much as 10%.

## The classroom

- Do not overheat. Try to observe an October to May heating season.
- Set thermostats to the desired room temperature and check their settings daily. Turning up the thermostat does not heat a room more quickly. It just runs the heater longer and costs money.
- Turn off water heaters, extract fans and similar equipment at night, weekends and holidays.
- Never place furniture in front of heaters unless they are designed to allow this.
- Clean the school during the pre-heat and residual heat periods.
- If rooms are too hot then switch the heaters off.
- Do not leave windows and doors open.

## The heating system

- Investigate areas that are always too warm.
- In zoned heating systems where one thermostat controls entire blocks or floors, solar gain can confuse the system. Some rooms become too warm, others remain cold. This is particularly noticeable

in buildings with north-south aspects. One solution is to fit the heaters in each room with their own thermostats. An alternative is to fit separate thermostats on north and south facing zones.

- Make sure that at the end of each day all heaters are switched on, the time clocks and controls correctly set and the heating system is ready to start heating the building the next day.
- Keep pre-heat time to a minimum. For a 9.00am start a three hour pre-heat period means the heating system must begin work by 6.00am. If working temperatures are consistently reached before 9.00am then cut the pre-heat time. A reduction of 15 minutes can save 2 - 5% on the heating bill. Some schools may have systems which do this automatically but it pays to monitor their operation.
- Switch off the heating as early as possible.
- Use approved portable electric and gas heaters only:

  as a last resort for supplementary heating;

  for emergency heating; and

  to provide local heat during holidays when only parts of the school are in use.
- Avoid overheating storerooms and other areas which are normally unoccupied.
- Fit:

  reflective foil behind radiators; and

  time and temperature control units to temporary classrooms.

## Electricity and lighting

Generally the recommended lighting level in schools is 300 lux on the horizontal working plane. A lumen is a measure of the flow of light from a light source. One lumen per square metre equals one lux.

## Maximum demand

The amount of electricity being used by a school at any instant is measured on a maximum demand meter. The greater the reading the

more you pay. The highest reading in any month, or quarter (It depends on the tariff) is used to calculate the bill even if consumption only lasted for an instant. Peaks in demand can be very expensive and wipe out any savings.

Electricity is under 15% of the energy used but over 40% of the energy bill. Unit for unit it offers the greatest savings.

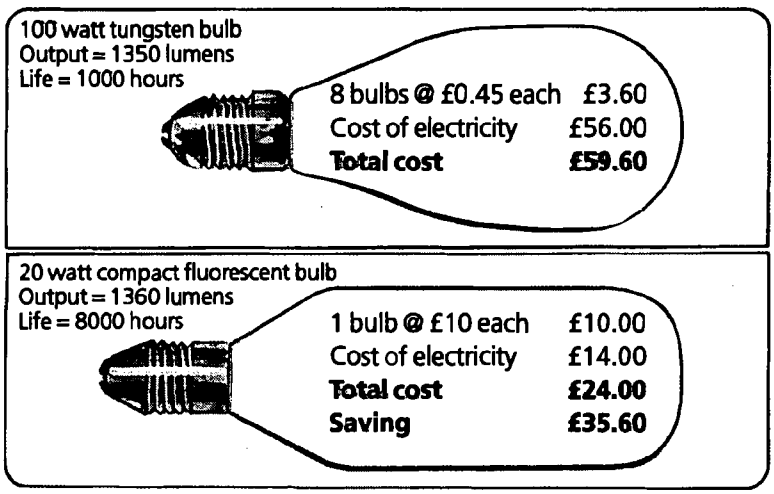
- Switch off lights when not needed. It is widely and wrongly believed that it is cheaper to leave fluorescent lights on all day than to switch them off when they are not needed. Frequent switching did shorten the life of old style fluorescent tubes but this is no longer true. Turning lights off when they are not needed can reduce lighting costs by around 50%.
- Fit:

  occupancy sensors to selected areas such as toilets and storerooms;

  banked lighting controls to all rooms and control the lights nearest windows separately; and

  timers to external lighting.
- Check that the cleaners only switch on lights where they are working and do not light up the entire school to clean one room.
- When electrical equipment, including computers, is not being used, switch it off unless continuous operation is essential.
- Keep windows and light diffusers clean. Dirty diffusers soak up a third of the light. Older types of opal plastic diffusers become discoloured with age. They absorb up to half the light output and should be replaced.
- Blackened ends on fluorescent tubes is a sign that they are reaching the end of their useful life. Regular inspections will replace them before this becomes a problem.
- Monitor maximum demand. Do not run heavy load items like kilns or stage lighting simultaneously especially during winter months. The greater your maximum demand the higher the charge per unit of electricity for every unit used.

