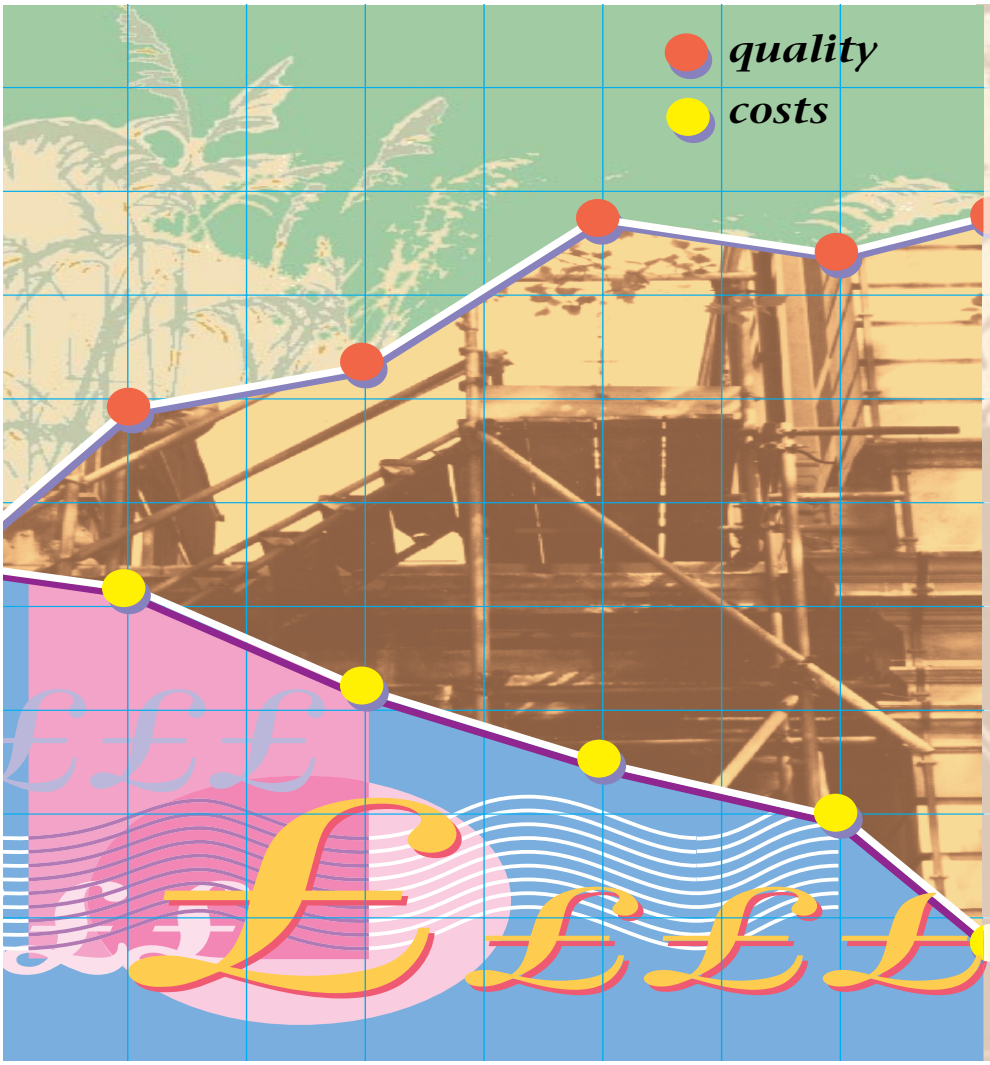
GOOD PRACTICE GUIDE 207

Cost-effective low energy buildings in further and higher education



- Key energy issues for new build and refurbishment projects
- Strategic energy advice for estates and academic department managers
- Energy savings of up to 50% available at the design stage
- Case study examples of successful measures

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

GOOD PRACTICE GUIDE 207

INTRODUCTION

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This Guide provides estates and academic department managers with an overview of key energy and cost issues to consider when planning new build and refurbishment projects. It gives advice on adopting a strategic approach to energy efficiency and on applying the strategy to a project. Energy efficiency measures applied to a range of further and higher education buildings are highlighted in a selection of case studies. Sources of further information and technical guidance are also provided.

