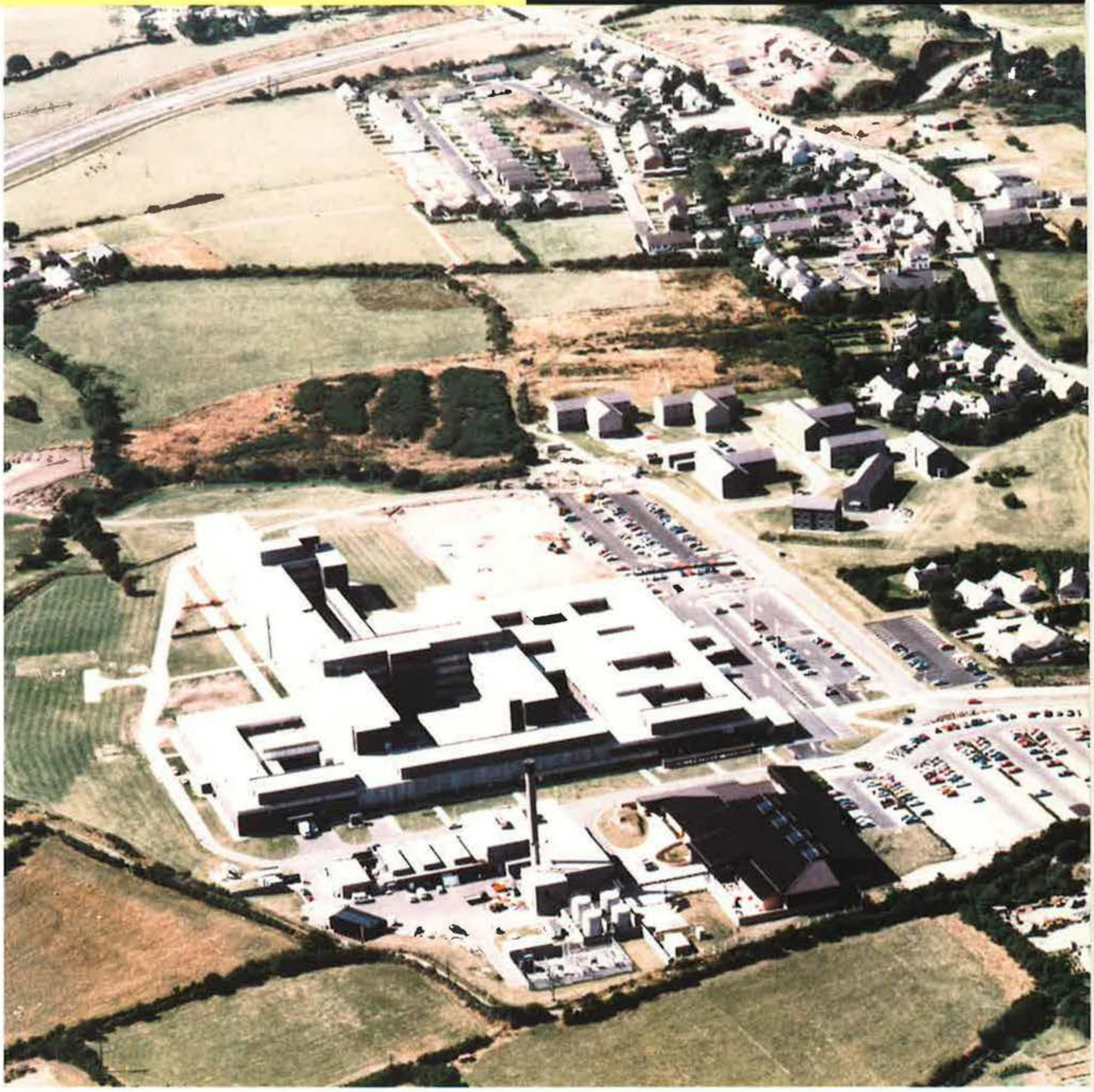
Introduction to Energy Efficiency in Health Care Buildings



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INTRODUCTION

1.1 Who this guide is intended for

This guide is aimed at estates managers and facilities managers and others who have responsibility for energy use in health care buildings.

It is intended to introduce the steps that anyone responsible for energy needs to take in order to control and reduce energy consumption. It shows how to gain an understanding of energy use in health care buildings 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 9.4; 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 to 7 describe methods for assessing energy use in health care buildings.
- The case studies (section 8) give examples of health care buildings where energy saving measures have been successfully implemented.
- Section 9 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 use the action plan (section 3), or the suggested measures (section 4) as aide-memoires. They may also use the method for calculating performance indices described in section 6 and appendix 1.

A manager responsible for energy on a number of different sites may wish to distribute the guide to the person responsible for energy management at each site.

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 costs in running health care buildings. 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 patients and staff.

Efficiently run buildings also require less manpower to service complaints, providing savings additional to the reduced costs of energy.

1.5 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:

Building Energy Solutions

Building Research Energy Conservation Support Unit (BRECSU)

Hull Royal Infirmary

NHS Estates

Somerset Health Authority

Ysbyty Gwynedd Hospital

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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:

- As a rule of thumb, organisations or sites with an energy bill over £1 million may justify the employment of a full time energy manager. Otherwise, energy management will normally be combined with other responsibilities.
- Each building should have someone responsible for energy management.
- In larger organisations, energy efficiency should also be managed centrally.
- Energy efficiency must be strongly supported at the highest levels with the authority and resources needed for initiatives to be effective.

Encourage your management board to sign up to the EEO's Making a Corporate Commitment campaign if it has not already done so (see section 9.5).

The duties and functions of an energy manager are discussed 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).

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, or commercially available systems can be purchased. Computer based systems are essential for effective monitoring of a large estate or site.

An M&T system should:

- Record energy consumption and any other factors that affect energy use (building usage, weather, etc).
- Compare a site's energy use to previous years, to other health care buildings, 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 that billed readings are correct. In shared or multi - meter sites ensure you are being billed for your use; label your meters.

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*

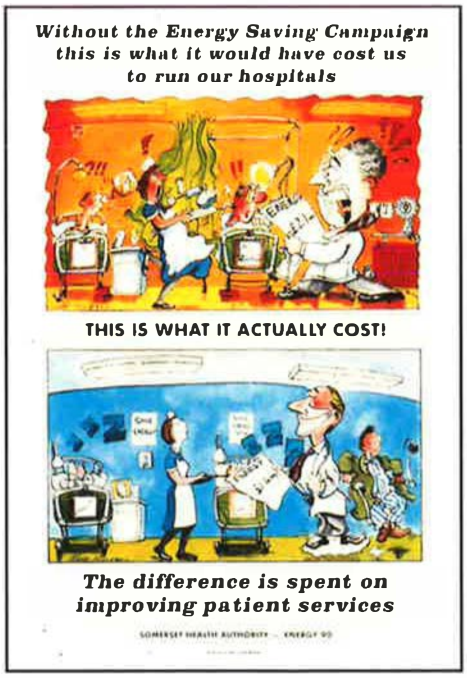
Meter Reading Date	kWh Used	Cost £
8.1.92	39,700	2756.29
5.2.92	38,700	2653.65
5.3.92	31,500	2200.35
9.4.92	25,000	1584.02

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:

- 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 9.8).



Energy Efficiency Poster

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. Foster their support and give them every chance to participate in energy saving initiatives. Feed back information to staff on the results of these initiatives.

Activities could include:

- Providing information about why energy conservation is important, describing practical and environmental benefits
- Setting up an incentive scheme
- Stressing that most energy is used by all occupants - for lighting, equipment and for maintaining comfortable conditions
- Encouraging staff to switch off equipment and lighting when it is not needed, by providing information and training on how to operate systems and controls, through stickers, posters and articles in staff magazines
- Relating energy use at work to energy use at home.