- Introduce a rolling programme of replacing tungsten bulbs with their low energy equivalents. Tungsten lamps convert about 5% of their energy into light compared to around 20% for fluorescent tubes. Using compact flourescent and other energy efficient lamps can cut lighting costs by 60-70%.




In many cases the old style 38mm diameter fluorescent tubes can be replaced on a one for one basis by modern 26mm fluorescent tubes. This will save 8-10% on running costs and costs nothing if done as part of the normal replacement programme.

- When redecorating take account of the brightness ratio between walls, ceilings, and the work area. The right colours can give a room a bright, airy appearance.

## Ventilation

Ventilation is the movement of fresh air into the work area and stale air out. In most schools this is achieved by natural means assisted by local mechanical ventilation where necessary. The School Premises Regulations require that all teaching areas, medical inspection rooms, sick rooms, sleeping and living accommodation shall be capable of

being ventilated at a minimum rate of 8 litres of fresh air per second for each of the usual number of occupants. They also require that the minimum background natural ventilation rate should be 3 litres per second of fresh air for each of the maximum number of occupants.

The emphasis should be on controllable ventilation to avoid excessive heat losses and draughts.

If a room is allowed to cool then it will take around half an hour to return to working temperature. Uncontrolled ventilation can mean heat losses of up to 60%.

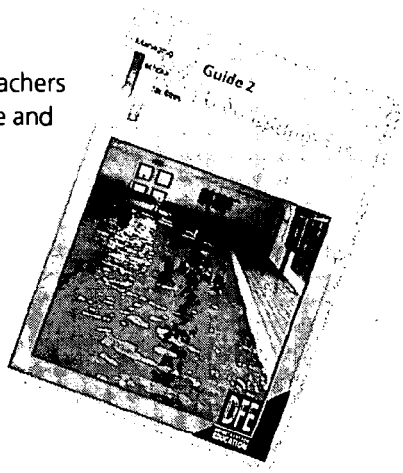
- Keep the draught lobbies at entrances to buildings in good repair and make sure that they are used properly.
- Fit:
  door closers to external doors and keep them in good repair; and
  draught strip external doors/windows.
- Make sensible use of open windows.

## Hot water

- Install point of use hot water heaters in staff rooms and similar areas.
- Do not heat the entire hot water system during the school holidays.
- Consider using appropriate cold water detergents for cleaning the school.

## Swimming pools

Guide 2 in this series for headteachers and governors is on the maintenance and management of swimming pools



Swimming pools can be expensive to run unless they are subject to a strict energy management regime.

The water should be heated to a maximum of 28°C with the surrounding air temperature 1°C higher. This keeps the relative humidity to around the ideal of about 65%. In these conditions ventilation is at a minimum and heat losses at their lowest.

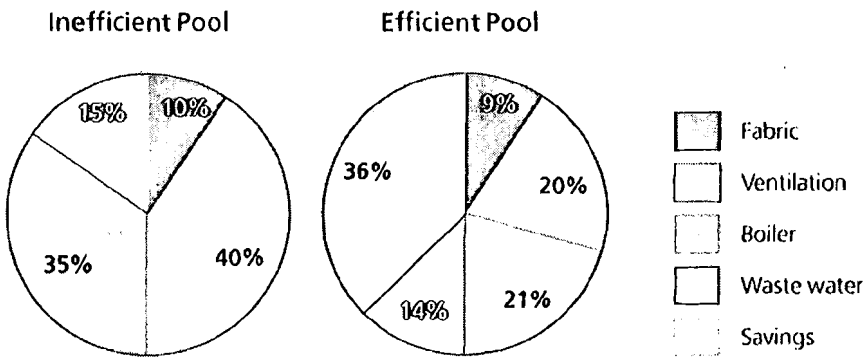
If the relative air temperature is more than 2°C above the pool temperature then evaporation levels rise, ventilation losses increase and more heat is needed to maintain pool and air temperatures. Heavy condensation can result in expensive damage to the building fabric.

