Introduction to Energy Efficiency in Hotels

BEST PRACTICE PROGRAMME

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

CONTENTS

1

INTRODUCTION

1.1 Who this guide is intended for

This guide is aimed at hotel managers, premises managers and others who have responsibility for hotel buildings. It should also be of interest to energy managers in larger hotel organisations.

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 hotels 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 hotels.
- The case studies (section 8) give examples of hotels 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 outgoings in running hotels. Using simple and cost effective measures, fuel bills in hotels 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 guests and staff. This can give rise to improved satisfaction amongst guests.

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 Research Energy Conservation Support Unit (BRECSU)

Copthorne Hotel

Forte Hotels

The Rank Organisation

The Ritz Hotel

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, productivity, etc).
- Compare your energy use to previous years, to other hotels, 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

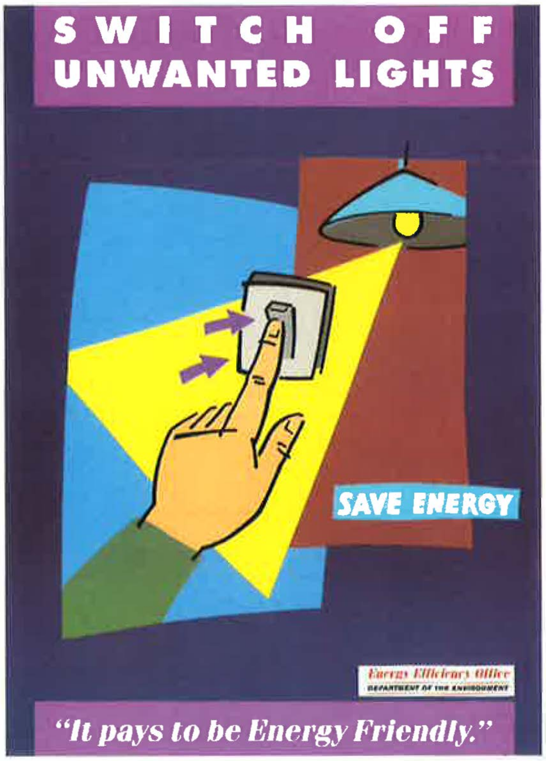
2.4 Getting on the right tariffs

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 9.9).

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 staff 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 in larger hotels

In larger hotels, a number of groups should be involved in energy management:

- Staff and their representatives
- General management
- Plant operators
- Security staff
- Maintenance contractors.

You should have regular contact with all of the above and with the individual building staff. A facilities manager often makes a good energy manager because they already have close contact with staff. 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 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 hotel premises, take the opportunity to select or specify:

- Energy targets
- The type of building - for example, the inclusion of full or partial air conditioning may double overall energy costs
- Systems which are simple and within the capabilities of the staff to manage
- High efficiency of major plant and equipment such as boilers 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 71 - Selecting air conditioning systems.

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

2.9 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. 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:

EEO Choosing an Energy Efficiency Consultant.

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.

1. Confirm who is responsible for energy management (it may be you) and seek senior management support

2. Obtain energy bills and start recording and assessing billed energy consumptions — **See section 2.3**

3. Check fuel and electricity tariffs and change where appropriate — **See section 2.4**

4. Undertake an initial 'walk around' of the premises to identify avoidable waste — **Use checklist in section 4.1**

5. Assess building energy performance and scope for initial energy saving measures — **See sections 5 and 6 for building performance index**

6. Consider technical and management responsibilities — **See sections 2.6-2.8**

7. Plan and start a programme of longer term energy saving measures — **See section 4 .3**

8. Plan and start a programme of motivating staff and encouraging good practice — **See section 2.5**

9. Carry out a more detailed energy survey and obtain advice when appropriate — **Refer to measures in section 4 and analysis in section 7**

10. Plan and implement identified measures

11. Reinforce motivation and encouragement of occupants

12. Review progress, assess savings and revise plans

Ongoing energy management

4

MEASURES TO ACHIEVE ENERGY SAVINGS

4.1 Initial measures

In most hotels 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 guests.