You should monitor the savings achieved and publicise them to help motivate staff and senior management. Obtaining capital investment for future energy efficiency measures may depend on demonstrating the cost effectiveness and the environmental benefits of measures that have already been completed.

For further information see:

EEO Good Practice Guide 84 - Managing and motivating staff to save energy.

2.6 Energy management in larger organisations

In larger organisations with estates of buildings, an energy manager may be responsible for many separate locations. He or she will have a different role from a site energy manager which is not addressed in detail here.

For further information see:

EEO General Information Report 12 - Organisational aspects of energy management

EEO General Information Report 13 - Reviewing energy management

Making a Corporate Commitment - various guides

2.7 Responsibilities at larger sites

In larger buildings and sites, a number of groups should be involved in energy management:

- Senior management
- Local or departmental management
- Facilities management
- Security staff
- Maintenance contractors
- Cleaning management.

You should have regular contact with all of the above and with the individual building staff. An estates manager often makes a good energy manager because they already have close contact with staff and have direct involvement with the buildings. You should find out about factors relating to occupants' comfort, including:

- How plant and equipment controls are set and who is responsible for their adjustment.
- How comments from occupants are acted on - especially those reflecting dissatisfaction.

2.8 Apportioning energy costs

In larger hospitals it may be worth introducing local accounting for energy use. Each department pays for the energy that it uses. The incentive of reduced overheads encourages departmental managers to use energy more efficiently. This can be done by charging departments on the basis of their floor area, but it is preferable to install sub-metering so that each department can be charged for the actual energy it uses.

2.9 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 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 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 moving or refurbishing health care premises, take the opportunity to select or specify:

- Energy targets
- Systems which are suitably simple and within the capabilities of staff to manage
- High efficiency of major plant and equipment such as boilers or main lighting systems

Refurbishment offers a rare opportunity to incorporate many energy efficiency measures

- Good levels of insulation
- 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 71 - Selecting air conditioning systems.

2.10 Getting help

Sources of further information are described and listed in section 9.

To obtain further information about possible energy saving measures (see section 4), 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 time is not available or if discussions with a selection of competing suppliers do not provide a consistent picture, 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 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 9.8)

For further information see:

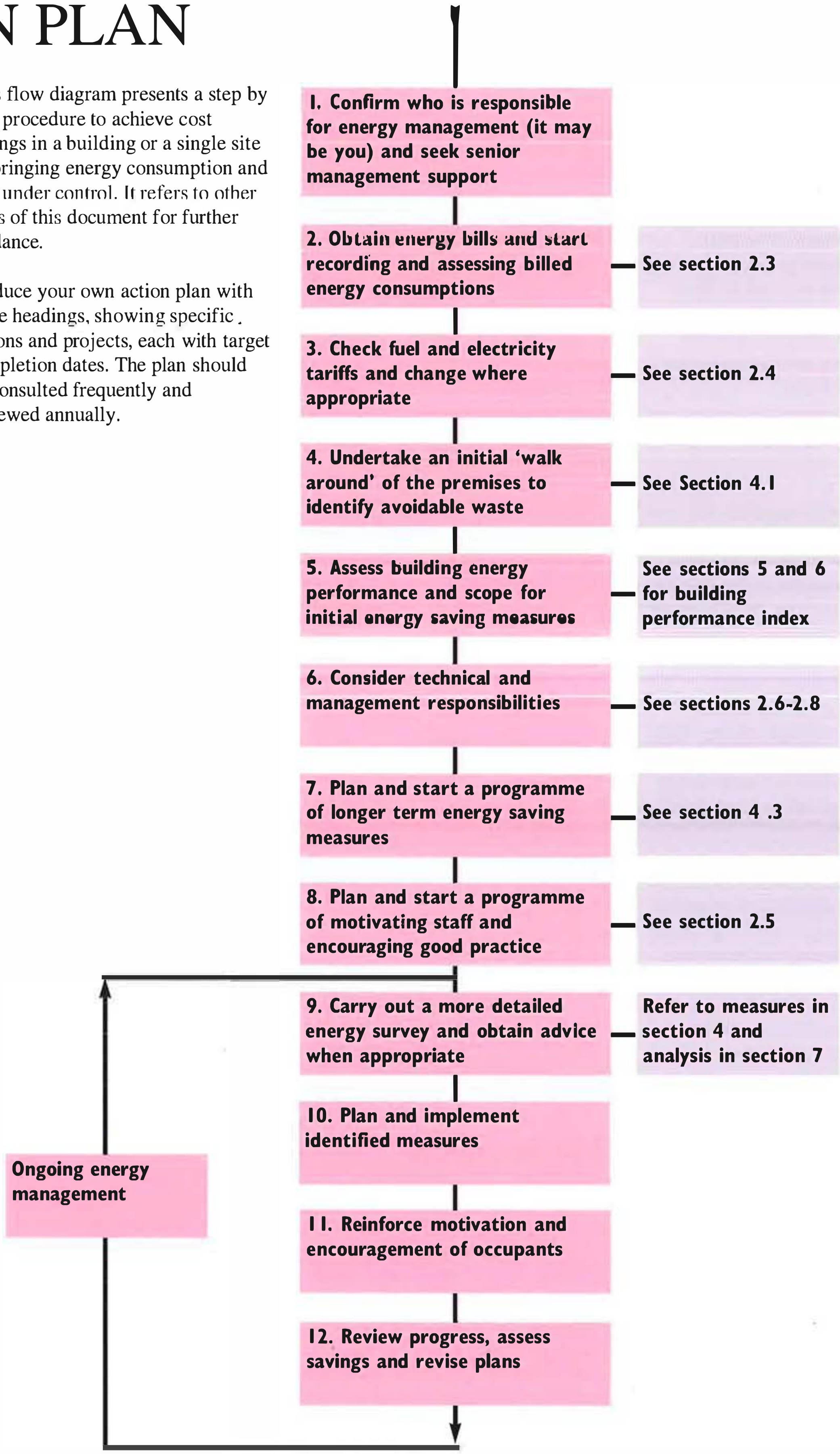
Choosing an Energy Efficiency Consultant (EEO)

3

ACTION PLAN

This flow diagram presents a step by step procedure to achieve cost savings in a building or a single site 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.



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MEASURES TO ACHIEVE ENERGY SAVINGS

4.1 Initial measures

In most health care buildings 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 patients.

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. Motivating staff to help is therefore important, although a long term task. An exercise to review energy purchasing tariffs (see section 2.4) should be carried out at the same time.

Detailed information on good housekeeping measures is given in other Best Practice publications.

For further information see:

EEO Good Practice Guide 52 - Good Housekeeping in the NHS. A Guide for Energy and Estate Managers.

4.2 Maintenance

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

- Replace filters at the manufacturer's recommended intervals and keep heat exchanger surfaces, grilles and vents clean in order to allow unobstructed flow of air
- Check plant operation and controls regularly
- Ensure that all motorised valves and dampers fully open and close without sticking
- Check that thermostats and humidistats are accurate
- Check calibration of controls
- Service the boiler plant and check combustion efficiency regularly
- Look for water leaks from mains, taps and showers 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 diagram on page 11)
- Clean lamps and luminaires regularly and replace at the manufacturer's recommended intervals.

4.3 Longer term measures

There will almost certainly be items of equipment or insulation which could be replaced with more efficient alternatives. The main areas for savings, starting with the most cost effective, are:

- Control systems
- Lighting and office equipment
- Heating and air conditioning plant
- 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
- 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.