If the relative air temperature is below the pool temperature then the pool acts like a huge radiator with correspondingly high heat losses.

Using a pool cover whenever the pool is not in use can save up to 30% of pool related energy costs by cutting:

- Evaporation losses;
- Heat losses;
- The energy needed to bring the pool back to working temperature;
- The amount of water to make up for that lost by evaporation;
- Ventilation requirements;

*Comparisons of cost between efficient and inefficient pools*




13

## Maintenance

The most energy efficient buildings are those which are wind and water tight with their heating, hot water and electrical systems in the best possible condition. This is the result of regular maintenance and the prompt repair of defects.

You might need the help of a heating engineer or your local energy management unit for some of the following:

- Before each heating season:

  service the heating system. Check that it is working efficiently and confirm that the fuel/air mixture in the boiler is within the manufacturer's recommended levels;

  check the froststat is correctly set. In cold weather a special thermostat, called the froststat, prevents the heating system freezing. It should be set at:

  2°C - if it is installed outside;
  5°C - if it is installed inside the building;

  If it is too high then the boilers will come on too soon and over heat an empty school; and

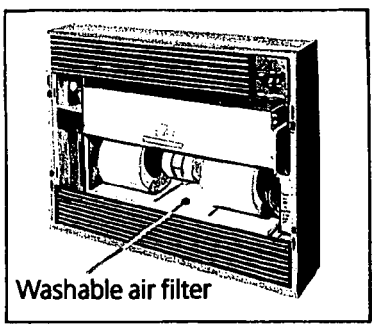
  bleed the radiators;

- Once a term:

  check the heating system is balanced so that every area is heated to its correct temperature. An unbalanced system will mean that some areas are overheated and others are too cold;

  visually check the insulation on pipe work; and

  clean the filters in fan assisted heaters. Except in the smallest schools it will not be possible to clean all filters during school holidays. Set up a rolling programme cleaning so many filters a week.



- Once a week:

  Check draught proofing to external doors and windows. Depending on the time of year the gap between a door, or window, and its frame can vary by 3mm. On a standard door this is a hole equivalent to a house-brick. Draught stripping solves this problem; and

  check the heating and hot water systems, including taps, for leaks

- As necessary:

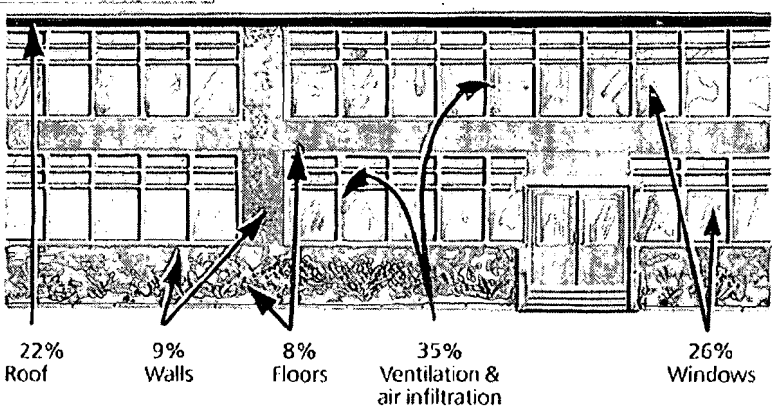
  when the clocks change and after every power failure reset all time-clocks; and

  repair broken windows promptly. A broken window is an open window. Use a purpose designed, proprietary self-adhesive polythene film. This holds the broken glass in place, and prevents heat loss until a proper repair can be carried out.

## Long term savings

Replacing a defective roof or boiler system are examples of long term energy conservation measures. Their long payback periods make it difficult to finance the work from the savings they promise but when they do arrive they can be substantial.

*Typical heat losses*




15

Cost is not a reason for ruling out any energy saving measure but no programme should be dependent upon the success of a single project. Every option should be considered and a priority list drawn up of those best suited to your school. It may not be possible to include all of them in the current budgets but a school with a comprehensive energy management strategy, knowing what it wants and how much it will cost, is in a strong position to respond quickly when resources become available.