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.

An exercise to review energy purchasing tariffs (see section 2.4) should be carried out at the same time.

Checklist of Initial Energy Saving Measures

Space and water heating

- Consider fuel switching (if your boiler 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.
- 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 lights when areas are not in use.
- Make the best use of daylight by keeping windows and roof lights clean.
- Investigate existing lighting controls to see if the hours of use of artificial lighting can be reduced.
- Avoid excessive lighting levels and hours of use in corridors.

Ventilation

- Ensure the main ventilation plant and toilet extractor fans are switched off outside occupancy hours.
- Check that windows are not being opened to avoid overheating during winter.
- Ensure kitchen fans are switched off when no cooking is taking place.

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).
- 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.

Equipment

- Encourage staff to turn off equipment when it is not being used.

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 all insulation and draught proofing is in a state of good repair.

Catering

- Inform kitchen staff of heat-up times for cooking equipment - less than ten minutes for many hobs, grills and convection ovens, 15-20 minutes for heavier equipment; discourage staff from using hobs or ovens for space heating.
- Encourage kitchen staff to assess how much equipment is needed at different times of the day, and to switch off equipment when it is not needed.

Laundries

- Encourage staff to run laundry equipment only at full load.

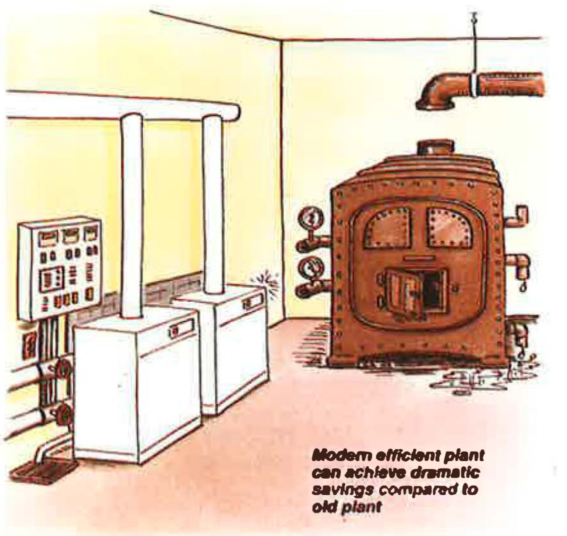
Swimming Pools

- If you have a swimming pool cover, ensure that it is being used when the pool is not in use.

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.
- Ensure kitchen equipment is in good condition.



Modern efficient plant can achieve dramatic savings compared to old plant

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
8 The economic thickness of insulation for hot pipes
10 Controls
12 Lighting

EEO Good Practice Guide 15 - Energy efficient refurbishment of public houses

EEO Energy Consumption Guide 36 - Energy efficiency in hotels

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, 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 2.9.

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 gas 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.

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.

HEATING MEASURES

- 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.
- Install a heater other than the main boiler to produce domestic hot water, and turn off the main boiler during the summer.

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 efficient means of generating electricity than conventional power stations. Overall efficiences 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 in the hotel. 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 maxium demand charges are at their highest. Any prolonged stoppage will also result in an increase in electrical consumption leading to higher overall energy costs.

LIGHTING

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).

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

Photographs supplied by Philips and Fitzgerald

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
- Fluorescent tubes
- 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.

Compact fluorescent lamps

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%.

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.

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

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

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

- 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 with tubular fluorescent lamps in areas where these are acceptable.
- 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.
- 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:
  - time controls for lighting in corridors
  - time controls or daylight correction controls for external lighting
  - presence detection controls for areas which are infrequently used, such as stores
  - consider installation of key fobs in bedrooms so lights and equipment can only be operated when rooms are occupied.