Energy in further and higher education accounts for about 2.5% of the sector's annual revenue budget. Most of this energy is used for heating and lighting. Although the greater part of the energy consumed (66%) is made up of fossil fuels, electricity forms the largest element (62%) of fuel costs. Total energy savings of between 30% and 50% can be made by using available techniques and technology. Savings of this magnitude will not only reduce costs, they will also provide significant environmental benefits by reducing emissions of carbon dioxide (CO_2) and other harmful gases.

The potential for reducing energy costs can arise from many estates activities. Even if no new build or refurbishment projects are planned, energy efficiency improvements can often be made as part of your building or plant maintenance programme.

Reaping the benefits of energy efficiency requires management support at the highest level. This support should be forthcoming as part of your institution's energy policy, and needs to be maintained throughout a project to ensure that goals are met. Discuss the matter with your energy manager at an early stage, along with all other energy features of a planned new build or refurbishment project.

KEY POINTS FOR A SUCCESSFUL PROJECT

- Include energy efficiency in your estate strategy.
- Appoint an integrated design team early and seek energy design advice.
- Set energy standards and ensure that the design team understand and agree to them.
- Apply financial appraisal techniques that take full account of long-term energy and maintenance costs.
- Require full testing and commissioning of the building and its services.
- Develop a monitoring system to keep your building on target.
- Promote the environmental benefits of the scheme to encourage a positive user attitude to energy efficiency.

Estate strategy

When developing your estate strategy, clear proposals should be made for the energy efficient development of the estate. Energy standards and targets should be set out so that they are clear for designers of new and refurbished buildings. A strategy for energy supply is important to ensure that the most appropriate fuel can be used at the best price.

Before putting the energy content of your estate strategy into place it is worthwhile identifying your institution's strengths and weaknesses in relation to energy management. The key to realising your organisation's potential to save energy is to adopt a structured systematic approach, as described in the Department of the Environment (DOE's) Good Practice Guide 200 'A strategic approach to energy and environmental management' (GPG 200). The approach is based on five basic steps:

- getting commitment from the top level in the organisation
- understanding the issues
- planning and organising an effective management programme
- implementing the programme
- controlling and monitoring performance.

Figure 1 (opposite) shows the basic process of evaluating your energy saving potential.

New build

This represents the greatest opportunity for including energy efficiency in a project because more options are open. Maximum benefits can be achieved by considering energy at an early stage in the design process. Energy savings of between 30% and 50% are possible. Remember that you are probably going to own and operate these buildings for at least the next 25 years.

Refurbishment

Although some opportunities - such as changing the location, orientation, or built form - are not available when you are looking at an existing building, significant reductions in energy usage can still be achieved.

PROJECT ISSUES

PROJECT ISSUES

Once you have a strategic commitment to energy efficiency, the application of the principles to each project needs careful consideration.

Briefing

Good communication between all parties involved in the project is essential. The most appropriate forum will depend on your institution's structure, but the aims are common. In order to ensure the cooperation and support of everyone affected by the project, including those who will be using the building and those who will be maintaining it, representatives from each group should be drawn into the discussions as early as possible.

Closing the loop, by reviewing your brief as it develops, will ensure that the original concepts and aims are satisfied and the balance is right for the project's many conflicting requirements.

A successful approach to briefing is outlined in Good Practice Guide 74, 'Briefing the design team for energy efficiency in new buildings' (GPG 74).

Design team

To realise its full potential members of the design team, including you as client, need to work together. Appointing professionals and establishing suitable communication channels at an early stage will ensure that the benefits of integrated design are realised.

Specialist energy advisers can provide valuable support to your team when examining and developing the design. Specialist advice is available through the Energy Design Advice Scheme (EDAS) (see Further Information, page 7).