Further information is given in references listed in section 9 - note particularly:

EEO Fuel Efficiency Booklets:
1 Energy audits for buildings
2 Steam
8 The economic thickness of insulation for hot pipes
10 Controls
12 Lighting
14 Economic use of oil fired boiler plant
15 Economic use of gas fired boiler plant
17 Economic use of coal fired boiler plant

EEO Good Practice Guides:
54 Electricity Savings in Hospitals
60 CHP in the Health Service

Energy Efficient Lighting in Buildings. A THERMIE Maxibrochure.

Assessing costs of measures

The cost effectiveness of an energy efficiency investment can be expressed as the initial cost divided by the monthly or annual cost savings - the simple payback period.

More sophisticated appraisal techniques for comparing different investments, such as 'discounted cash flow' methods, are sometimes used in larger organisations and for major investments. If these are needed, advice should be sought from those who use these methods.

If energy-saving initiatives are taken during refurbishment or when constructing a new building, capital cost is often substantially reduced and interference with normal working practices is kept to a minimum.

For measures included during replacement or refurbishment, the initial cost (for calculating the payback period) is only the over-cost: for example, the extra cost of a high efficiency 'condensing' boiler compared with a conventional boiler. This reduces payback periods and increases cost-effectiveness.

In some cases, energy efficiency measures can reduce overall capital costs, such as providing natural ventilation which avoids the need for air conditioning.

Where shortage of funds and/or lack of expertise is holding up promising measures, it may be worth considering contract energy management as described in section 2.10.

Measures can be split into those which require limited attention such as insulation, and those which require management time to ensure that they continue to be effective, such as building energy management systems. For the latter, manageability is as important as the potential for energy savings, and should be a prime consideration in the design.

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.

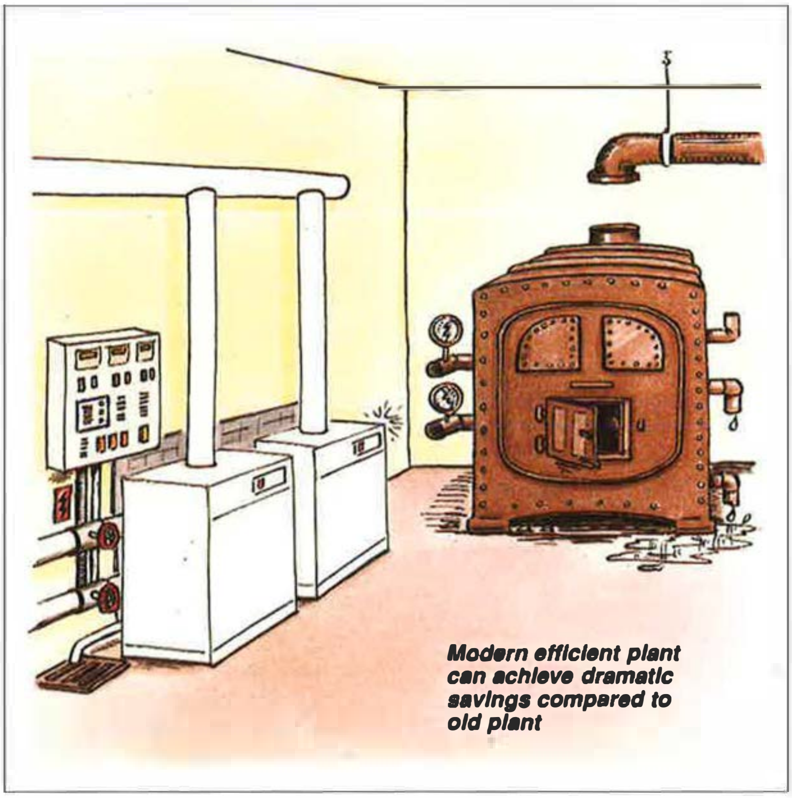
Fossil fuels such as gas, oil or coal are usually burnt in a boiler and the heat is transferred to a heating system. Boilers have varying seasonal efficiencies - old boilers may convert less than 50% of the energy content of the fuel into heat in the heating system. The most efficient systems include condensing boilers and combined heat and power (CHP) installations. Condensing boilers can achieve seasonal efficiencies of over 90% and can be used with most existing heating systems. They ought to be considered whenever boilers are replaced. In addition, CHP should also be considered wherever there is a continuous demand for heat and power.

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.

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
- Room thermostat: keeps the temperature in a room to a required level
- Thermostatic radiator valves (TRVs): regulate the flow of hot water through the radiators in a room in order to maintain a local temperature
- Boiler sequence control: enables only the number of boilers required to meet the system demand
- Night setback control: operates the heating system at lower temperatures during the night.

The 1990 Building Regulations specify that new non-domestic buildings should have time controls and weather compensation, room thermostats or TRVs, and that large buildings should also have optimum start control.



Modern efficient plant can achieve dramatic savings compared to old plant

HEATING MEASURES

- Separate the heating system into zones so that areas of the building with different heating requirements can be controlled separately.
- Fit TRVs in rooms which are prone to over-heating, due to solar gain, for example.
- Upgrade heating controls to include a seven day programmable timer, optimum start control and weather compensation as a minimum.
- Where small volumes of domestic hot water are required a long way from the main heating plant, consider installing local instantaneous water heaters.
- Install spray taps where possible.
- Insulate hot water tanks and boilers, and all pipework, valves and flanges which do not provide useful heat to occupied spaces.
- Replace an old boiler installation with one that provides a minimum seasonal efficiency of at least 80%, preferably including at least one condensing boiler. Specify multiple boilers with a sequence controller rather than one large boiler in installations over 100kW, with the most efficient boiler leading the firing sequence.
- Ensure that boilers can only run when there is a heat demand. Unnecessary firing is known as "dry-cycling" and is often remedied by correctly wiring the boiler thermostat into the control system. In multi-boiler installations, wide band thermostats often overcome dry-cycling.
- In areas where background heating is required at night, night setback controls should be installed in order to operate the heating system at lower temperatures than daytime. Each degree Celsius that the temperature is reduced saves roughly 5% of the heating at that time.
- Install a heater other than the main boiler to produce domestic hot water, and turn off the main boiler during the summer.
- On steam systems, install automatic blowdown with a heat recovery system; ensure that the maximum amount of condensate is returned from the site.

COMBINED HEAT AND POWER

CHP plant provides both electricity and heat. The fossil fuel supplied to the plant displaces high cost electricity. As the heat which is inevitably produced is used for heating rather than being wasted, it is a more energy efficient means of generating electricity than conventional power stations. Overall efficiencies are typically 60-80%.

It is essential that the CHP plant is sized correctly in order to maximise the hours it runs and hence the savings achieved. This generally means matching the plant to the base load energy demands on the site. When assessing heat loads, take account of space heating, laundry, swimming pool and domestic hot water systems. CHP is usually cost effective if it runs for greater than 4,500 hours/year.

CHP should be installed under a long term service contract with the supplier. The contract should specify the periods when essential maintenance should take place. It should also include penalty clauses for non compliance to reduce the risk of increased electricity maximum demand tariff charges which would occur when the CHP plant was not running, even for the shortest period. This is particularly important during winter when maximum demand charges are at their highest. Any prolonged stoppage will also result in an increase in electrical consumption leading to higher overall energy costs.

BUILDING FABRIC

Most building fabric measures except simple roof insulation and draught proofing are most cost effective when they form part of general maintenance or refurbishment.

Caution: Insulation measures should be checked for condensation and water penetration risks. Double glazing may reduce air infiltration rates to a level where additional ventilation becomes necessary.

BUILDING FABRIC MEASURES

- Insulate roof voids.
- Draught proof around windows and doors.
- Fit secondary glazing.
- Install cavity wall insulation or internal or external insulation.
- Reduce excessive glazing areas by replacing the glass with insulated wall panels.
- If windows are being replaced, fit multiple glazing, preferably with low emissivity glass which reduces heat loss in winter.