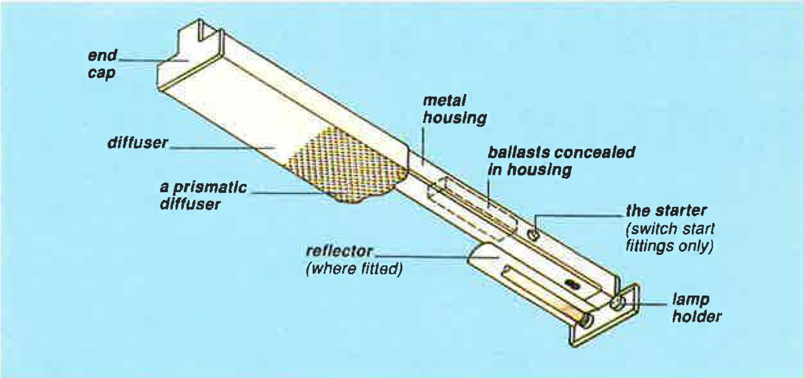
MECHANICAL VENTILATION AND AIR CONDITIONING

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 typically 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.

The parts of a fluorescent light fitting



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.
- 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 or replaced 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.

BUILDING FABRIC

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

Caution: Insulation measures should be checked for condensation and water penetration risks.

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.

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.

5

ENERGY USE IN HOTELS

5.1 Why analyse energy use?

Assessing the energy performance of a hotel allows you to:

1. Compare performance with standards to suggest the potential for energy saving in the hotel.
2. Compare with other hotels in an estate or group 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.

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

5.2 Types of hotel and their energy use patterns

Hotels and their facilities vary considerably, but in this guide three types of hotel are defined. Typical and good examples of each type of hotel are used as yardsticks against which a given building can be compared.

Smaller hotel

Typically a two star hotel occupying an older, probably converted building, usually having between 20 and 100 bedrooms. Floor area can vary widely, and room sizes tend to be large.

Business or holiday hotel

A three or four star purpose-built hotel catering principally for the business or holiday trade. There are a restaurant, conference rooms and leisure facilities. Size is generally between 50 and 150 bedrooms.

Luxury hotel

A luxury hotel often in a city centre location. It may be of Edwardian grandeur or modern. Reception and circulation areas are generous, and there is a high class restaurant and usually extensive conference and leisure facilities. Number of rooms ranges from 100 to 500 or more.

5.3 Comparing energy use in the different hotel types

A comparison of energy cost per bedroom by the three hotel types is shown in figure 5.1. Energy cost generally increases with the standard of hotel. The energy cost per bedroom of a luxury hotel is typically around 30% more than for smaller hotels.

Hotels with full air conditioning generally use about 50% more electricity than those without. They also use more energy for heating because of additional ventilation. The typical costs figures for the business and luxury hotels assume that there is some air conditioning in public areas, but not in bedrooms.

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

Figure 5.2 shows the average breakdown of energy costs for various uses from a range of hotels, including some with air

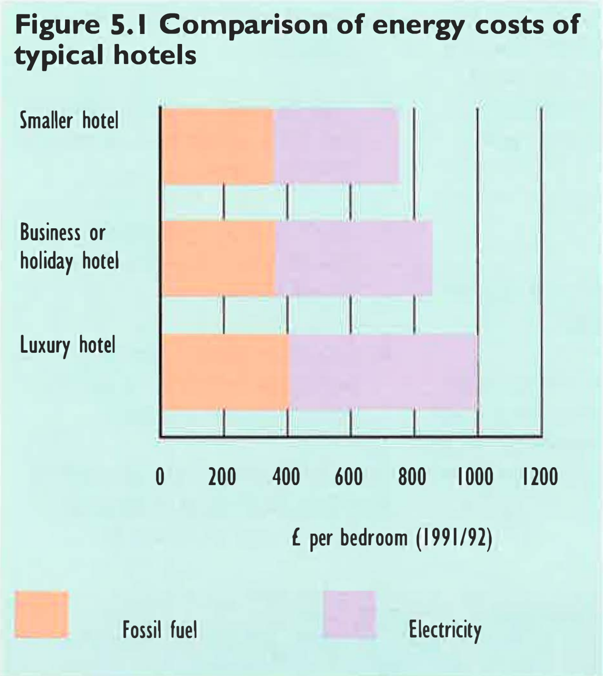
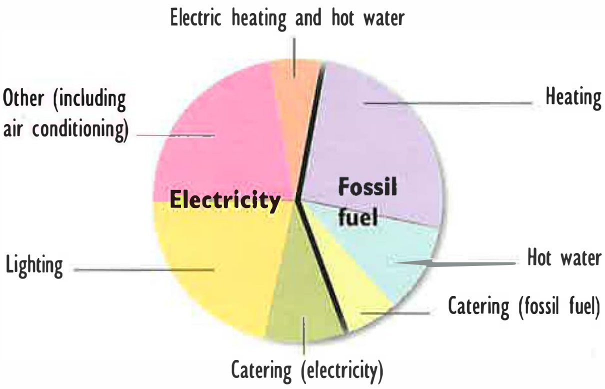