Setting standards

As the brief develops, it is worth while setting targets for energy as well as a number of other criteria. Energy consumption targets for buildings found within the higher education sector can be obtained from Energy Consumption Guides published under the DOE's Best Practice programme (see Further Information).

Having an energy policy or strategy in place before progressing a new project will assist in formulating the most appropriate criteria. It will also pave the way to gaining recognition for your high standards of energy and environmental efficiency through the Energy Efficiency Accreditation Scheme and BREEAM (see Further Information).

Monitoring

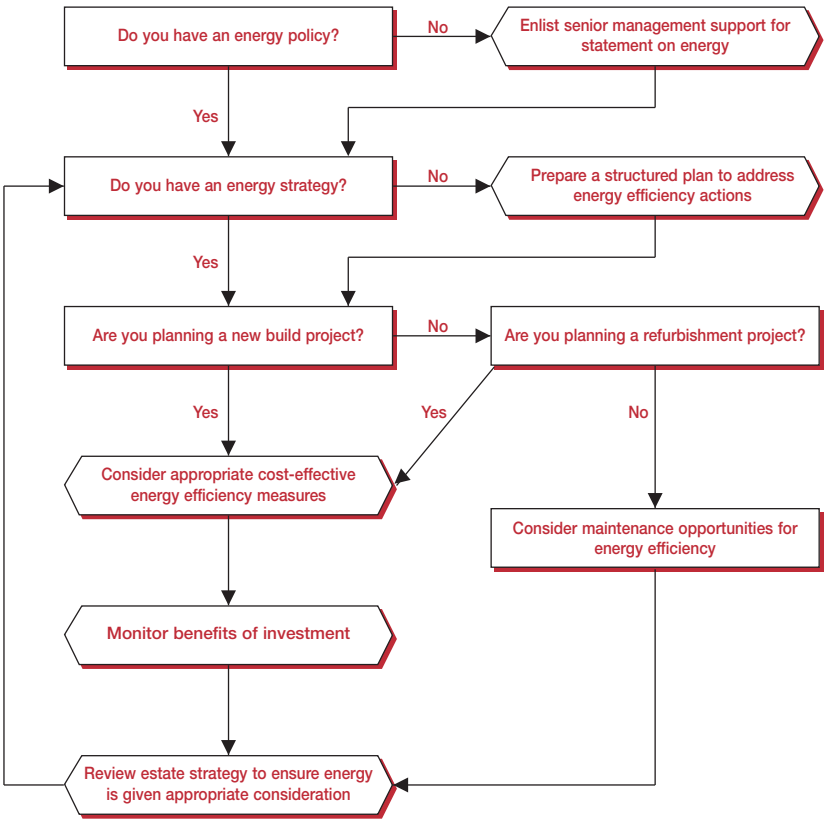
Once work is under way, the various professionals will each have their agreed areas of responsibility, but it is your strategic overview that gives direction to the project. The checklist on page 8 will assist you in reviewing the key energy issues as the project progresses.

Handover and beyond

As the construction phase of the project draws to an end, responsibility for the building and its energy efficiency shifts to you and your institution's management. This is a critical stage in the realisation of an energy efficient building, and again good communication is important. The checklist on page 8 provides key points to address with your team.

An organisation can provide a clear signal of its attitude to energy and the environment, and send a clear message to its designers, by joining the Making A Corporate Commitment (MACC) scheme (see Further Information).

Figure 1 Evaluating your energy saving potential



CASE STUDIES

These case studies show how cost-effective energy efficiency has been applied to new build and refurbishment projects involving a range of buildings found in the further and higher education sector.

Constable Terrace, University of East Anglia

1 RESIDENTIAL ACCOMMODATION

Building form, site layout, insulation levels and internal space planning should be balanced to minimise the cost of energy use. Students are in residence for relatively short periods so it is essential to consider the use of automatic controls and manual overrides for heating and lighting.

Site layout for residences

High quality student accommodation has been constructed on a dramatic site along the River Wear in Sunderland (New Practice Initial Profile 91). Panns Bank provides accommodation for 270 students in two courtyards separated by a public access to a slipway. Four-storey accommodation blocks follow the curve of the river to the north side of each court, with lower buildings to the south. The courtyards are south-facing to provide a sheltered entrance and meeting area on a site exposed to cold north-easterly winds.