Implementing some long term measures might depend on other projects. For example, around 22% of the heat losses from a 1960s system built school are through the roof but insulating a flat roof can only be carried out when the school is being re-roofed. Replacing some windows with insulated panels is cheapest as part of a window replacement programme. The creation of draught lobbies can be included in adaptations or extensions to the school.

Before committing resources to a long term project or signing any contract, always seek independent, professional advice from reputable consultants or your local authority energy management unit.

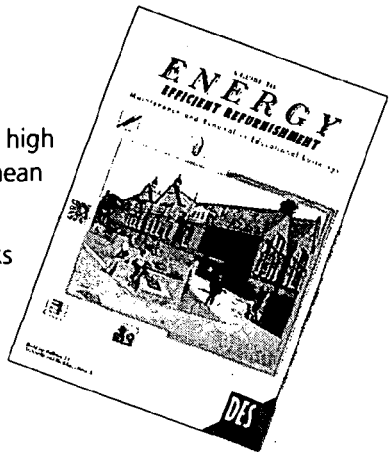
Projects which typically have payback periods of between two and five years are:

- Installing heat pump recovery to swimming pools .
- Fitting pool covers .
- Installing push button spray taps and showers. These automatically switch off after a pre-set period. Individual showers are better than the run through type where all the heads are on regardless of the numbers using the showers.
- Altering wiring systems to allow for banked lighting in classrooms.

The following usually have payback periods of over five years but if they are carried out as part of some other project then some or all of their cost can often be absorbed and the payback period correspondingly reduced.

- Installing draught lobbies,
- Replacing some windows with insulated panels,
- Insulating the roof,

- Insulating walls,
- Replacing boilers,
- Fitting suspended ceilings in rooms with high ceilings, but remember this may also mean modifying the light fittings,
- Building covered walkways between blocks and round courtyards used for circulation.




DFE Building Bulletin 73 describes how energy saving measures can be adopted during maintenance and refurbishment.

## Lettings and shared use

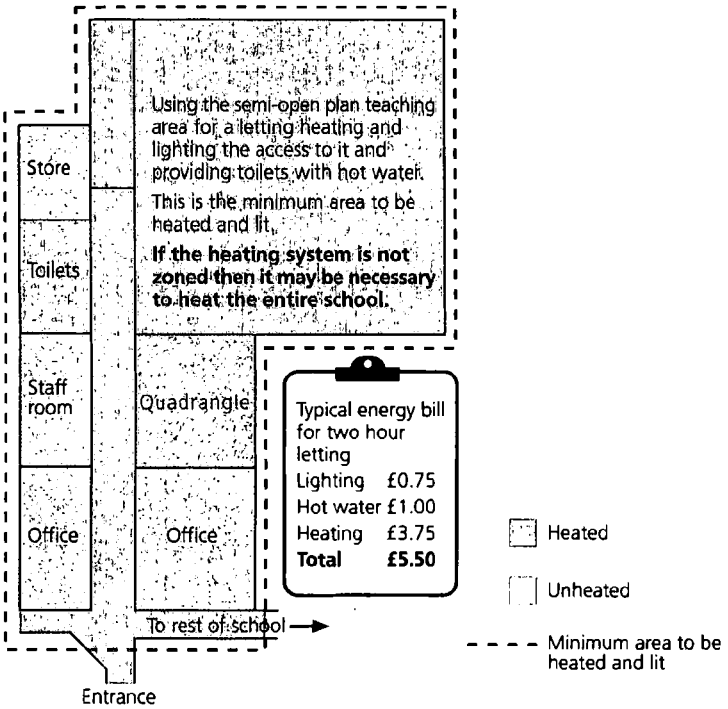
Hiring school facilities to outside bodies is only a source of income if the full cost of providing the facility is recovered. Heating and lighting costs are often underestimated. Providing hot water in a secondary school costs around £2.50 an hour. Use a standard hourly rate for heating and lighting as a basis for letting charges.

Try encouraging as many hirers as possible to use the same one or two nights a week. This keeps the costs of shared areas like toilets and corridors to a minimum and allows the zoning of the heating system to be used efficiently.

Tell hirers about the school's energy conservation policy and how they can reduce costs. Identifying energy charges separately and passing on some or all of the savings they make might help to highlight the benefits of energy conservation.