Figure 5.2
Energy cost breakdown for a typical hotel



conditioning. Although heating is the largest cost, lighting represents about 20% of the total. About one quarter of the total is taken up by other items of electrical equipment including mechanical ventilation, local air conditioning, lifts and many other items.

The actual breakdown of energy costs in a particular hotel may vary considerably from the average figures shown here. In particular, if there is no air conditioning, the 'other' category is likely to be smaller while a hotel with full air conditioning is likely to have a greater proportion of its energy costs in this category.

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 hotel types are given below, with electricity consumption and fossil fuel energy consumption shown separately.

The procedure is:

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

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

Floor area information.

The measure of floor area used to standardise energy consumption is treated area, defined as follows in relation to the more commonly available gross and net floor areas:

Gross — Total building area measured inside external walls. These figures are often used by architects and quantity surveyors.

Treated — Gross area less plant rooms and other areas not heated (e.g. stores, covered car parks and roof spaces).

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

	ft² ÷ 10.76 =	m²				Treated floor area	
Gross floor area			x	0.90	=		m²
Treated floor area			x	1.00	=		m²

Annual energy consumption of your building.

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

Figure 6.1 Energy Performance Index Calculation

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

Note * for kWh conversion factors see Appendix 2

There may be exceptional reasons to explain a low or high consumption. For example, a hotel may have a low consumption because it is has seasonal business and so is lightly used in winter, or a high consumption because it has a large public restaurant.

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.

6.3 Alternative performance assessments

An alternative set of yardsticks is provided in terms of energy cost per bedroom. This provides a quick check if floor area data are not available and is obtained by dividing the total annual energy cost by the number of guest bedrooms. Note that assessments based on floor area are usually more reliable and the method given in section 6.2 above should be used if possible.

The cost-per-bedroom index described in figure 6.3 is an example of an overall performance index. Overall performance indices can also be based on carbon dioxide (CO_2) emissions or cost of energy per m^2 of floor area. These can be used for league tables of groups of hotels and for assessing hotels which differ from those on which the separate yardsticks are based. This may occur, for example, in hotels with electric heating and hotels which have combined heat and power systems.

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 hotel 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 hotels in different parts of the country.

Figure 6.2 Energy Consumption Yardsticks

Performance Assessment - Energy Use per m²

	Low consumption Less than	Medium consumption Between	High consumption Greater than
	Yardsticks in kWh/m²		Yardsticks in kWh/m²
Smaller hotel			
Fossil fuels	240		360
Electricity	80		120
Business or holiday hotel			
Fossil fuels	260		400
Electricity	80		140
Luxury hotel			
Fossil fuels	300		460
Electricity	90		150

Figure 6.3 Energy Cost Yardsticks

Performance Assessment - Energy Cost per Bedroom

	Low cost Less than	Medium cost Between	High cost Greater than
	Yardsticks in £/bedroom		Yardsticks in £/bedroom
1. Smaller hotel	520		740
2. Business or holiday hotel	560		860
3. Luxury hotel	620		1000

