Introduction to Energy Efficiency in Shops and Stores

BEST PRACTICE PROGRAMME

Energy Efficiency Office

DEPARTMENT OF THE ENVIRONMENT

CONTENTS

SECTION		PAGE

1

INTRODUCTION

1.1 Who this guide is intended for

This guide is aimed at those responsible for energy in an estate of retail premises. In smaller organisations this may be the property manager and in larger organisations the corporate energy manager. The guide may also be of use to a manager of an individual store and can also form the basis of material to be distributed to Store Managers.

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 these 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. This guide is not applicable to head office buildings, which are covered by the Guide on offices.

- 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 your estate or building.
- The case studies (section 8) give examples of stores 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.

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 larger controllable outgoings in running retail 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 customers and staff. This can give rise to better productivity and increased sales.

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:

ASDA Stores Ltd

BhS plc

Budgens Stores Ltd

Building Energy Solutions

HMV UK Ltd

The Littlewoods Organisation plc

Nationwide Building Society

J Sainsbury plc

Sears plc

W H Smith Ltd

2

ENERGY MANAGEMENT

2.1 Energy efficiency - a management issue

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

- 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.
- In organisations with an estate of buildings, energy efficiency should be managed centrally.
- Each building should also have someone responsible for energy management.
- 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 responsible for an estate of buildings are outlined in this section. Section 3 includes a suggested action plan which can be used to get things moving.

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

2.2 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.

An M&T system should:

- Record energy consumption and any other factors that affect energy use (building usage, weather, turnover, etc).
- Compare a site's energy use to previous years, to other buildings in the estate, 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. In larger department stores and supermarkets, consideration should be given to sub-metering by floor or major load, such as refrigeration, in order to target areas for action.

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

2.3 Getting on the right tariffs

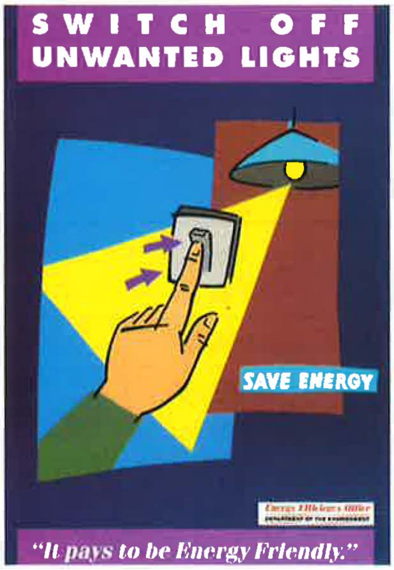
Making sure that fossil fuels and electricity are purchased at the cheapest rates is increasingly important. Considerable cost savings are sometimes possible by changing to more suitable tariffs for electricity, or by making alternative supply arrangements.

It may also be possible to reduce energy costs by negotiating single purchase agreements for all the buildings in an estate.

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.
- Check that the supply capacity for electricity at each site (the agreed maximum available supply charged as shown on your electricity bill) is not excessive compared to the existing or expected maximum demand.
- 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 9.9).

Energy Efficiency Poster



For further information see:

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

2.4 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 unnecessary lighting left on all night. Other waste may be more difficult to identify and take more expertise or resources to correct (see section 4).

If you are a central energy manager, you will be responsible for many separate locations. For large estates, savings can be maximised by employing energy saving measures and initiatives which can be widely applied across the majority of premises. These measures should be easy to implement, manage and follow up.

A good working knowledge of the estate is required to identify these measures. This can be gained by:

- Visiting sites and then considering a programme of standard energy surveys
- Reviewing building services specifications
- Talking with refurbishment design staff, consultants and maintenance and other contractors.

Your first priority should be to establish a comprehensive and reliable M&T system and have good site information. The most suitable stores for energy surveys can then be identified by producing a league table of performance indices (see section 6) and starting with the worst performers.

For more complex measures, conduct trials at selected sites to establish payback periods and installation and operating parameters, such as the best location for equipment and the optimum control settings.

2.5 Interaction with other groups in the organisation

Guidelines showing the cost and environmental benefits of energy conservation together with a package of information explaining simple energy saving measures should be disseminated to each store. In large organisations it will be impracticable for the Energy Manager to liaise directly with each store, and the existing management structure should be utilised. For example: Energy Manager → Regional Manager → Store Manager → store staff.

In organisations with smaller estates, you may find it possible to deal directly with each site.

You should ensure that someone is responsible for energy management in each building, ideally the Store Manager, and provide training through seminars and literature. Literature might include checklists such as the one in section 4.1. Managers' responsibilities would include:

- Briefing all store staff on how to operate controls
- Undertaking walk arounds to identify avoidable waste
- Acting as an interface between store staff and the central energy manager for comments reflecting dissatisfaction and suggestions for energy saving measures.

2.6 Motivating staff

The greatest possible savings can only be achieved with the cooperation of staff throughout a site or organisation. Foster their support and give staff every chance to participate in energy saving initiatives. Feed back information to staff on the results of these initiatives.

The primary motivation for Area and Store Managers will be the financial benefits to area/store operating performance. Set targets and produce league tables of performance trends within an area or similar stores. This may provide an additional incentive to Store Managers through peer competition. Store staff may be motivated more by the environmental benefits and the improved levels of comfort.

Awareness and motivation can be further raised by energy and environmental messages from senior management using staff magazines and videos and by the production of company posters, stickers and leaflets.

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.

2.7 Refurbishment and new construction

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

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

When moving or refurbishing premises, take the opportunity to select or specify:

- Energy targets
- The type of accommodation - for example, the inclusion of full or partial air conditioning may double overall energy costs
- Systems which are suitably simple and within the capabilities of the occupants to manage
- Fossil fuel rather than electric heating where possible
- High efficiency of major plant and equipment such as boilers, refrigeration or main lighting systems
- 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 34 - Energy efficient options for new offices - for the design team.

EEO Good Practice Guide 35 - Energy efficient options for refurbished offices - for the design team.

EEO Good Practice Guide 71 - Selecting air conditioning systems.

2.8 Getting help

Refurbishment offers a rare opportunity to incorporate many energy efficiency measures.