The very energy efficient passive design incorporates high levels of insulation, gas central heating and a building energy management system. Rooms are designed to be naturally lit, particularly at study-bedroom desks. Circulation spaces also have natural light.

Well insulated student residences

Energy efficient design at the University of East Anglia (New Practice Final Report 80) has yielded substantial energy, environmental and economic benefits without incurring higher construction costs. Constable Terrace is highly insulated and sealed, and has mechanical ventilation and heat recovery. Much of the heating is supplied by heat gains from occupants, lights and appliances. Monitoring shows energy usage is about 50% and fuel costs 63% of the low yardstick for university residential buildings. Occupancy surveys have revealed a high level of satisfaction with the building.

Energy is used intensively in kitchens so there is a high potential for savings

2 CATERING

Installing energy efficient cooking equipment and considering the energy impact of the kitchen layout will reduce fuel bills. Operational policy can also realise significant energy savings without compromising the quality of service.

An all-gas kitchen

Catering for over 250 people, the restaurant at the Royal College of Surgeons offers three meals a day and regularly hosts banquets.

The kitchen was redesigned to incorporate a number of energy efficient appliances including:

- a well-insulated conveyor dishwasher
- gas-fired combination ovens
- a gas-fired pressure cooker
- gas-fired salamander grills.

In addition, the catering manager was allocated the responsibility of ensuring good housekeeping.

Restaurant staff were pleased with the resulting savings and the improved menus they could offer.

Good housekeeping in a kitchen

Gas and electricity sub-meters were installed in the kitchens of York University and the consumption recorded for two years. At the end of the first year a survey of the catering function was carried out. As a result, the estates department ran four one-hour training sessions on saving energy by good housekeeping. Messages included:

- switching off equipment, lights and extractors when possible
- using the most efficient equipment for the job
- using lids and covers on pans
- closing doors on cold rooms
- reducing drain-down on dishwashers.

Average energy savings of 25% were achieved in the second year.

CASE STUDIES

3 LECTURE AND STUDY AREAS

Occupancy patterns can be dense but intermittent, or extended but sparse. Environmental control tends to be remote from the individual occupants. Providing robust low energy designs with appropriate control strategies can significantly reduce running costs.

Ventilation

Teaching spaces designed to accommodate more than 100 people usually require some form of mechanical ventilation.

Energy consumption for the first year of operation at De Montfort University's School of Engineering equated to 114 kWh/m^2 for gas and 43 kWh/m^2 for electricity, or carbon dioxide emissions of 53 kg/m^2. Referring to Department of the Environment yardsticks, these figures are around half those expected of a typical university building (New Practice Final Report 102 – in press).

Heat load testing in the lecture theatre indicates that the night-time cooling of the heavyweight structure, coupled with the natural ventilation, appears to be working well. In simulated occupancy conditions the internal temperature was held below 25˚C when the external temperature exceeded 29˚C.

Lighting refurbishment

Many teaching spaces are inefficiently lit with old-style luminaires and lamps. Simple changes can often be effective, as demonstrated by Alness Academy (Good Practice Case Study 101). Half the fluorescent tubes were removed and new reflectors installed in the luminaires with only slight reductions in the lighting level. Controls were also introduced which provide a basic level of lighting through a rocker switch, with additional lighting available via a key switch. The additional lighting is automatically switched off after a pre-determined period.

Energy cost savings of £8000 a year are predicted which, with a capital outlay of £30 000, gives a payback period of under four years.

Alness Academy teaching block

4 RESEARCH FACILITIES

Energy consumption in research facilities is buildings-related, but additional demands may arise from processes and requirements for maintaining special conditions in laboratories.

Making the best use of daylight and beneficial solar gains can help to minimise energy demand, while efficient lighting and boilers will reduce fuel consumption.