LIGHTING

Lighting usually accounts for 30 - 50% of electricity use in hospitals, and good savings can be achieved by ensuring that the lighting equipment and its controls and management are of a high standard.

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
- Tungsten spotlights - used for display lighting; even the most efficient lamps are much less efficient than fluorescent lamps
- Compact fluorescent lamps - efficient replacements for tungsten bulbs, although not as efficient as modern tubular fluorescent lamps

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

Photographs supplied by Philips and Fitzgerald.

- Fluorescent tubes - used in most office areas
- Metal halide and sodium discharge lamps - these vary in efficiency depending on type (most are more efficient than fluorescent tubes). Sometimes used in uplighters; well suited to lighting large areas such as car parks.

Tungsten bulbs typically have a life of about 1,000 hours, while fluorescent and discharge lamps typically last for 8,000 hours or more. Removing tungsten bulbs therefore gives substantial savings in maintenance costs in addition to any energy savings.

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

These figures give an indication of the typical savings which may be made by replacing lamps with more efficient alternatives. For example, replacing an old inefficient tubular fluorescent system (1) with a modern efficient system (3) would reduce energy consumption by a factor of 13/18, a reduction of about 30%.

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
High pressure mercury (MBF)	22
compact fluorescent with electronic ballast	18
metal halide (MBI)	15
high pressure sodium	11
Low pressure sodium	7
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

As well as lamps, light fittings (luminaires) contain a number of other elements, including:

- Diffusers or louvres - these are designed to give a good distribution of light without glare. Luminaires with prismatic and especially opal diffusers are less efficient than those with reflectors.
- Control gear - fluorescent and older discharge lamps need control gear to strike up and maintain light output. Old fluorescent luminaires have chokes and starters; modern electronic controls (ballasts) are more efficient.

Lighting controls should be used to ensure that, as far as possible, lights are off when they are not needed. It should be possible to control lights in each area of the building from local switches. Some automatic control may also help to reduce the length of time for which lights are left on. Automatic controls include:

- Time controls - allow any group of lights to be switched on or off automatically at set times of the day
- Presence detectors - automatically switch lights on when somebody enters a space, and off again after the space is vacated
- Daylight detectors - allow groups of lights to be switched off or on according to the level of daylight. Some lights can also be dimmed as daylight levels alter.

LIGHTING MEASURES

- Replace tungsten lamps with compact fluorescent lamps or, better, with tubular fluorescent lamps.
- Replace tungsten spotlights with low voltage tungsten halogen lamps.
- Replace existing control gear in fluorescent fittings with electronic, high frequency ballasts.
- Replace diffusers in tubular fluorescent fittings with reflectors and reduce the number of tubes if possible.

Compact fluorescent lamps

- If light fittings are over 15 years old, replace with new efficient fittings and consider installing new lighting controls.
- Use metal halide or sodium discharge lamps for outside areas such as car parks.
- Improve lighting controls, including:
  - Local manual switching
  - Time controls for areas with regular patterns of use
  - Time controls or daylight correction controls for external lighting
  - Presence detection controls for areas which are infrequently used, such as stores
  - Daylight detection controls for lighting adjacent to windows.

MECHANICAL VENTILATION AND AIR CONDITIONING

Mechanical ventilation provides air which is filtered and heated. Air conditioning additionally provides cooling and humidity control.

Pumps and fans consume a considerable amount of energy; in air conditioned buildings they consume at least half, and often more, of the total energy used for air conditioning.

Cooling is usually provided by an electrically driven refrigeration plant. Cooling systems should be controlled and insulated in the same way as heating systems. The savings will be proportionally higher as cooling is considerably more expensive to produce than heat.

MECHANICAL VENTILATION AND AIR CONDITIONING MEASURES

- Install variable speed controls on fans and pumps; these allow motor speeds to be controlled according to the demand instead of running at full power continuously.
- Set the temperature required for cooling as high as possible (24°C or higher) to reduce the demand for refrigeration.
- Ensure that controls are set or improved to avoid both heating and cooling air at the same time.
- Ensure that air conditioning systems make use of outside air for 'free cooling' whenever possible.
- When heating or mechanical cooling is required, ensure that the proportion of air recirculated within the building is as high as possible within the requirements for minimum fresh air rates.
- If humidifiers are being specified use ultrasonic humidification. (Ensure that adequate precautions are taken to avoid Legionella).
- Explore the opportunities for heat recovery from any source of warm exhaust air but bear in mind the increase in pump and fan power that will be required.

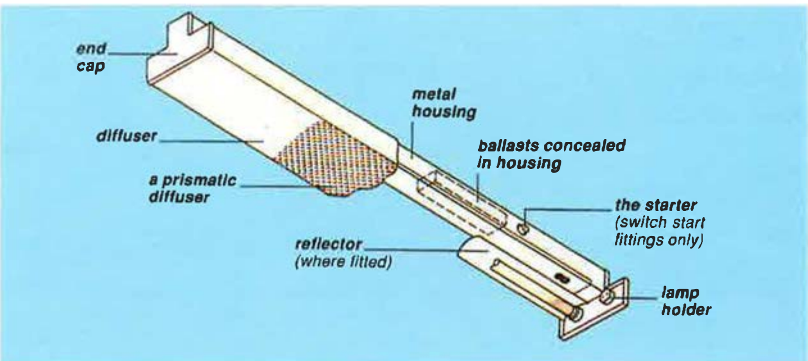
BUILDING ENERGY MANAGEMENT SYSTEMS (BEMS)

BEMS are computer-based systems which automatically monitor and control a range of building services such as heating, air conditioning, ventilation and sometimes lighting. They may also provide data on energy performance to enable energy savings to be targeted. They are most cost-effective in large buildings with complex building services.

Caution: A BEMS should be considered as an aid to management and not a substitute for it, and it is important that someone manages it to ensure that it operates effectively.

LIFTS

Energy savings can sometimes be achieved by improving the lift system. Two examples are given in the case studies in section 8.



The parts of a fluorescent light fitting

5

ENERGY USE IN HEALTH CARE BUILDINGS

5.1 Why analyse building energy use?

Assessing the energy performance of a building allows you to:

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

2. Compare with other buildings within the health authority or Trust to help identify which should be investigated first.

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

4. Consider the energy use in more depth to help understand where energy is used and wasted, and hence where savings are most likely to be made.

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

5.2 Types of health care building and their energy use patterns

Four common types of health care building are defined as follows:

- Small acute hospital (<25,000m^3)
- Large acute hospital (>25,000m^3)
- Long stay hospital
- Nursing/residential care home.

Acute is defined as hospitals in which at least 40% of the beds are allocated to medical nursing, physiotherapy, surgical operations, accident and emergency treatment, maternity and intensive care.
Long stay is defined as hospitals in which more than 85% of the beds are allocated to the care of geriatric, psychiatric or mentally handicapped patients. Note that some psychiatric patients may only require short term treatment in a long-stay hospital.

Energy costs

Figure 5.1 shows typical annual energy costs per 100 m^3 for the four types of building. It shows that energy costs in a typical large acute hospital are about 20% higher than in each of the other types. This is a result of the greater level of services and equipment usually found in such hospitals

These figures are for typical health care buildings. The good practice equivalents tend to use 15 to 25% less energy, mostly achieved by good management and simple measures. Still lower energy consumption is achievable in new buildings and major refurbishments. On the other hand, some new buildings have much higher levels of energy costs, particularly where there is extensive air conditioning.

Energy cost breakdown

A typical energy cost breakdown for a hospital is shown in figure 5.2. The consumptions of energy for different purposes in any one building may be significantly different from the typical breakdowns given here.
The precise split depends upon the type of hospital and the extent and sophistication of equipment and services. New hospitals usually have a greater degree of air conditioning, with associated chiller plant, and more extensive ventilation systems.