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

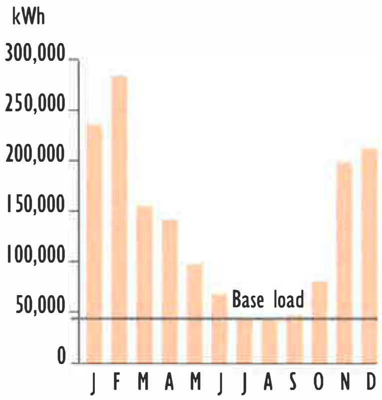
You can ask your supplier for monthly fuel data, or take monthly meter readings yourself. Larger sites have monthly energy bills. By looking at how these vary with the seasons some valuable insights can be obtained. Produce a monthly consumptions bar chart plot for each energy source over a year.

The billing periods should be checked. If they are not regular, some months will appear unrealistically low and others unrealistically high. 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.

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 hotel 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.

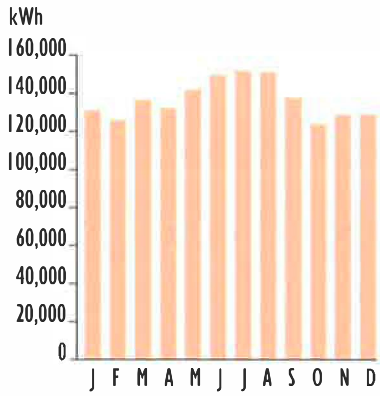
Example monthly fossil fuel use



The figure above shows the monthly fossil energy consumption of a fairly efficient hotel 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

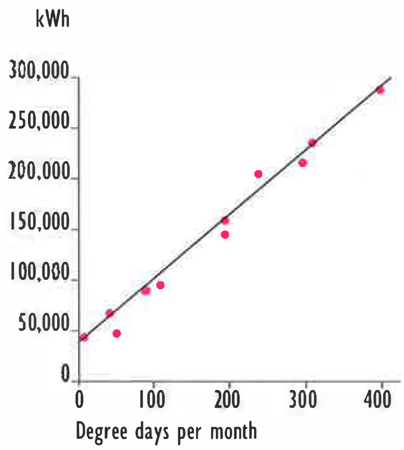


The figure above shows monthly electricity consumption for an air conditioned hotel showing a small increase in the summer months as the cooling load increases. A possible small increase in winter may be due to increased lighting or some electric heating.

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 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).

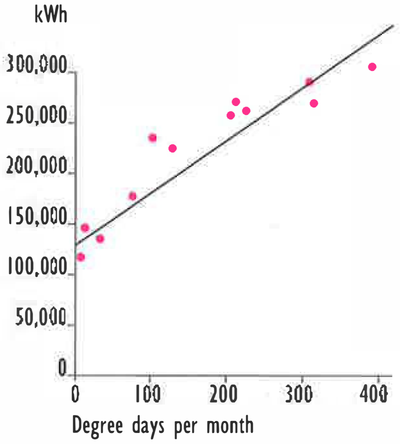
Example monthly heating energy use in a well controlled hotel



The hotel 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 use goes up proportionally. For this building the energy consumption falls to a small value in summer when only hot water is being provided.

A hotel 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 hotel



The figure above has a large scatter of points indicating a hotel 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 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.

7.5 Comparing energy use with standards

More detailed information on energy use in hotels is available from the EEO. It is possible to meter or estimate energy usage for a particular service such as heating or lighting and compare against published levels. This helps to ask more detailed questions, such as:

- Are the lights left on longer than necessary ?
- Is the lighting level too high (find typical values) ?
- Is the lighting equipment inefficient ?

For further information see:

EEO Energy Consumption Guide 36 - Energy efficiency in hotels. A guide for owners and managers

CIBSE Applications Manual 5 Energy Audits and Surveys.

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 Ritz Hotel

The Ritz Hotel was built in 1898 and is internationally famous as one of London's most prestigious luxury hotels. The hotel has 128 bedrooms and a restaurant.