Condensing boilers

Ageing buildings and the heating demands of research facilities such as chemistry, physics and engineering often provide a good case for condensing boilers. At Keele University (Good Practice Case Study 42) the chemistry block has a heating load of 3 MW for a floor area of 2100 m^2. Three gas-fired condensing boilers were installed in 1987. Domestic hot water is supplied separately by two direct-fired storage water heaters to maximise summer efficiencies.

The overcost of condensing boilers was £18 000. Annual savings of £5500 provided a payback period of just over three years.

Lighting for research

Much of today's research involves personal computers, and good lighting is essential. While many people prefer to operate under 'glare-free' artificial lighting, the new learning resource centre at Anglia Polytechnic University (Good Practice Case Study 334) uses light shelf technology to shade and reflect daylight to achieve the same result. Artificial lighting is provided at a background level and is controlled to respond to daylight availability. Low energy task lights allow lighting levels to be increased locally.

Keele University chemistry block

CASE STUDIES

Brune Park Sports Hall

5 SPORTS AND RECREATION

Energy efficiency in areas of intensive energy use, such as swimming pools, can be improved by utilising proven techniques such as pool covers. The detailing of the building envelope can also have a significant impact. Public sector facilities provide useful examples of energy efficient operation.

Pool covers

Swimming pools are generally unused for at least 8 hours every night, but many maintain 24-hour heating and ventilation regimes that are appropriate to daytime occupancy. Eastern Leisure Centre in Cardiff has shown how using a pool cover can greatly reduce energy consumption when the building is closed, without adversely affecting bathing conditions.

In ten years of operation the system has saved over £80 000 after deducting the initial cost of the installation.

Heating and water costs were cut by nearly £40 000 a year at one of Southwark College's pools after it commissioned a consultant to carry out an energy survey. No capital expenditure was required (see Good Practice Case Study 333).

Well insulated sports halls

Brune Park sports hall was built for Hampshire County Council within normal cost yardsticks, yet it incorporates a high standard of insulation, and triple glazed rooflights which provide glare-free daylight through a velarium (a translucent diffuser). The daylighting component is estimated to save some 18 400 kWh/year. The scheme also benefits from a condensing gas boiler which, in isolation, has a payback period of 2.4 years (General Information Report 35 in press).

Heslington Hall

The BRE Low Energy Office

6 OFFICES AND ADMINISTRATION

Adopting a low energy philosophy need not involve a significant increase in the capital cost of an office. Low cost measures can lead to significant reductions in fuel bills and can be included in new build and refurbishment projects.

Refurbishment of university offices

Heslington Hall, a listed building, houses the administration offices of York University (Good Practice Case Study 16). An energy audit revealed very poor annual fuel consumption. A programme of low cost energy saving measures was adopted, including:

- rationalisation of building use
- draughtstripping and roof insulation
- separating domestic hot water heating from space heating boilers
- high efficiency gas-fired boiler adding dual fuel capability
- electronic energy management.

These measures gave savings of 40% with a payback period of under two years and brought the building to a 'satisfactory' category for energy consumption in naturally ventilated offices.

Low Energy Office

The Building Research Establishment Low Energy Office, with 2000 m^2 of cellular office space occupied mainly by research staff, has a lot in common with many academic office buildings. Energy efficiency was a key design objective, but at a capital cost no higher than the norms at the time (1981) (Good Practice Case Study 62). The resulting 3-storey design was of simple construction, well insulated for the time, and double glazed. Exposed ceiling soffits were used to improve thermal stability and limit overheating. Most offices faced either north or south. Monitoring revealed low energy consumption and costs.

In 1988 insulation and glazing were upgraded to study the effect on energy consumption of a range of modern heating and ventilation systems. These included well controlled electric panel heaters and gas condensing boilers. The electric system led to improved user satisfaction and reduced energy usage and maintenance costs, but energy costs rose due to the higher cost of electricity. The gas system used more energy than the electric systems, but the cost was lower and CO_2 emissions were reduced.