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. For organisations with less than 500 employees the EEO's Energy Management Assistance Scheme (EMAS) may offer financial help towards energy consultants' fees (see section 9.5).

If the availability of finance and management time is a problem for opportunities requiring substantial investment, contract energy management (CEM) organisations may provide a solution - they offer a comprehensive service including finance and management responsibility. ESTA can provide a list of companies (see section 9.9).

For further information see:

Choosing an Energy Efficiency Consultant (EEO).

ACTION PLAN

This flow diagram presents a step by step procedure to achieve cost savings in an estate of buildings 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.

1. Confirm who is responsible for energy management (it may be you) and seek senior management support
2. Establish a system for recording and assessing billed energy consumptions at each site — See section 2.2
3. Check fuel and electricity tariffs and change where appropriate — See section 2.3
4. Consider technical and management responsibilities — See section 2.4 - 2.5
5. Organise initial 'walk arounds' of all the premises to identify avoidable waste — See section 2.5 & 4.1
6. Assess energy performance of all the sites in the estate and construct league tables based on energy performance — See sections 5 and 6 for building performance index
7. Undertake energy surveys starting with those sites that have high energy consumption — See section 2.4
8. Plan and implement identified energy saving measures, obtaining advice when appropriate — See section 4.3
9. Plan and implement a programme of motivating staff and encouraging good practice — See section 2.6
10. Review progress, assess and publicise savings and revise plans

Ongoing energy management (from step 10 back to step 7)

MEASURES TO ACHIEVE ENERGY SAVINGS

4.1 Initial measures

In most 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 customers.

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 cooperation of staff. Motivating staff to help is therefore important, although a long term task. The list below indicates the type of items to check in an initial assessment of 'good housekeeping' opportunities. An exercise to review energy purchasing tariffs (see section 2.3) should be carried out at the same time.

Checklist of Initial Energy Saving Measures

Space and water heating

- Consider fuel switching (if your boiler(s) can operate using more than one fuel).
- Check that time switches are set to the minimum period and ensure that room thermostats and radiator controls are on minimum settings commensurate with comfort conditions.
- Consider reducing store temperatures where possible; in winter, customers wearing outdoor clothing can find stores too hot for comfort.
- Set temperatures in DIY stores to the minimum required for staff comfort.
- Ensure that only occupied areas are heated, and that heating is off or reduced in non-working hours.
- If you have a building energy management system (BEMS), check that it is operating correctly and ensure that operators are trained to use it effectively.
- Reduce temperature of stored domestic hot water by turning down the thermostat to a minimum of 60°C, but no lower because of the risk of Legionella.
- Make sure that pumps are running only when required.

Lighting

- Ensure that someone is responsible for switching off in each room or area when not in use. Label or colour code light switches to assist this.
- Make the best use of daylight in non-sales areas by keeping windows and roof lights clean and by using working areas near windows where possible; encourage staff to turn off lights when daylight is good.
- Turn off display lighting outside opening hours.
- Use reduced lighting levels for cleaning and shelf stocking periods if possible.
- Ensure that display lighting is not left on when the associated displays are removed.

Ventilation

- Ensure the main ventilation plant and toilet extractor fans are switched off outside occupancy hours.
- Ensure kitchen fans are switched off when no cooking is taking place and that restaurant area ventilation is turned off out of opening hours.
- If a warm air curtain is provided over the main doors, ensure it only operates in winter months when the doors are open.
- Ensure door closers operate effectively and that main doors are not jammed open during hours of use (this is important in summer as well as winter if the store is air conditioned).

Air conditioning

- Set temperature controls for cooling to 24°C or higher - lower settings require more cooling energy and may be 'fighting' the heating.
- Where the design permits, ensure heating and cooling are not on at the same time in the same part of the building (the advice of a consultant or on site services engineer may be needed). For example, ensure that the controls of any ceiling cassettes are set so that cassettes do not provide heating and cooling in the same space simultaneously.
- Make sure that refrigeration plant such as chilled water systems do not run unnecessarily.
- Ensure that fans and pumps do not run when not required.

Refrigeration

- Minimise defrost cycles and ensure defrost is effective.
- Fit insulated night blinds to freezer cabinets and insulated covers to chest freezers, and ensure they are used.
- Ensure the doors to walk in freezer store rooms are not opened unnecessarily and are not wedged open during restocking periods.

Controls

- Ensure all controls are labelled to indicate their function and, if appropriate, their new reduced settings.
- Establish responsibilities for control setting, review and adjustment.

Building fabric

- Ensure that goods doors are kept closed when not in use.
- Ensure all insulation is in a state of good repair.

Office equipment

- Encourage staff to turn off office equipment when it is not being used, particularly at lunchtime and at the end of the working day.

4.2 Maintenance

Regular maintenance is a prerequisite to controlling energy costs and is also essential for maintaining a healthy environment in buildings.

Maintenance contractors can be a useful source of information about buildings and services. If suitably qualified, they can also be used cost effectively to undertake brief energy surveys and to install simple energy saving measures.

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
- Service refrigeration equipment regularly
- 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
- Check time and temperature settings of electric panel and storage heaters
- Service the boiler plant and check combustion efficiency regularly
- Look for water leaks and carry out repairs where necessary
- Clean windows to maximise daylighting
- Replace 38mm diameter fluorescent tubes in switch start fittings with 26mm diameter high efficiency triphosphor tubes as the former expire (see diagram on page 10)
- 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
- Refrigeration 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
- Widely applicable across the estate
- 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
8 The economic thickness of insulation for hot pipes
10 Controls
11 The economic use of refrigeration plant
12 Lighting

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 moving, 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 using natural ventilation rather than 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 2.8.

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.

LIGHTING

Lighting is one of the largest energy costs in most retail stores, 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.

The use of lighting for effective and efficient display of retail products is a complex subject. The larger lamp and light fitting manufacturers can provide useful advice and demonstrations of how lighting can be used for this purpose. It may also be worth seeking advice from a professional lighting consultant.

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; an increasing range of compact flourescent downlighters is available including some that are suitable for display lighting
- 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 high ceiling buildings such as DIY stores and large areas such as car parks.