Calculate charges to organisations sharing the premises, including outside contractors, on a full cost recovery basis. If they use a lot of energy then it might be worthwhile to install check meters so that they can be billed for what they use. Finding costs by formula might seem easier but it passes on the results of the school's efforts without encouraging the other users to make any serious effort to control their consumption. It is not necessary to charge all users the same rates. It is possible to recover more of the costs on some lettings in order to offer discounted rates to activities requiring financial support.

*FINDING AREA USED FOR A LETTING*




## Surplus accommodation

A survey by DFE identified some 1.3 million surplus places in England in 1991. Not all are necessarily surplus in the sense of rooms standing empty, but any school which has unoccupied places is paying more per pupil for its energy than it ought.

Review the use of space. If there is accommodation which is no longer required or under-used then ways of either recouping or avoiding its energy costs should be vigorously investigated. As a priority any hut or other temporary accommodation which is surplus to requirements should be removed. Other options for surplus accommodation which schools can take include:

- Some alternative use such as:

  an extension of the school's activities to bring the space into profitable use; and

letting the space at an economic rent.

- Moth-balling. This can be difficult and can bring unexpected costs as background heating and lighting will still be needed.
- Demolition; although the cost of demolition and making good must be balanced against future savings.

## Education and training

Build on children's enthusiasm for green issues to encourage an informed awareness of energy conservation. Involve pupils directly and use the school as a living laboratory to bring energy issues to life.

Energy can be taught through various National Curriculum subjects, including science, technology, mathematics, history, geography and English; as well as through non-statutory studies, including economic and industrial understanding, health education, environmental education and education for citizenship.

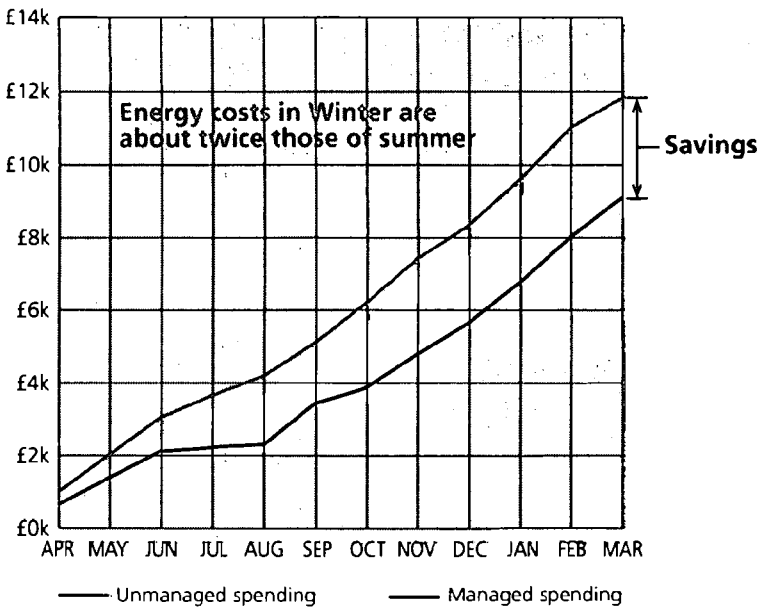
Pupils must see some practical benefit from their contribution. Consider appointing pupils as energy monitors to switch off unnecessary lights, and close doors and windows. If this saves money then they should be told how much and how the cash is being spent. A little money spent on projects chosen by the pupils will encourage them to greater efforts. Turning out lights because teacher says so is a project with a very short shelf life.

Putting energy conservation on the agenda of staff meetings keeps staff informed and provides a forum for views and ideas. Staff need support training. Everybody should attend an introductory course. Others may need more detailed skills. Identify training needs and make arrangements for them to be met. Knowledge breeds competence. Competence raises confidence. Confidence brings success.

## ... and finally

Energy conservation is a mixture of low-tech people power and state of the art technology. Even in schools at the leading edge of knowledge and technology it is important that their energy systems can be readily understood and controlled by the lay person. Simplicity is always a virtue.

Success will come from a carefully thought out, balanced action plan that brings together the widest range of measures. If supported by sensible energy saving targets and a regular review and monitoring programme to make sure targets are attained then there will be a steady stream of savings.




In the best schemes staff, pupils and governing bodies accept a personal responsibility to cooperate with each other to save energy. It is a team effort but there must be positive leadership. If those in charge are not enthusiastic and prepared to take the first steps then the willingness of others to play their part will come to nothing.