Figure 5.1 Typical energy costs of health care buildings

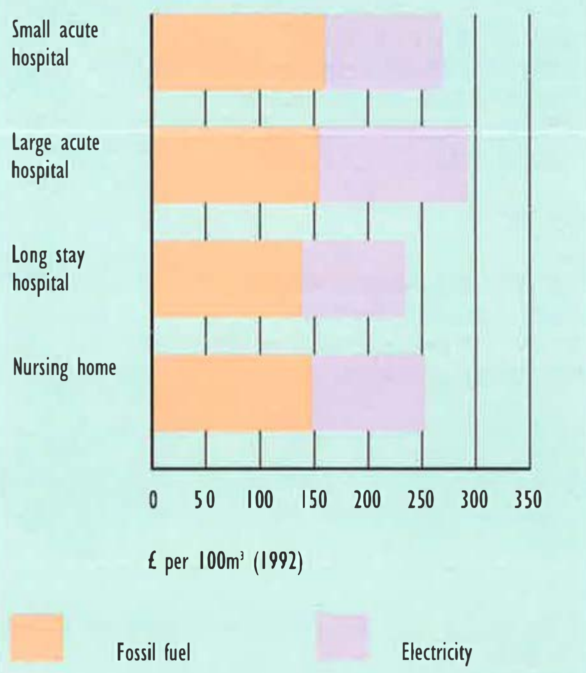
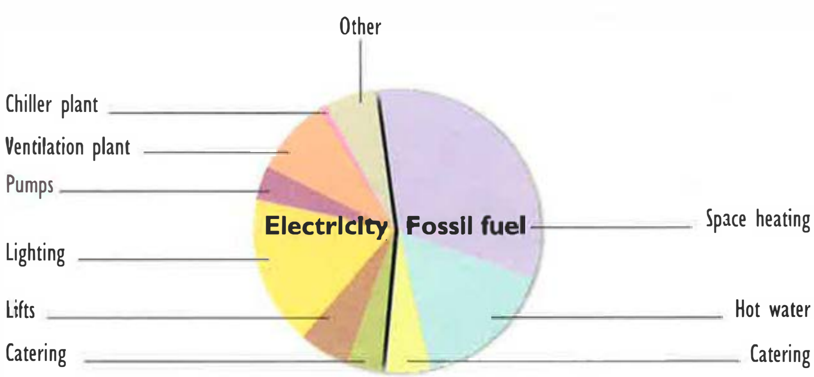


Figure 5.2 Energy cost breakdown for a typical hospital



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.

5.3 Support Services

Larger hospitals usually have support services:

- Laundries
- Central sterilisation
- Incineration and waste burning.

These all have an effect on energy consumption and if possible should be metered separately from the energy consumed in the buildings. By introducing metering it is possible to assess energy use in relation to the throughput of the process, such as energy used per kilogram of laundry.

Some of these activities are carried out centrally within a region, one hospital providing these services to other outlying hospitals. Where this is the case, the energy used could have a major influence on the consumption of the whole site. Waste burning boilers can provide heat which can contribute to the domestic hot water load or to the space heating. Heat recovery from incinerators can also contribute to the supply of heat. Where this is carried out on a large scale, it can reduce the need for other heating fuels, and in some cases make it appear that a hospital is performing more efficiently than is actually the case.

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 the yardsticks. They can indicate the potential for improvements and can be used to show progress over time. They can also allow comparisons to be made between buildings in a group or estate.

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

Two separate indices are calculated for the building, 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 building energy use by the floor area of the building. Yardstick values for the different types of health care building 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 volume of the building in column 4.
4. Divide the energy use of each fuel by the building volume and multiply by 100 to get energy use per 100 m³ in column 6.
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 note take account of the effect of weather on heating energy use (see section 6.4).

There may be exceptional reasons to explain a good or poor rating. For example, a building may obtain a good rating because it has a waste burning boiler that provides a significant proportion of the space heating, or a poor rating because it has a large laundry unit, which has not been properly allowed for.

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. Section 4 then shows possible energy saving measures for each energy use. The next step is to select and progress suitable measures.

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.

The volume of buildings
This should be the volume, in cubic metres (m³), of the parts of the building which are directly or indirectly heated, and includes corridors, toilets and storage spaces. Exclude completely unused or unheated areas such as basements and laundries. If you have the floor area in square metres (m²), multiply the average height in metres to get the volume in cubic metres (m³).

Figure 6.1 Energy Performance Index Calculation

		Column 1 Annual Billed Units		Column 2 *GJ Conversion	Column 3 Annual GJ	Column 4 Treated volume (m³) divide by	Column 5 Multiply by	Column 6 Annual GJ/100m³
Gas			kWh	x 0.0036			100	
Oil, type			litres	x			100	
Other Fossil fuel							100	
Total of fossil fuel								
Electricity			kWh	x0.0036			100	

Note * for GJ conversion factors see Appendix 2

To convert performance indices expressed in kWh/m² to GJ/100m³

If you have the energy consumption in terms of kWh/m² the conversion factor depends upon the floor to ceiling height.

Ceiling height m	To convert to GJ/100m³ multiply kWh/m² by:
2.5	0.144
2.7*	0.133
3.0	0.120

*Typical average

Energy consumption by hospital laundries

The yardsticks in figure 6.2 exclude hospital laundry facilities. This factor should be allowed for separately. If the steam laundry supply is not separately metered, usage can be assessed from an average consumption figure. The Department of Health publication ENCODE 1 gives an average usage figure for hospital laundries of 1.5kg steam per article laundered. This is based on an average of a mix of laundries where the steam supply provided hot water as well as process steam. If steam conditions are taken as 100 psi (7 bar) and 0.95 dryness factor, this usage figure is equivalent to 0.004GJ per article laundered.

6.3 Overall yardsticks

Overall yardsticks based on carbon dioxide (CO_2) emissions or the cost of energy per m³ of volume can be used to provide a single performance index. These can be used to prepare league tables which compare groups of buildings or to assess buildings which have fuel supply arrangements which do not fit into the yardstick categories. This may occur, for example, in health care buildings which use combined heat and power (CHP).

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.

6.4 Refining the performance indices

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

- If your building has unusual occupancy, or experiences unusual weather or exposure you may want to know their likely effect.
- You can compare your building or site performance with the 'Normalised Performance Indicator' used in previous editions of these guides.
- You may wish to take account of the effect of weather when comparing buildings in different parts of the country.

Figure 6.2 Energy Consumption Yardsticks

Performance Assessment

Low consumption Less than → ← **Medium Consumption** Between → ← **High consumption** Greater than

	Yardsticks in GJ/100m³	Yardsticks in GJ/100m³
Small acute hospital (<25,000m³)		
Fossil fuels	54	72
Electricity	6.0	8.0
Large acute hospital (>25,000m³)		
Fossil fuels	62	70
Electricity	8.0	10.0
Long stay hospital		
Fossil fuels	55	63
Electricity	5.5	7.0
Nursing/residential care home		
Fossil fuels	54	68
Electricity	6.0	7.5

7

A CLOSER LOOK AT ENERGY CONSUMPTION

7.1 Introduction

Often a fuller understanding of energy use in a building may be useful, for example after the initial measures have been undertaken, if there is a problem, if the building has poor performance or if it has unexpected energy bills. This section outlines techniques which you may find useful.

7.2 Monthly energy use

You can ask your supplier for monthly fuel data, or take monthly meter readings yourself.