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

Photographs supplied by Philips and Fitzgerald.

Figure 4.1 Typical relative energy consumption

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

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 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%.

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 other 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.

Compact fluorescent lamps

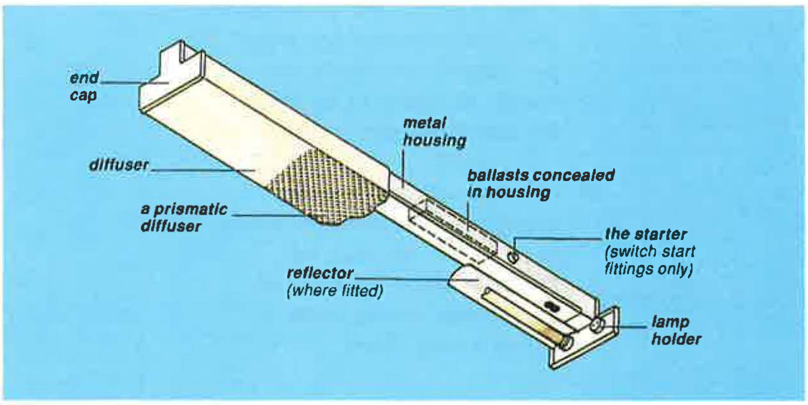
Lighting controls should be used to ensure that, as far as possible, lights are off when they are not needed.

Lighting controls include:

- Manual control - it should be possible to control all lights manually, whatever automatic controls are also used
- 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 spotlights with compact fluorescent lamps or low voltage tungsten halogen lamps. The choice of replacement lamp will depend on the application.
- In non food stores, department stores, small food stores and supermarkets consider installing 26mm triphosphor fluorescent tubes for general sales area lighting if it is not already in use.
- In DIY warehouses, where ceilings are high and the lighting may not have to be of the same quality as in other types of retail store, consider using high pressure sodium lamps as the main lighting source in sales areas.
- 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.
- 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, so that staff can control local lighting levels
  - time controls which, for example, switch off at the end of the day (ensure lights are switched off in stages)
  - time controls or daylight detection controls for external lighting
  - presence detection controls for areas which are infrequently used, such as storage rooms.



The parts of a fluorescent light fitting

HEATING

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.

Boiler systems

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

Electric systems

Electric heating can be provided by panel, storage or fan coil heaters or by electric heat pump. Due to the significantly higher cost of electricity, panel and storage heaters are more suited to smaller dispersed rooms, or in premises where gas or oil is not available. Storage heaters make use of cheaper night rate electricity, if metered, but are less easily controlled and are therefore less efficient. Electric heat pumps allow one unit of purchased electricity to provide one to three units of heating, but their running costs still tend to be higher than fossil fuelled systems. Reverse cycle heat pumps always provide cooling as well as heating and are usually installed where there is a need for cooling.

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. Some heaters are fitted with individual time switches.
- 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. Some heaters are fitted with their own air thermostat.
- Boiler sequence control: enables only the number of boilers required to meet the system demand.

The 1990 Building Regulations specify that new non-domestic buildings should have time and temperature controls, and that large buildings should also have optimum start and boiler sequence controls.

HEATING MEASURES

- Separate the heating system into zones so that areas of the building with different heating requirements can be controlled separately.
- In large volume areas with high ceilings, such as warehouses and DIY stores, use direct fired gas radiant heaters to heat occupants rather than the space. Alternatively, use high velocity warm air systems in areas with high bay racking.
- Upgrade heating controls - in larger stores controls should include a seven day programmable timer, and weather compensation of any heating circuits and optimum start control; smaller stores may only justify a seven day timer and thermostat.
- 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.
- Install a heater other than the main boiler to produce domestic hot water, and turn off the main boiler during the summer.
- Install temperature and time control of electric panel and storage heaters.
- Fit weather compensation control to the heat input of electric storage heaters.

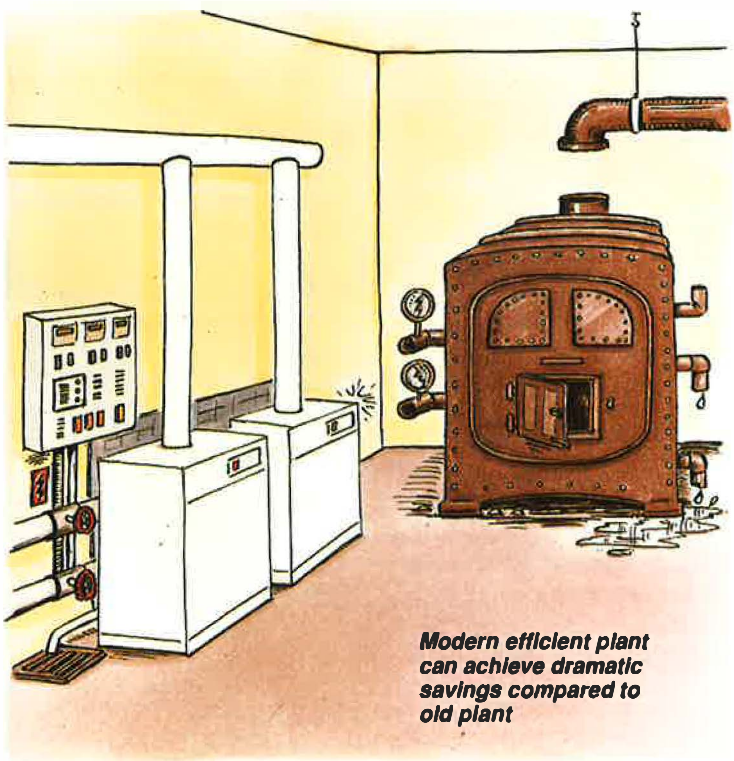
MECHANICAL VENTILATION AND AIR CONDITIONING

Air conditioning can be the largest single user of energy in stores which are fully air conditioned. Improving its control and operation may provide significant savings.

Central mechanical ventilation provides air which is filtered and if necessary heated. Full air conditioning additionally provides cooling and humidity control. Partial air conditioning allows local environmental conditions to be met without the capital and running costs of full air conditioning.