Energy cost savings of 30% have been achieved by replacing aged boiler plant and controls in a refurbishment project funded by a contract energy management arrangement. The work was carried out over a four month summer period with minimal inconvenience to staff and guests, the only disruption being a single two hour break in heating during a quiet night time period. The opportunity was taken during the refurbishment to install cooling in the restaurant, so providing improved comfort conditions.

Space heating can represent one half of the overall energy cost of a typical hotel. The Ritz example shows that the efficiency of boiler plant and the effectiveness of the associated control arrangements can have a dramatic effect on this cost.

Contract Energy Management

The Ritz Hotel's energy requirements were managed from 1989 under a contract energy management (CEM) arrangement in which the contractors take responsibility for plant management, maintaining comfort conditions and energy purchasing.

The contractors put forward a proposal to refurbish the heating plant, with capital for the refurbishment project provided by the CEM company in return for a share of the resulting savings. As the CEM company also installs and manages the energy consuming plant at the hotel, all responsibility for energy use was borne by the CEM company, allowing the client to concentrate on core business.

Heating and hot water

The previous boiler plant consisted of three old and inefficient gas-fired steam boilers. The boiler system was changed to eliminate the need for steam and the boilers were replaced with four modern gas-fired boilers with greatly improved efficiencies of up to 85%. The new boilers were connected directly into existing heating circuits.

Changing from bulky steam boiler plant to smaller boilers led to considerable space saving. Heat losses were also reduced, as the steam-fed hot water heaters were replaced by high efficiency heat exchangers to provide hot water for the kitchens and for the guest bedrooms.

Control system

A building energy management system (BEMS) was installed to control the new plant. The BEMS was also capable of being extended to control other major energy-using plant, such as chillers, at a later date. The system included a telephone link with the CEM contractor's headquarters, allowing remote monitoring and adjustments to be made when needed.

Energy Savings

Before the inception of the project in 1988, the annual gas consumption of the hotel was 7.5 million kWh/annum, giving a fossil fuel performance index of 526 kWh/m^2/annum, a 'high consumption' level. Following the refurbishment, gas consumption dropped to 4.6 million kWh, a saving of 39%. The performance index for gas dropped to 322 kWh/m^2, a 'medium consumption' level.

Electricity consumption showed a decrease over the period despite the installation of cooling in the restaurant.

Annual Energy Consumption and Costs - Before and After Refurbishment

Heated area - 14,250 m^2

	Pre-refurbishment energy use			Post-refurbishment energy use		
	kWh	£	kWh/m^2	kWh	£	kWh/m^2
Gas	7,495,500	87,648	526	4,587,660	53,700	322
Electricity	2,700,000	123,322	189	2,055,662	94,560	144
Total		210,970			148,260	

8.2 Forte Crest Hotel, Brighouse

The 94 bedroomed Forte Crest hotel at Brighouse was purpose built in 1989 with the normal facilities of fully appointed rooms, bar and restaurant plus health and fitness centre, syndicate and function rooms.

An energy efficient lighting system for public and private areas was designed, installed and operated successfully, achieving savings of 45% in lighting costs while obtaining a favourable reaction from guests and staff.

The system makes use of compact fluorescent and low voltage tungsten halogen light fittings. It was designed as a pilot study by specialist designers in conjunction with Forte engineering staff and was required to be aesthetically pleasing, emphasising the interior design and ambience of the hotel while realising low energy and maintenance costs.

Lighting Systems

Bedrooms are illuminated with compact fluorescent lamps ranging from 7W to 13W.

The corridors, stairways and lobbies have recessed downlighters equipped with compact fluorescent lamps. One third of these lamps are on an emergency lighting circuit while the remainder are switched centrally by the night porter at reception.

Lighting in the restaurant and lounge is principally by low voltage tungsten halogen lamps in recessed downlighters. This arrangement gives an even and naturally bright environment and is supplemented by local table or standard lamps fitted with compact fluorescent or tungsten filament lamps. The restaurant and lounge have chandeliers fitted with 13W compact fluorescent lamps. The overhead lighting is dimmed in the evenings to give a warm congenial atmosphere.