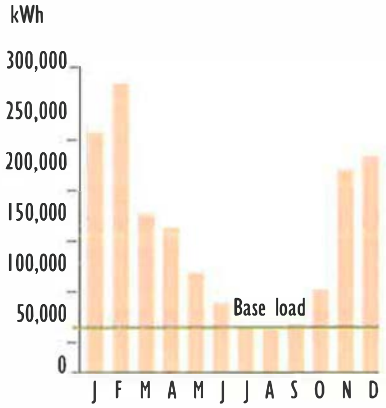
Larger sites have monthly energy bills. By looking at how these vary with the seasons some valuable insights can be obtained. Produce a monthly consumptions bar chart plot for each energy source over a year.

The billing periods should be checked. If they are not regular, some months will appear unrealistically low and others unrealistically high. If this is the case the average daily consumption for each month can be plotted to give more accuracy.

Fossil fuel consumption, used mainly for heating, should reduce greatly in summer - to zero if it is not being used for other services such as hot water or catering.

Electricity consumption should decrease in summer in a building which is not air conditioned, because of lower lighting loads. In an air conditioned building, peaks in spring and autumn may indicate simultaneous heating and cooling.

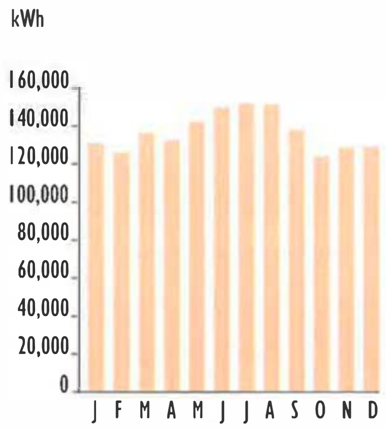
Example monthly fossil fuel use



The figure above shows the monthly fossil energy consumption of a fairly efficient building which has a central boiler system for heating and hot water - the summer usage is much lower than winter usage and is at a fairly steady 'base load' level which suggests that the heating is off, though it is useful to confirm this by checking that heating pumps are off, and that pipework used solely for heating is cold.

This graph shows a base load, which helps to identify the hot water load and system losses, and the heating load which depends on the weather.

Example monthly electricity use

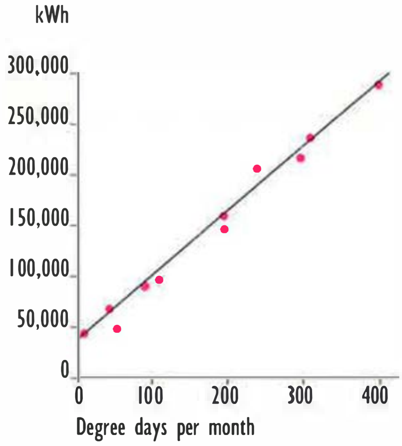


The figure above shows monthly electricity consumption for an air conditioned building showing a small increase in the summer months as the cooling load increases. A possible small increase in winter may be due to increased lighting or some electric heating.

7.3 Relating heating use to weather

A fuel that is mainly used for heating should be used more in colder weather. The coldness of the weather can be expressed by a measure known as degree days. This shows by how much and for how long the outside temperature is below a control temperature (usually 15.5°C). Drawing a graph of fossil fuel consumption against the degree days for each month in the year shows how energy consumption is related to weather. Monthly figures for degree days for different areas of the country are available from NHS Estates (see section 9.8) and are also published in the EEO's free bimonthly magazine 'Energy Management' (see section 9.4)

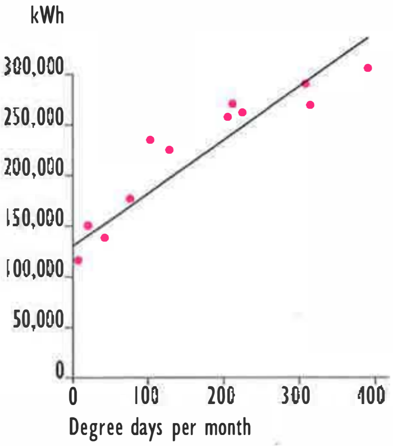
Example monthly heating energy use in a well controlled building



The building represented above has a well controlled heating system, shown by the close fit of the straight line. As the weather gets colder the energy used goes up proportionally. For this building the energy consumption falls to a small value in summer when only hot water is being provided.

A building with better insulation would have a less steep slope because energy consumption in winter would be lower.

Example monthly heating energy use in a poorly controlled building



The figure above has a large scatter of points indicating a building with poor control, and the energy use in the summer months remains higher than in the previous figure, indicating that either heating is being used unnecessarily in the summer or that the boiler and hot water systems have high losses which lead to excessive waste.

For further information see:

EEO Fuel Efficiency Booklet 7. Degree Days

7.4 Adjusting energy use for weather

Once you know how weather conditions affect energy use, it is possible to allow for varying conditions. For example, it is possible to take account of the weather when comparing a building energy performance from year to year. Such comparisons show with greater accuracy the effect of any energy saving measures.

In order to adjust for weather it is necessary to know how much of the fossil energy is used for heating and how much is a steady base load. The base load can be estimated by looking at the monthly consumption of fossil energy as shown in section 7.2 or the graphs of fossil fuel against degree days as shown in section 7.3, and the rest is the energy used for space heating which varies with weather conditions.

8

CASE STUDIES

This section gives examples of buildings where energy saving measures have been implemented.

The use of the Performance Index calculation is also demonstrated, both for assessing how energy efficient a building is, and as a means of evaluating the improvement in energy performance resulting from the implementation of energy saving measures.

8.1 Ysbyty Gwynedd, Bangor

The District General Hospital for Gwynedd, Ysbyty Gwynedd was opened in 1984; it provides 535 beds for acute adult and child cases, as well as for geriatric and psychiatric patients. It has a floor area of approximately 37,000m² and a maximum of four storeys. It is situated on a highly exposed site.

Electrical Audit

An audit of electricity use at the hospital gave the breakdown shown in figure 8.1.

Figure 8.1 Electricity consumption

Although lighting is the largest single category, the good condition of the existing lighting systems and the relative high capital cost of changing them, meant that initial efforts were directed elsewhere.
Persistence, accompanied by well-engineered solutions to problems of energy waste, led to valuable savings through a number of successful, completed projects.

Lifts

Initially, the generator sets ran continuously regardless of lift usage and constituted a major waste, especially at night and other periods of low utilisation. A run-on timer has now been fitted on each of the eight generator sets to shut the machine down automatically if the lift is not called within twenty minutes.

Heating pumps

Initially the secondary heating pumps, which pump hot water to the individual heating circuits, ran continuously. The building energy management system (BEMS) now operates the pumps so that they are switched off when the outside temperature rises above a certain value.

A variable speed drive was fitted to the primary pump, which pumps water around the boilers. This controls the flow rate according to the demand for heat from the heating circuits.

Ventilation plant

Outside normal usage hours, the theatre ventilation rates and temperatures are reduced but override switches are fitted, for use in emergencies, to restore the full rates. To prevent the override switches being left on, as was often the case, an alarm switch was connected to alert the BEMS operator when the theatre ventilation plant was operating at full rate outside normal hours.

Chiller plant

A refrigeration plant serves the operating theatres and X-ray department. In the spring of 1989 an ambient temperature sensor was fitted to the chiller plant to take advantage of free cooling during the colder spring and autumn weather. This measure halved the running hours of the plant during the summers of 1989 and 1990.

Boiler house conversion

The main heating system was converted from using steam to hot water: this resulted in electricity savings as fewer pumps and fans were required.

Energy Performance

During the first years of operation, electricity usage was very high as a result of air conditioning for the operating theatres and X-ray department, and a generally high specification for other building services (ventilation plant, lighting and lifts).

The cumulative effect of the measures undertaken was to reduce electricity consumption between 1987 and 1990 such that the electricity performance index fell from 15.5 GJ/100m³ to 14.5 GJ/m³. This is in contrast to the rising trend elsewhere, that might otherwise have led to a rise of 25%.