Cooled air can also be provided locally by ceiling-mounted cassette or locally-ducted units which recirculate room air.

Cooling is usually provided by



Modern efficient plant can achieve dramatic savings compared to old plant

electrically driven refrigeration equipment or reverse cycle heat pumps that can also provide heating. 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.

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

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.
- Check the location of temperature sensors and controllers for cassette units and relocate if they are not effectively controlling the units to provide the required conditions.
- 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 replaced or specified, use ultrasonic humidification (but ensure that 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.

REFRIGERATION

Where refrigerators are used for storing food produce, the electrical energy used by the refrigeration equipment is normally a significant percentage of the total energy used in the store.

Compressors are the main consumers of power in a refrigeration system. They should be sized to match the cooling load and, where significant load variations can occur, it should be possible to match the compressor capacity to the load as closely as possible.

Refrigeration plant always generates heat and where possible this heat should be recovered and used by either domestic hot water or space heating systems.

REFRIGERATION MEASURES

- Insulate all pipework, valves and flanges that carry refrigerant and cooling water.
- Consider centralising refrigeration plant for similar cooling applications such as chilling or freezing.
- Where self contained refrigeration units are in place use the waste heat to heat the sales floor where the units are located.
- Recover the waste heat from centralised refrigeration plant and use it in the hot water service system or space heating system.
- On larger new systems use inverter drives for the compressor motors to match output to load.
- On existing systems install motor controllers to match output to load more closely.

For further information see:
EEO Good Practice Case Study 27 - Compressor Motor Controllers on Refrigeration Plant

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.

BUILDING FABRIC MEASURES

- Insulate roof voids.
- Install automatic door closure devices.
- Insulate goods doors.
- Draught proof around windows and doors.
- Fit secondary glazing.
- Install cavity wall insulation or internal or external insulation.
- If windows are being replaced, fit multiple glazing, preferably with low emissivity glass which reduces heat loss in winter.

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.

ENERGY USE IN RETAIL PREMISES

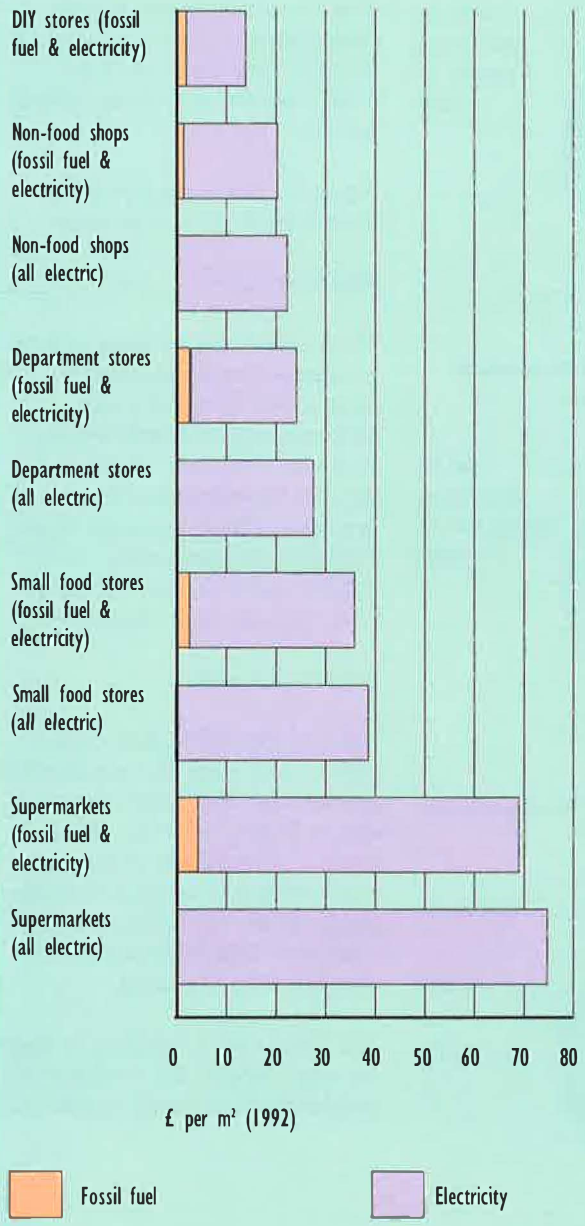
5.1 Why analyse building energy use?

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 in an estate or group of buildings 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 helps to concentrate attention on priority areas, especially where the use of one of the fuels is particularly high.

Figure 5.1 Typical annual energy costs



5.2 Types of building and their energy use patterns

The buildings covered in this Guide have been categorised as follows:

- DIY stores with a fossil fuel and electricity supply
- Non-food stores with a fossil fuel and electricity supply
- Non-food stores with electricity only
- Department stores with a fossil fuel and electricity supply
- Department stores with electricity only
- Small food stores with a fossil fuel and electricity supply
- Small food stores with electricity only
- Supermarkets with a fossil fuel and electricity supply
- Supermarkets with electricity only.

Typical annual energy costs of the nine types are shown in Figure 5.1. The graph shows that typical energy costs are slightly greater for all-electric buildings than for buildings that use both fossil fuel and electricity. It is generally more expensive to use electricity for space heating than to use a fossil fuel such as gas or oil.

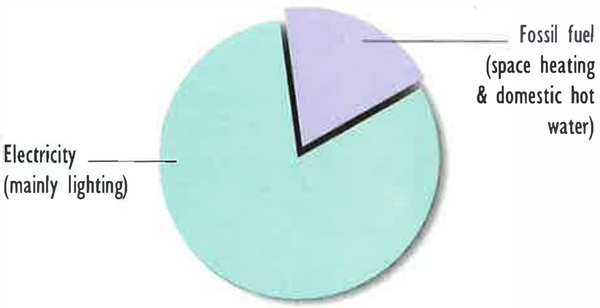


Figure 5.2 Typical energy cost breakdown for DIY stores

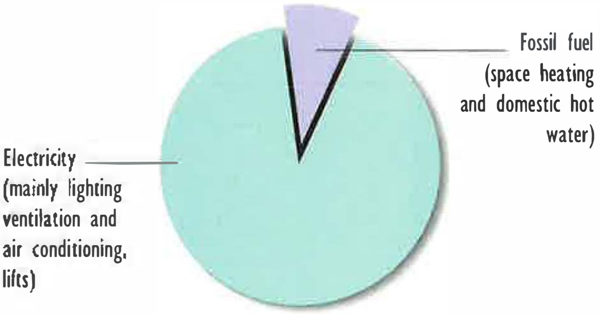


Figure 5.3 Typical energy cost breakdown for non-food stores with a fossil fuel and electricity supply