Back of house, which includes offices and catering facilities, is illuminated with 26mm fluorescent tubes, locally switched. External lighting is mainly by high pressure sodium (SON) lamps switched by solar sensors.

The quantities of installed lamp types and estimated annual consumption by type is given as follows:

	No of lamps	% of lighting energy
Tungsten bulbs	470	17%
Compact fluorescent	790	18%
Tungsten halogen	220	23%
Fluorescent tubes	150	31%
External high pressure sodium	60	7%
Other	50	4%
	1,740	100%

All fluorescent lamps require control gear or ballasts - some compact fluorescent lamps include control gear in the lamp, while others use control gear in the light fitting. The latter type has generally been used at the Brighouse Forte Crest, leading to slightly higher installation cost for the fitting, but reduced lamp replacement costs. This type has the important advantage that lamps are less likely to be stolen because they can not be used in domestic light fittings for normal tungsten lamps.

Maintenance

The time spent replacing lamps is only 15% of that for an equivalent hotel using solely tungsten lamps and the resulting saving in labour costs was estimated at £6,840 per year. Low lamp failure rates also mean that only small stocks of replacement lamps need be kept.

Energy and Cost Savings

Electricity consumption for lighting is estimated at 38.1 kWh/m²/annum or £143/bedroom/annum. This compares with an estimated 68.7 kWh/m²/annum had internal lighting by conventional tungsten filament lamps been installed within public areas. This represents a 45% reduction in lighting energy consumption. The annual energy saving from not using tungsten filament lamps is 187,000 kWh. The estimated annual cost savings are:

Labour	£6,840
Lamps	(£130)
Energy	£11,230
Total Saving	£17,940

The additional capital cost for high efficiency lighting was assessed at £18,000, giving an overall payback period of 1 year.

8.3 Copthorne Hotel, Plymouth, Devon

The Copthorne in Plymouth is a 4 star hotel comprising 135 bedrooms, two restaurants, two conference rooms and a leisure centre. It is a five storey air conditioned hotel and was opened in 1987.

Between 1988 and 1992 energy costs were reduced by 53% from £174,000 to £83,000 a year, by a combination of modest capital expenditure and committed energy management (all costs are adjusted to 1992 prices). The savings were achieved while maintaining full comfort standards and guest satisfaction.

Six months after the hotel opened, the property manager started an enthusiastic campaign of energy efficiency and cost reduction. It is this enthusiasm with the support of the maintenance team that has been the motivation for the success of the campaign.

Heating and hot water

The building was fairly well insulated with double glazing throughout. A third layer of glazing was added on one facade which faced the prevailing wind and a nearby road.

Originally the three boilers operated all year round for space heating, pool heating and hot water. Subsequent improvements in the control arrangements and the campaign to avoid waste meant that only rarely is more than one boiler required, giving a significant saving in heat losses from the boiler system.

Additional water heaters were installed so that the main boilers could be turned off altogether in summer. The new direct fired gas heaters provided pool heating as well as hot water.

Heat is recovered from the pool ventilation extract to offset heating required for the leisure area ventilation.

Electrical savings

Improvements in electricity consumption were achieved by using high efficiency lamps in fittings specially selected to maintain lighting quality.

Guest bathrooms and all toilets use compact fluorescent lamps, with occupancy sensing controls in staff toilets to further reduce usage. Guest bedrooms are still lit with tungsten filament bulbs because of experience of theft of low energy lamps in early trials. Corridor lighting is by 26mm diameter slimline fluorescent tubes.

External lighting is high pressure sodium floodlighting, and garden cluster lamps have been changed from tungsten filament lamps to compact fluorescents. All external lighting is controlled by a photocell which turns lights off during daylight hours.

Maintenance and operation

A planned preventive maintenance programme was developed by the maintenance team using the newly installed building energy management system to schedule routine maintenance and monitor the condition of plant. This has nearly eliminated emergency breakdowns and hotel staff now carry out most of the maintenance.

The building energy management system is used to reduce operation of pumps and fans, and allows convenient records of gas and electricity consumption to be kept.