For further information see:

EEO Good Practice Case Study 130 Ysbyty Gwynedd Hospital, Bangor.

8.2 Somerset Health Authority

In 1987 Somerset Health Authority (HA) embarked upon a programme aimed at reducing its annual energy bill of £2.1 million by 25% over a five year period whilst maintaining or improving on the standards of service and comfort required by the Department of Health. The target savings were to be achieved by the combination of good housekeeping measures, described here, and a parallel programme of capital investment in energy cost reduction projects.

The Somerset Health Authority Units referred to in this text are now operating as NHS Trusts. However, the practices described in this case study remain in operation.

The Good Housekeeping Programme

Initially, a policy statement set out the saving objectives and the methods to be used to achieve them. An Energy Management Group was set up for each of the three Units, consisting of members of the Unit Management team and chaired by the Unit General Manager.

Cost savings (£ thousands)			
1987/88	1988/89	1989/90	Cumulative
55	153	123	331

Senior management commitment

The visible commitment of senior management was seen as a vital element of the programme, to give it a permanent degree of authority rather than let it be seen as a temporary measure.

Each Unit General Manager chaired monthly meetings of their Energy Management Group. The Group examined energy performance information, reviewed the effects of new saving initiatives and directed future programme activities. Department heads received copies of the meeting minutes.

Energy Information

Using information from energy meters and regional degree day data, a comprehensive monitoring system was developed to provide energy consumption figures.

Targets were set for each site based on previous consumption information and known improvements made both by good housekeeping measures and by investment in energy cost reduction projects.

Energy Expertise

Each Unit had its own Energy Manager responsible for implementing the good housekeeping programme, developing and implementing capital projects and evaluating energy saving initiatives from staff.

Departmental Energy Monitors

Good housekeeping calls for attention to detail at the point of energy use and a close knowledge of departmental activities. For this reason, 'Energy Monitors' were appointed for each area. They were given the task of maintaining a watch on the day-to-day use of energy using equipment and identifying opportunities for savings.

Training

Departmental managers were informed about the energy cost reduction programme and the means by which it would operate.
Energy Monitors received training to enable them to understand the consumption and cost of running equipment and to assist them to understand cost saving opportunities. All new employees receive a brief introduction to the programme at their induction.

Publicity

The programme was publicised in a number of ways:

- Posters to promote ideas for reducing waste
- Handbook containing examples of wasteful practices
- An ideas scheme to encourage staff to submit ideas for cost saving, including competitions and prizes
- Colouring competitions, using energy posters, for children and patients
- End of year posters to tell staff of energy programme achievements.

Motivation

The programme aimed to motivate staff by arranging for the achieved revenue savings to be re-allocated to development funds and thereby contribute towards the provision of additional equipment and facilities.

Cost Savings

The table opposite shows the cost savings achieved. These savings are the difference between expected energy costs without savings initiatives and the actual energy costs.

For further information see:

EEO Good Practice Case Study 129 - Somerset Health Authority.

8.3 Hull Royal Infirmary

Hull Royal Infirmary is a 771 bed hospital which opened in 1960. It became part of a self governing trust in April 1993. The building consists of a variety of low rise buildings plus a fifteen storey reinforced concrete frame tower block.

Variable speed control of lifts

In 1989 the lift system was reaching the end of its life. It was decided to replace the original motor/generator sets with static converter drives, which convert the electrical supply to direct current for accurate speed and directional control of lifts.

Measure	Cost (£)	Savings (£)	Payback Period (years)
* Lifts	12,000	8,600	1.4
Lights	55,000	30,000	1.8
Ventilation plant	40,000	20.000	2.0
Boiler feedwater pumps	2,000	1,000	2.0
Combined heat and power	400,000	158,000	2.5
**Exhaust air heat recovery		7,000	

* Savings include energy and maintenance
**Savings are compared with conventional electric heating

The new system cost £12,000 more than would have been spent on a standard system. The investment was justified in terms of:

- reduced energy costs due to traffic handling improvements, more efficient regenerative braking and closer matching of motor power to lift duty
- shorter response times to lift calls
- reduced maintenance costs.

The reduced energy and maintenance costs resulted in a payback period for the extra investment of under 1 year.

Lights

The efficiency of lighting in wards, theatres, kitchen, staircases, corridors and stores was improved by:

- replacement of tungsten filament lamps with fluorescent tubes or compact fluorescent lamps
- installation of higher efficiency reflectors, mainly in stores areas
- installation of high frequency fluorescent tubes with manual dimming controls for adjustment of lighting levels in ward areas.

In addition, as wards are redecorated, lighter colours are used, thus reducing artificial lighting requirements.

Ventilation plant

The ventilation fan motors originally operated at a single speed. In 1989, inverter drives were fitted to all ventilation motors and linked into the building energy management system (BEMS). This enabled ventilation rates to be controlled according to demand, and allowed the ventilation to be switched off completely when not needed.

The ventilation plant that serves the theatres is now set to 60% of normal running speed when the theatres are not in use. Initial fears of contamination were overcome through a small amount of research and contact with other hospitals where similar measures were applied.

Variable speed motors

An inverter speed controller was applied to the feedwater pump that supplies the steam boilers. This enables the pump speed to be controlled to match the feedwater requirements.

High efficiency motors are also used to replace the more heavily used motors throughout the hospital when they reach the end of their life.

Heat recovery

Two heat pumps were installed to recover heat from the hospital ventilation extracts in order to supply heat to a new children's ward on the 12th and 13th floors. Gas and steam services were not available on these floors and direct electric heating would have required an uprated supply. The savings against direct electric heating were £7,000 per year.

Combined heat and power

In 1991 a combined heat and power (CHP) unit was installed. This has significantly reduced energy costs and carbon dioxide emissions.

Cost savings

The table illustrates the cost, savings and payback periods associated with the measures described above.

The measures resulted in the hospital's electricity consumption being reduced from 23,375 GJ in 1987/88 to 22,034 GJ in 1991/92, against a trend of rising electricity consumption elsewhere owing to increasing levels of equipment. The electricity performance index reduced from 12.2 GJ/100m^3 to 11.5 GJ/100m^3.

9

ADVICE AND HELP

9.1 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.

9.2 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).

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

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

3 Introduction to small scale CHP

51 Good housekeeping in the NHS. A guide for senior financial managers

52 Good housekeeping in the NHS. A guide for energy and estate managers

53 Electricity savings in hospitals. A guide for senior financial managers

54 Electricity savings in hospitals. A guide for energy and estate managers

60 The application of CHP in the health service

71 Selecting air conditioning systems

General Information Leaflets and Reports also give advice on how to implement energy saving measures. General Information Leaflets relating to health care buildings are:

1 The success of condensing boilers in non-domestic buildings. A user study

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 relating to health care buildings are:

40 Energy efficiency in hospitals: condensing gas boilers

129 Somerset Health Authority. Energy efficiency in hospitals by good housekeeping

130 Ysbyty Gwynedd, Bangor (Large acute). Reducing electricity consumption and costs in hospitals

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
2 Steam
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
14 The economic use of oil fired boiler plant
15 The economic use of gas fired boiler plant
17 The economic use of coal fired boiler plant

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

9.3 Other publications available from BRECSU

Energy Efficient Lighting in Buildings (1992). A THERMIE Maxibrochure

9.4 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, building societies 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)

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 from the EEO.
Tel: 071 276 6200

Guidelines for Contract Energy Management in the Public Sector. Available from the EEO
Tel: 071 276 3777

9.5 Other EEO Programmes

Making a Corporate Commitment Campaign

The 'Making a Corporate Commitment' campaign seeks board level commitment to energy efficiency. It encourages directors to sign a Declaration of Commitment to responsible energy management, prepare a business plan for energy efficiency and ensure that it becomes an item that is considered regularly by their main board.