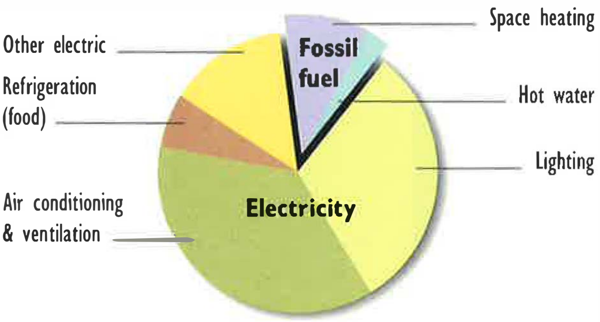


Figure 5.4 Typical energy cost breakdown for department stores with fossil fuel and electricity supply

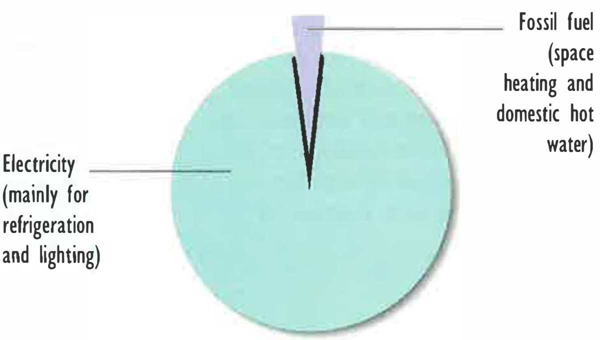


Figure 5.5 Typical energy cost breakdown for food stores with a fossil fuel and electricity supply

DIY stores

These are usually large buildings, away from town centres, selling DIY products. They often have high ceilings and therefore a large internal volume.

Figure 5.2 shows the typical cost breakdown for DIY warehouses.

Non-food stores

These include a wide range of types of high street premises including those selling electrical goods, hardware, footwear, and clothing, books and stationery. These shops may also be within covered shopping malls or precincts. Figure 5.3 shows the energy cost breakdown for shops with both a fossil fuel and electricity supply.

Department stores

These are large town centre shops selling a wide range of mostly non-food products, and often occupying several storeys. Figure 5.4 shows a typical energy cost breakdown for department stores with a fossil fuel and electricity supply. Stores with electricity only would have a similar breakdown of electricity costs by end use.

The 'Other electric' category in figure 5.4 would include lifts, escalators and possibly staff and public restaurants.

Small food stores

These are stores which primarily sell food products. The energy consumption of food stores can vary considerably depending on the range of food products sold. Figure 5.5 shows the typical energy cost breakdown for a mini-market with a fossil fuel and electricity supply selling products that include refrigerated and frozen food.

For food stores with little or no refrigeration, space heating will represent a much larger proportion of the overall energy costs.

Supermarkets

These are large self service food stores, but increasingly stocking a range of non-food products. Larger supermarkets sometimes include on-site bakeries and restaurant facilities. Figure 5.6 shows a typical energy cost breakdown for supermarkets. The breakdown is representative of both supermarkets which have electricity only or which have a fossil fuel and electricity supply.

The consumptions of energy for different purposes in any one building may be significantly different from the typical breakdowns given in figures 5.2 to 5.6.

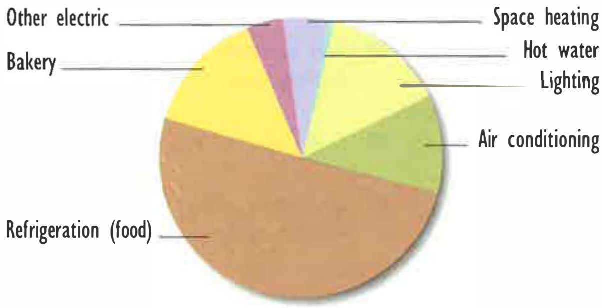


Figure 5.6 Typical energy cost breakdown for supermarkets

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. For all-electric buildings a single performance index is calculated.

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

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 sales floor area of the building in column 4.
4. Divide the energy use of each fuel by the floor area to get energy use per unit area (kWh/m²) in column 5.
5. Add the fossil fuel figures together to get a fossil fuel index - the electricity figure can be used directly.
6. Compare the indices with yardsticks for the building type in figure 6.2 to give an energy performance assessment.

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

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.

Floor area information.

The measure of floor area used to standardise energy consumption is sales area. Exclude completely staff rooms, staff restaurants, offices, toilets, plant rooms, storage areas, etc. If floor area is available as ft², convert to m² by dividing by 10.76.

Figure 6.1 Energy Performance Index Calculation

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

Note * for kWh conversion factors see Appendix 2

Figure 6.2 Energy Consumption Yardsticks

Performance Assessment

	Low consumption Less than	Medium Consumption Between	High consumption Greater than
	Yardsticks in kWh/m²	Yardsticks in kWh/m²	
Buildings with a fossil fuel and electricity supply			
DIY stores			
Fossil fuels	150	195	
Electricity	130	160	
Non-food shops			
Fossil fuels	80	130	
Electricity	200	260	
Department stores			
Fossil fuels	150	220	
Electricity	240	290	
Small food stores			
Fossil fuels	80	100	
Electricity	400	500	
Supermarkets			
Fossil fuels	160	290	
Electricity	670	920	
Buildings which are electrically heated			
Non-food shops			
Electricity	230	300	
Department stores			
Electricity	290	370	
Small food stores			
Electricity	440	550	
Supermarkets			
Electricity	750	1050	

There may be exceptional reasons to explain a low or high consumption. For example, a store may have a low consumption because it is naturally ventilated, or a high consumption because it has full air conditioning.