Performance assessment

The table shows the building energy use and performance indices achieved after the campaign.

Performance Assessment 1992

Heated area 7,730 m² Number of bedrooms 135

		Gas	Electricity	Total
Annual consumption	kWh	1,559,280	1,102,280	
Performance index	kWh/m²	202	143	
Assessment		Low consumption	Medium consumption	
Annual cost		£21,782	61,056	£82,838
Performance index	£/Bedroom	161	452	613
Assessment		Low cost	Low cost	Low cost

Two direct gas fired water heaters provide hot water during the summer months.

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 hotels are listed here.

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

36 Energy efficiency in Hotels - A guide For owners and managers.

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

3 Introduction to small scale Combined Heat and Power (CHP)

15 Energy efficient refurbishment of public houses

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 hotels 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.

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

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

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

Details of publications and events can be obtained from:

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

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

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 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.

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

Publications:

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

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

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)

CIBSE Lighting Guide 3(LG3)(1989). Areas for Visual Display Terminals.

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
GL5 5EB
Tel: 0453 886776
Fax: 0453 885226

Major Energy Users' Council
10 Audley Road
London W5 3ET
Tel: 081 997 25611/3854
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 hotel. It also 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 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 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 hotels, 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 weather on energy consumption can easily be exaggerated, making the building performance seem better than is really the case.

Note also that while a normalised performance index is a better

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

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

The worksheet in figure A1.4 can be used to obtain performance indices which are normalised to standard conditions of weather 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.
- 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 A1.3

Carbon dioxide and cost yardsticks

CO_2 Performance Assessment

Hotel Type	Low Emissions / Medium Emissions: Yardsticks in kg CO_2/m^2	Medium Emissions / High Emissions: Yardsticks in kg CO_2/m^2
1. Smaller hotel	100	160
2. Business or holiday hotel	110	180
3. Luxury hotel	120	200

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

Cost Performance Assessment

Hotel Type	Low Cost / Medium Cost: Yardsticks in £/m²	Medium Cost / High Cost: Yardsticks in £/m²
1. Smaller hotel	9.00	13.60
2. Business or holiday hotel	9.30	15.50
3. Luxury hotel	10.60	17.10

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

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

*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)
(F) Exposure factors from the 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

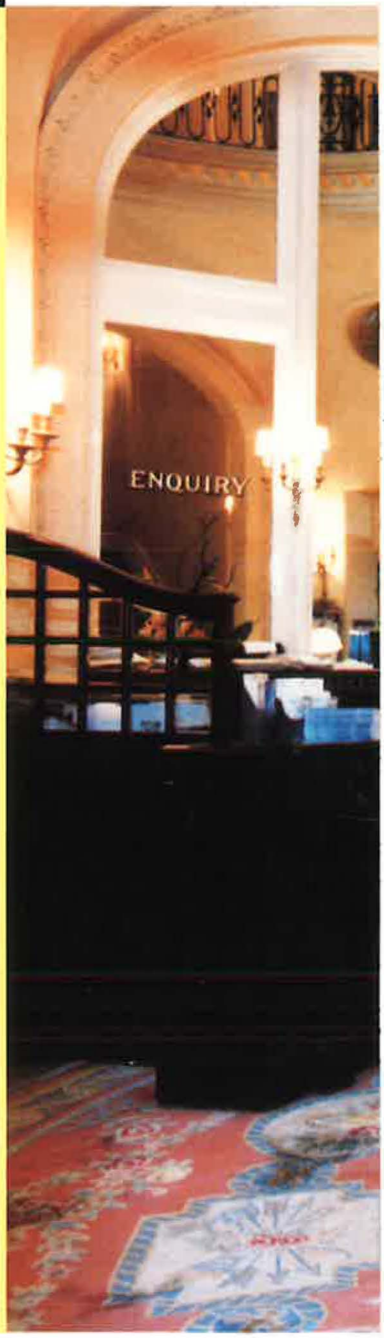
APPENDIX 2

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

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