Publications:

Chairman's Checklist
Executive Action Plan
Energy, Environment and Profits - Six case studies on corporate commitment to energy efficiency.

Further information is available from the Campaign Offices on 071 276 4613.

Energy Management Assistance Scheme

The Energy Management Assistance Scheme may provide support for small and medium sized businesses (up to 500 employees) to employ an energy consultant. This aims to upgrade the expertise in energy efficiency among smaller companies, and tackle the capital priority barrier through financial support.

Further information can be obtained on 071 276 3787.

9.6 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

9.7 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 over 500m² gross area.

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 aimed at demonstrating energy efficiency measures and encouraging energy efficiency R&D. Details change periodically. For further information contact BRECSU for buildings and ETSU for industry.

9.8 Other Publications and Organisations

1. Publications from the 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 Applications Manual, AM3:1989, Condensing Boilers

CIBSE Applications Manual, AM8:1992, Private and Standby Generation of Electricity

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

2. **ENCODE,** Department of Health

Volume 1 illustrates the magnitude of potential savings and gives a checklist of typical energy saving measures. It also contains sections on survey and auditing methods, planning a programme and measuring effectiveness.

Volume 2 provides detailed guidance and information on good housekeeping, standards, retrofit practices for the building fabric and mechanical and electrical services. It also contains guidance on building energy management systems (BEMS), finance, training and a technical reference section. Revised March 1994.

ENCODE Vol.1 (ISBN 0 11 3214162) and Vol.2 (ISBN 011 3210779) are available from HMSO Publications Centre, PO Box 276, London SW8 5DT.

3. Other publications from NHS Estates:

A strategic guide to energy management for General Managers and Chief Executives

A strategic guide to combined heat and power for General Managers and Chief Executives

Available from:
NHS Estates, Department of Health,
1 Trevelyan Square,
Boar Lane, Leeds LS1 6AE
Tel: 0532 547000
Fax: 0532 547299

4. Combined Heat and Power Association, Third Floor, Grosvenor Gardens House, 35/37 Grosvenor Gardens, London SW1W OBS.
Tel: 071 828 4077.

5. The Audit Commission:

NHS Energy Management Audit Guide, January 1991. Produced by the Audit Commission for local authorities and the National Health Service in England and Wales.

Saving Energy in the NHS: Audit Commission Occasional Paper No 2. HMSO 1991. ISBN 0118860496.

Available from:
The Audit Commission
Tel: 071 828 1212.

6. Energy Systems Trade Association (ESTA)
PO Box 16, Stroud, Gloucestershire
GL5 5EB
Tel: 0453 873568
Fax: 0453 872334

7. 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. 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 buildings. It describes the effect of weather, building occupancy and exposure on the performance of a building, with a method to allow for weather and exposure 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.

Figure A1.1
CO_2 Performance Index Calculation

	Column 1 Annual energy use GJ/100m³	Column 2 CO_2 conversion* factors kg/GJ	Column 3 Annual CO_2 emissions kg/100m³
Gas		x 56	
Oil		x 81	
Coal		x 89	
Electricity		x194	
Total CO_2 emissions per 100m³			

*typical 1993 emission factors

Figure A1.2
Cost Performance Index Calculation

	Column 1 Annual energy use GJ/100m³	Column 2 Cost conversion* factors £/GJ	Column 3 Annual cost £/100m³
Gas		x 2.2	
Oil		x 1.9	
Coal		x 2.0	
Electricity		x 13.9	
Total energy cost per 100m³			

*typical 1992 prices

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 or combined heat and power (CHP). 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 in 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 GJ/100m³ figure in Column 1, and multiply by the relevant conversion factors in column 2 to get either the kg of CO_2 per 100m³ or the cost per 100m³ in column 3.

The conversion factors shown are broadly representative of the current fuels used in hospitals, 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 own 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 presented 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, or in air conditioned buildings where the cooling energy will be higher during a warm summer.

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

The yardsticks are for buildings or sites with a typical range of activities, most of which are 24 hours. On some sites a proportion of the building(s) will be for administration and day clinics which operate during the daytime only. If these form the majority of the building or site, the yardsticks will not be applicable.

Normalised performance indices

It is possible to adjust (normalise) performance indices for weather and exposure, but care is needed as incorrectly applied adjustments, or adjustments that are too simplistic, may introduce larger errors than the typical variations discussed above.

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 overleaf can be used to obtain performance indices which are normalised to standard conditions of weather and exposure.

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 energy cost is obtained by using figure A1.1 or A1.2 and inserting the normalised performance indices 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.

Figure A1.3 Carbon dioxide and cost yardsticks

CO_2 Performance Assessment

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

Overall CO_2 yardstick — Type of health care building	Yardsticks in kg CO_2/100m³	Yardsticks in kg CO_2/100m³
1. Small acute hospital (<25,000m³)	4,200	5,600
2. Large acute hospital (>25,000m³)	5,000	5,900
3. Long stay hospital	4,100	4,900
4. Nursing/residential care home	4,200	5,200

Cost Performance Assessment

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

Overall cost yardstick — Type of health care building	Yardsticks in £/100m³	Yardsticks in £/100m³
1. Small acute hospital (<25,000m³)	200	270
2. Large acute hospital (>25,000m³)	250	290
3. Long stay hospital	200	240
4. Nursing/residential care home	200	250

CO_2 and cost yardsticks are based on factors on page 24

- 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 A1.4 Normalised Performance Indices calculation

	Gas	Oil	Other		Total of Fossil Fuels	Electricity
	Fossil fuel					
Total energy consumption (GJ)				(A)		
Space heating energy (GJ)				*(B)		
Non space heating energy (GJ)				A-8 = (C)		
Find the degree days for the energy data year				*(D)		
Weather correction factor = 2462 ÷ D =				(E)		
Obtain the exposure factor below				*(F)		
Annual heating energy use for standard conditions				BxExF = (G)		
Normalised energy use = C + G =				GJ (H)		
Find heated volume				m^3 (J)		
Find the Normalised Performance Indices = (H ÷ J) x 100 =				GJ/100m^3 (K)		

*Notes:
(B) Estimation of weather-dependent heating energy use is discussed in section 7.
(D) For degree day information, see Fuel Efficiency Booklet 7 - Degree Days
Monthly degree day figures are published in 'Energy Management' (see section 9.4) and are also available from NHS Estates (see section 9.8)
(F) Exposure factors from the following table.

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

APPENDIX 2

Energy Conversion Factors

The SI (System International) unit of energy is the joule. The unit of energy used in this guide is the gigajoule (GJ), equivalent to 1,000,000,000 joules. For fuels which are metered in other units, multiply the metered value by the relevant conversion factor from the following table to obtain the value in GJ.

Figure A2.1 Conversion to GJ

	GJ conversion	
Light Fuel Oil	0.040	GJ/litre
Medium Fuel Oil	0.041	GJ/litre
Heavy Fuel Oil	0.041	GJ/litre
Gas Oil (35 second)	0.039	GJ/litre
Kerosene - burning oil 22 second	0.037	GJ/litre
Electricity	0.0036	GJ/kWh
Natural gas	0.105	GJ/therm
Liquid Petroleum Gas (LPG) (Propane)	0.025	GJ/litre
Coal (washed shingles)	28.4	GJ/tonne
Coal (washed smalls)	28.1	GJ/tonne

BEST PRACTICE PROGRAMME

Energy Efficiency Office

DEPARTMENT OF THE ENVIRONMENT

Published by the Department of the Environment.
Printed in Great Britain on environmentally friendly paper. March 1994.
93EP672.