Even a building with a low consumption may have opportunities for cost-effective improvement. This is particularly relevant in supermarkets with heat reclaim from refrigeration plant, where this will reduce heating energy requirements and possibly hide inefficiencies in the heating system.

The indices show which fuel requires the most attention. Section 4 then shows possible energy saving measures for each energy use. The next step is to select and progress suitable measures.

6.3 Overall yardsticks

Overall yardsticks based on carbon dioxide (CO_2) emissions or the cost of energy per m² of floor area 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.

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 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.

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.

This section is applicable mainly to buildings with both a fossil fuel and electricity supply. All-electric buildings are much more difficult to analyse.

7.2 Monthly energy use

You can ask your supplier for monthly fuel data, or ask the building manager to take monthly meter readings.

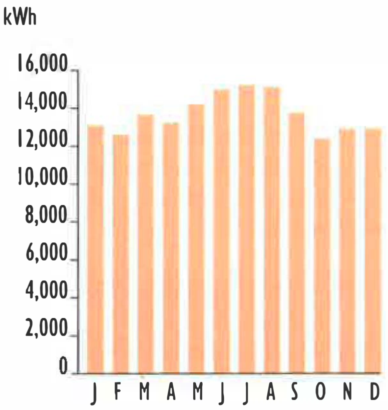
Larger sites have monthly energy bills. By looking at how these vary with the seasons some valuable insights can be obtained. Produce a monthly consumptions bar chart plot for each energy source over a year.

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

The seasonal variation in electricity will depend on the level and type of services in the building.

Electricity consumption should decrease during 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.

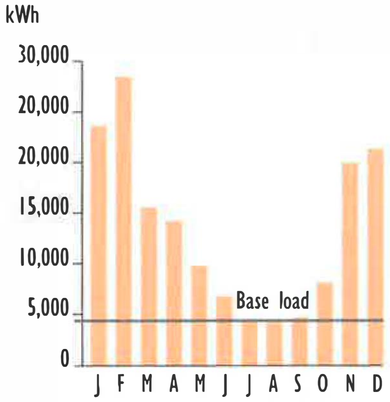
Example monthly electricity use



The figure above shows monthly electricity consumption for an air conditioned building with fossil fuel heating. It shows a small increase in the summer months as the cooling load increases. In a building which is heated by a fossil fuel and which has no air conditioning, a small increase in electricity use in winter may be due to increased lighting or some electric heating. However, an all-electric building with air conditioning would probably have a fairly constant monthly electricity consumption owing to cooling in summer and heating in winter.

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.

Example monthly fossil fuel use



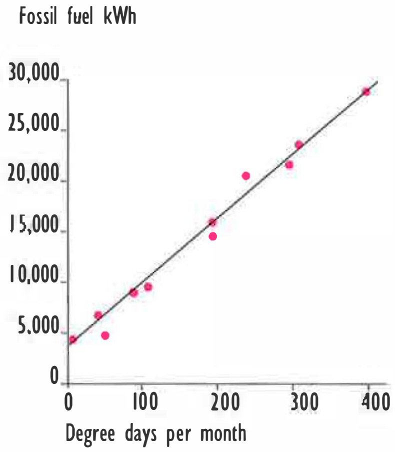
The figure above shows the monthly fossil energy consumption of a fairly efficient building which has a central boiler system for heating and hot water - the summer usage is much lower than winter usage and is at a fairly steady 'base load' level which suggests that the heating is off, though it is useful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

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 consuption is related to weather. Monthly figures for degree days for different areas of the country are published in the EEO's free bimonthly magazine 'Energy Management' (section 9.4).

Example monthly heating energy use in a well controlled building

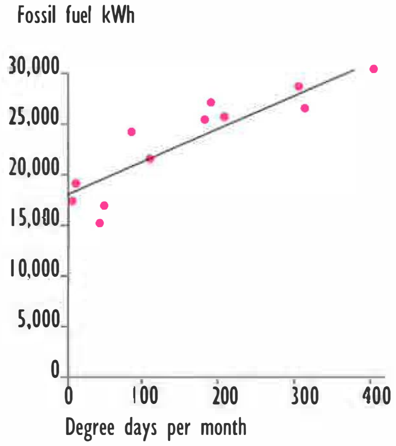


The building represented above has a well controlled heating system shown by the close fit of the points to the straight line. As the weather gets colder the energy used goes up proportionally. For this building the energy consumption falls to a small value in summer when only hot water is being provided.

The same plot can be drawn for electricity use in an electrically heated building as long as it is not air conditioned to any significant degree. The consumption in summer will reflect lighting, refrigeration, small power and electric domestic hot water use.

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. 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 or electricity 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 or electricity as shown in section 7.2 or the graphs of fossil fuel or electricity against degree days as shown in section 7.3, and the rest is the energy used for space heating which varies with weather conditions. These plots will not give you the proportion of electricity used for space heating in an all-electric building with air conditioning. In this situation an estimate would often have to be made (see figure A1.4 in Appendix 1).

CASE STUDIES

This section gives examples of organisations which have implemented a central energy management policy, and briefly reviews some stores 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 Sears plc

Sears has signed up to the EEO's Making a Corporate Commitment campaign. Sears' estate is managed by Sears Retail Properties Ltd, which incorporates an energy management team. The team has set up a monitoring and targeting system which allows it to:

- Present summary energy consumption data to regional managers - energy is included in the monthly profit-and-loss report sent to each Store Manager, providing an incentive to keep energy costs to a minimum
- Highlight stores with high energy consumption so that action can be taken to reduce it.

The team also provides a central tariff analysis and energy purchasing function for the Group, and ensures that improvements to energy efficiency are included in store refurbishment programmes.

Saxone, Birmingham Branch

Saxone is one of several shoe retail chains controlled by Sears. The Birmingham branch of Saxone occupies a four storey building and employs five full-time and around 45 part-time staff.

In common with many retail outlets, the store has all-electric building services. Tempered ventilation air is supplied from a roof-top plant room and paid for as part of the service charge to the building landlord. It is thus excluded from energy consumption figures. Otherwise, services comprise split system, cassette-type air conditioning equipment on all floors, small convector heaters in storage areas, over door heaters and general and display lighting.