Action must be informed and acknowledged. Staff and pupils must know what they are trying to achieve and be given real, tangible credit for their efforts. Encouragement is not enough. Long term savings come from long term commitment. Energy conservation is for life.

## Management action plan checklist

| Step | Action | By | Date |
|---|---|---|---|
| 1 | Headteacher and Governors take an overview of current energy use and agree targets for savings. | | |
| 2 | An energy manager is appointed. | | |
| 3 | An action plan is prepared and resources allocated. | | |
| 4 | The action plan is implemented. | | |
| 5 | All energy is being bought at the best price on the cheapest tariff and after investigating alternative suppliers. | | |
| 6 | A regular check is made of the maximum demand. | | |
| 7 | A programme of staff training is introduced. | | |
| 8 | Involve the pupils. Energy conservation is part of the curriculum. | | |
| 9 | Review action plan, tell staff and pupils the results and introduce improvements. | | |

**DFE architects and building publications on energy and maintenance**

**Priced publications available from HMSO**

Building Bulletin 70, *Maintenance of mechanical services*
ISBN 0 11 270717 3, HMSO, 1990, £10.95

Building Bulletin 73, *A guide to energy efficient refurbishment*
ISBN 0 11 270772 6, HMSO, 1991, £8.50

Building Bulletin 76, *Maintenance of electrical services*
ISBN 0 11 270799 8, HMSO, 1992, £13.50

Building Bulletin 79, *Passive Solar Schools, A Design Guide,*
ISBN 0 11 270876 5, HMSO, 1994, £19.95

**Free publications (from DFE Publications Centre, PO Box 2193, London, E15 2EU, Tel: 081 533 2000)**

Broadsheet 22, *Use of heat pumps in rural schools,* 1986

Broadsheet 24, *Saving energy in schools: three case studies in Nottinghamshire,* 1987

Broadsheet 27, *Energy Efficient school refurbishment,* 1991

Broadsheet 29, *Energy use in educational buildings,* 1992

Broadsheet 30, *Engineering services in schools,* 1993

**Other titles in this series:**

Guide 1, Saving Water
ISBN 0 11 270851 X, HMSO, 1993, £3.95

Guide 2, Swimming Pools
ISBN 0 11 270871 4, HMSO, 1993, £3.95

DFE has worked with the Energy Efficiency Office and supported the publication of a series of Best Practice Guides for schools

Available free from
BRECSU,
Building Research Establishment,
Garston,
Watford, WD2 7JR.
Tel: 0923 664258.

23

Energy costs account for up to a quarter of non-staff running costs in schools. This is three times as much as is spent on books.

Good housekeeping measures could reduce the energy costs by 10% and a well thought out action plan could double this.

This guide advises headteachers and governors on how to implement an energy saving action plan.

HMSO

Published by HMSO and available from:

**HMSO Publications Centre**
(Mail, fax and telephone orders only)
PO Box 276, London SW8 5DT
Telephone orders 0171 873 9090
General enquiries 0171 873 0011
(queuing system in operation for both numbers)
Fax orders 0171 873 8200

**HMSO Bookshops**
49 High Holborn, London WC1V 6HB
(counter service only)
0171 873 0011 Fax 0171 831 1326
68-69 Bull Street, Birmingham B4 6AD
0121 236 9696 Fax 0121 236 9699
33 Wine Street, Bristol BS1 2BQ
0117 9264306 Fax 0117 9294515
9-21 Princess Street, Manchester M60 8AS
0161 834 7201 Fax 0161 833 0634
16 Arthur Street, Belfast BT1 4GD
01232 238451 Fax 01232 235401
71 Lothian Road, Edinburgh EH3 9AZ
0131 228 4181 Fax 0131 229 2734

**HMSO's Accredited Agents**
(see Yellow Pages)

*and through good booksellers*

ISBN 0-11-270880-3

9 780112 708803

**U.S. Department of Education**
*Office of Educational Research and Improvement (OERI)*
*National Library of Education (NLE)*
*Educational Resources Information Center (ERIC)*

# NOTICE

## REPRODUCTION BASIS

☒ This document is covered by a signed "Reproduction Release (Blanket) form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").