The refurbishment of an ageing electrical system provided an ideal opportunity to improve poor controls and the energy efficiency of the building's systems.

New control system

A new, key-operated "energy management panel" allows staff to switch lighting and other services according to the activities being carried out. The new control regime defines three modes of operation for the store.

- The "night" mode allows essential security lighting and business equipment to be left on overnight.
- "Keyswitch" mode covers times when staff are present at the store before and after trading, when general fluorescent lighting and the heating and ventilation plant is needed.
- The system is automatically switched to "trading" mode when the store is open for business and full window and display lighting is required, together with over door heaters.

In the morning the system is switched from night mode to keyswitch mode. A few minutes before the store is open to shoppers timers switch the lighting to trading mode. At the close of business, the timers switch back into keyswitch mode. The last member of staff to leave switches the system from keyswitch to night mode. This approach is a big improvement to the previous system which relied on banks of switches on all four floors, some of which were often left on overnight.

"We find that keeping the system simple is best for staff and gives excellent savings", says the Engineering Services Manager.

The control panel cost £5,400 to install and paid for itself in electricity savings in under a year.

Lighting

Window and display lighting was upgraded from tungsten filament lamps to more efficient low voltage tungsten halogen lamps using the same tracks. This has also improved lighting levels in the store.

Door heaters

Tamper-proof room thermostats were installed to control the over door heaters which had previously been on continuously. The thermostats were located away from the main warm airstream so as to measure the actual temperature of the area at the front of the store. The new controls have improved comfort levels and reduced energy costs.

Energy savings

This package of measures has reduced annual electricity consumption from 493 to 325 kWh/m², a reduction of about a third.

8.2 BhS plc

BhS has 146 sites and has a total energy bill of £8.5 million. The central items of the company's energy policy are:

- Monthly review of energy consumption in all stores in order to ensure that savings are achieved and maintained
- A monitoring and targeting programme, which supplies monthly reports to Branch Managers comparing present consumption with last year and this year's target, as well as identifying stores using 20% more energy than the average
- The introduction of building energy management systems (BEMS) at all the larger stores.

BhS, Oxford Street

BhS' Oxford Street branch in London is the company's flagship store and employs about 450 staff. It has an annual energy bill of around £250,000.

Building Services

All of the sales areas of the Oxford Street store are air conditioned via central air handling units, but without humidity control. Space heating is by gas fired boilers and water heating by separate direct fired water heaters. The main heating boilers are isolated in the summer to ensure that only the water heating boilers operate to satisfy hot water loads. Plant is set and controlled remotely from BhS headquarters, with local control possible should central control fail.

Lighting in the store is by a mixture of efficient triphosphor fluorescent tubes in recessed luminaires and low voltage tungsten halogen display lamps.

Building energy management system (BEMS)

The first modules of a new BEMS were installed in 1992 to optimise the operation of the main boilers. Subsequent modules were added and commissioned separately for the chilled water plant and later the air handling units with lighting control added in March 1993.

Heating is controlled on a two stage basis - firstly for trading periods and secondly for other times when the store is being re-stocked and cleaned. Similarly, the provision of lighting is controlled in three stages: the lighting level for cleaning and re-stocking is set at a third of the 850 lux provided for trading, and a third level covers night-time security activities.

The BEMS has allowed the lighting to be controlled very precisely against the usage pattern of each part of the building. Lighting in the changing rooms, for example, is only activated during trading hours, and external sign lighting is switched by a daylight sensor.

The BEMS provides optimum start and weather compensation control, ensures the air handling units use free cooling where possible and prevents simultaneous provision of heating and cooling. The sales area temperature set point is allowed to vary with external temperature, moving higher in the summer and lower in winter. This minimises energy use and keeps shoppers comfortable.

The system also produces complete reports on the operation and energy consumption of the store. The store trades for much longer hours than it ever used to, but, due to efforts made towards energy efficiency, uses hardly any more energy.

"Control by the BEMS is one of the secrets. It takes the control of the store's environmental systems out of the hands of busy store managers altogether. It leaves managers free to manage their selling activities secure in the knowledge that the store is being operated as efficiently as possible", says the Technical Services Manager

Catering

The restaurant dishwasher is fitted with a high level of insulation and a heat recovery system.

Energy savings

The new BEMS cost £48,000 but reduced electricity, gas and maintenance costs by £43,000 over the year to the end of 1993. Conditions in the store have also improved.

Gas consumption was reduced from 274 kWh/m²/year in 1990/91 to 147 kWh/m²/year, a 'low consumption' figure, in 1992/93. Overall electricity consumption was reduced by 8% between 1992/3 and 1993/4, although the hours of trading in the store have increased. Electricity use at night has been cut by 30%, showing the particular benefits of improved control out of trading hours.

8.3 J Sainsbury plc

J Sainsbury aims to minimise the amount of energy used throughout its operation and continues to seek further reductions in order to reduce its cost and environmental impact. This is achieved in a number of ways.

- Targets are set for energy use in stores, depots, vehicles and all support services.
- Achievement against those figures is regularly monitored and any variances investigated.
- A review programme has been established to ensure that new technology is fully evaluated for its application to the business and used where applicable.
- Stores are designed, built and maintained to maximise the efficient use of energy throughout their life.
- Suppliers of its services are required to apply similar standards to their individual operations.

Sainsbury, Beckenham

Sainsbury's store at Beckenham, which was opened in 1983, had a good level of energy efficient services when it was designed. The store has 20 checkouts, a large bakery and an extensive meat preparation area. It is classified as a medium sized store.
The original building incorporated the following energy efficient features:

- The cooling and air handling plant was designed with a heat recovery system to make use of waste heat from refrigeration, lighting and from the bakery for heating the store and for hot water
- There are six central refrigeration packs which are fully sequenced so that the plant can match the requirement for cooling; heat is recovered from the chillers to provide both space heating and hot water
- High efficiency modular gas boilers with sequence control provide supplementary space heating and hot water, including that for over-door warm air heaters, which are only enabled during trading hours when the outside temperature is below 15ºC
- Two speed fans were employed so that the rate of supply air can be regulated according to the demand for heating or cooling.

As part of a continuous programme to reduce operating costs, further improvements have been made which counteract the inevitable increase in energy consumption due to longer opening hours. Simple measures included the installation of insulated covers on refrigerated display cabinets for use at night.

In 1992 a building energy management system (BEMS) was installed, allowing the existing plant to be operated in ways which were not possible before, and hence reduce energy and maintenance costs further.

The air handling plant is controlled by the BEMS so that it operates between full recirculation to retain energy, and full fresh air to take advantage of free cooling from outside.

The store is split into four zones: main sales area, bakery, meat preparation area and staff areas. Each zone is controlled separately by the BEMS to ensure that use of plant and lighting is minimised. Each zone has separate optimum start control.

"You can get much better control of plant and save energy using BEMS and the Beckenham site reconfirms the viability of introducing BEMS in supermarkets", says Sainsbury's Energy Engineer.

The BEMS ensures that heating and cooling are not called for simultaneously. A carbon dioxide (CO_2) sensor measures the air quality in the store. If it is acceptable, and neither cooling nor heating is required, the fans which supply fresh air and extract stale air are switched off by the BEMS.

Energy savings are achieved at night by allowing space temperatures to vary, and by switching off the extract fans and setting the supply fans to low speed. The BEMS also controls the lighting so that just security lighting is on at night and there is only 40% of full capacity during stocking periods, rising to 100% during trading hours.

Sainsbury's central energy management team controls the BEMS to ensure that the store is functioning correctly and carries out a range of remote energy monitoring and targeting functions. The BEMS is automatically programmed to check set points and temperatures and print a report which shows the potential savings owing to poorly set controls.

The store's energy consumption is not as low as that of more recent stores which have been designed with modern energy saving equipment and systems, but the introduction of the BEMS has enabled consumption to remain fairly steady despite an increase in store opening hours and extra refrigeration and lighting loads.

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 retail stores are listed here.

Good Practice Guides give advice on how to implement energy saving measures. Relevant titles are as follows:

34 Energy efficient options for new offices - for the design team

35 Energy efficient options for refurbished offices - for the design team

71 Selecting air conditioning systems

84 Managing and motivating staff to save energy.

General Information Leaflets and Reports also give advice on how to implement energy saving measures. A relevant General Information Leaflet is:

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 better energy users to be more energy efficient. A relevant title is:

27 Compressor motor controllers on refrigeration plant.

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

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

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

Details of publications and events can be obtained from:

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

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

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
Museums, galleries, libraries and churches
Offices
Post Offices, banks, building societies and agencies
Prisons, emergency buildings and courts
Schools
Shops and stores
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.

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 NEl 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 352 292

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 878 665

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 4662

REEO Wales
Cathays Park
Cardiff
Wales CFl 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

There are 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

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, Condensing Boilers

CIBSE Applications Manual, AM8, 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.

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.

9.9 Other Useful Addresses

Energy Systems Trade Association Ltd (ESTA)
PO Box 16, Stroud, Gloucestershire
GL6 9YB
Tel: 0453 886776
Fax: 0453 885226

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

APPENDIX 1

Development of Building Performance Indices (PI)

Introduction

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

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

Overall performance indices

Overall performance indices provide a single measure of building performance, and can be expressed in terms of carbon dioxide (CO_2) emissions or energy cost. Overall energy indices are useful for comparing a stock of buildings. 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 kWh/m² figure in Column 1, and multiply by the relevant conversion factors in column 2 to get either the kg of CO_2 per m² or the cost per m² in column 3.

The conversion factors shown are broadly representative of the current fuels used in retail stores 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.

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. For example, the effect of extended hours of use on energy consumption can easily be exaggerated, making the building performance seem better than is really the case.

Figure A1.1
CO_2 Performance Index Calculation

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

*typical 1993 emission factors

Figure A1.2
Cost Performance Index Calculation

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

*typical 1992 prices

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.

Figure A1.4 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 store.
- Normalised performance indices are used when more sensitive comparisons are required and the effect of factors such as exposure and weather become significant. But if you choose to normalise, be aware of introducing errors.

Figure A1.3 Carbon dioxide and cost yardsticks

CO_2 Performance Assessment

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

	Yardsticks in kg CO_2/m^2	Yardsticks in kg CO_2/m^2
Buildings with a fossil fuel and electricity supply		
DIY stores	120	150
Non-food shops	160	210
Department stores	200	250
Food stores	300	370
Supermarkets	500	700
Buildings which are electrically heated		
Non-food shops	160	210
Department stores	200	260
Food stores	310	390
Supermarkets	530	740

Cost Performance Assessment

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

	Yardsticks in £/m²	Yardsticks in £/m²
Buildings with a fossil fuel and electricity supply		
DIY stores	11	14
Non-food shops	15	20
Department stores	19	24
Food stores	30	37
Supermarkets	50	69
Buildings which are electrically heated		
Non-food shops	16	21
Department stores	21	26
Food stores	31	39
Supermarkets	53	75

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

Figure A1.4 Normalised Performance Indices calculation

	Fossil fuel				Total of Fossil Fuels	Electricity
	Gas	Oil	Other			
Total energy consumption (kWh)				(A)		
Space heating energy (kWh)				*(B)		
Non space heating energy (kWh)				A-B = (C)		
Find the degree days for the energy data year				*(D)		
Weather correction factor = 2462 ÷ D =				(E)		
Obtain exposure factor for heating energy use from below				*(F)		
Annual heating energy use for standard conditions				BxExF = (G)		
Normalised energy use = C + G =				(H)		
Find floor area				m^2 (J)		
Find the Normalised Performance Indices = H ÷ J =				kWh/m^2 (K)		

* Notes:
(B) Estimation of weather-dependent heating energy use is discussed in section 7.
If you have a building that is electrically heated and cannot identify the energy used for heating assume that the proportion of the electricity which is used for heating is:
Non-food shops 20%
Department stores 30%
Small food stores 15%
Supermarkets 15%
(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)
(F) Exposure factors from figure A1.5.

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

Figure A2.1 Conversion to kWh

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

BEST PRACTICE PROGRAMME

Energy Efficiency Office

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