FURTHER INFORMATION

Energy Design Advice Scheme

Specialist advice on energy efficient design is available from regional centres through the Department of Trade and Industry's Energy Design Advice Scheme (EDAS). Centre staff may give up to one day's free advice. Where further advice will increase the likelihood of energy savings, EDAS may provide further support.

Contact:	Edinburgh	Tel 0131 228 4414
	Belfast	Tel 01232 364090
	London	Tel 0171 916 3891
	Sheffield	Tel 0114 272 1140

Making A Corporate Commitment

Companies and public sector organisations may join over 1600 others in the Department of the Environment's Making A Corporate Commitment campaign to achieve financial and environmental benefits from responsible energy management.

On joining the campaign, a senior board member signs a declaration which covers a number of elements, eg publishing a corporate policy, appointing an energy manager, setting performance targets and increasing energy awareness among staff. Contact the DOE on Tel 0171 890 6568.

Energy Efficiency Accreditation Scheme

Environmentally responsible organisations are being urged to seek public recognition of their efforts. Accreditation is awarded to organisations that can demonstrate a high level of achievement, similar to that of the Queen's Award, in the field of energy and environmental efficiency. Contact ESTA on Tel 01453 886776.

BREEAM

The Building Research Establishment's Environmental Assessment Method, BREEAM, is a method of assessing the environmental quality of buildings. The scheme is voluntary and is carried out by independent assessors licensed by BRE. A certificate is issued identifying where the building has satisfied the criteria set for individual environmental impacts. Contact BRE on Tel 01923 664462.

DOE ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

The documents mentioned in the text, and others in the DOE's Best Practice programme, are available from the BRECSU Enquiries Bureau (see back page for details).

Good Practice Guide

16 Guide for installers of condensing boilers in commercial buildings

Good Practice Case Studies

76 Energy efficiency in sports and recreation buildings: swimming pool covers

335 Investment in energy efficiency at the University of Warwick (in press)

336 Energy efficiency in further and higher education – monitoring and targeting, University of Wales, Cardiff

General Information Leaflet

12 Energy efficiency in offices. Posford House, Peterborough

New Practice Initial Profile

90 Low energy multi-residential housing

Energy Consumption Guide

10 Energy efficiency in offices. Energy consumption guide for senior managers

54 Energy efficiency in further and higher education – cost-effective low energy buildings

Energy Efficiency in Buildings

1 Introduction to energy efficiency in schools

2 Introduction to energy efficiency in catering establishments

5 Introduction to energy efficiency in further and higher education

6 Introduction to energy efficiency in offices

7 Introduction to energy efficiency in sports and recreation centres

CHECKLIST

Checklist of key points

Subject area	Specific issue	Estate strategy	New build	Refurbishment	Operation
Planning	Energy supply options	✓	✓	✓	✓
	Site location	✓	✓		
	Building form and orientation		✓		
	Internal layouts		✓		
	Room layout		✓	✓	✓
Energy targets	Energy efficient standards	✓	✓	✓	
	Environmental benefits	✓	✓	✓	
	Embodied energy	✓	✓	✓	
	Comfort criteria	✓	✓	✓	
Fabric	Integration		✓	✓	
	External walls		✓	✓	
	Floors		✓		
	Roofs and ceilings		✓	✓	
	Windows		✓	✓	
	Thermal bridging		✓	✓	
	Air leakage		✓	✓	
Services	Heating options		✓	✓	
	Domestic hot water		✓	✓	
	Lighting		✓	✓	✓
	Ventilation		✓	✓	
	Controls		✓	✓	✓
Handover	Testing		✓	✓	
	Commissioning		✓	✓	✓
	Familiarisation/training		✓	✓	✓
Post-completion	Operation and maintenance manuals		✓	✓	✓
	Maintenance procedures		✓	✓	✓
Operational	Good housekeeping	✓	✓	✓	✓
	Monitoring and targeting	✓			✓
	Accountability	✓			✓

The Government's Energy Efficiency Best Practice programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice programme are shown opposite.

Visit the website at **www.energy-efficiency.gov.uk**
Call the Environment and Energy Helpline on **0800 585794**

For further specific information on:

Buildings-related projects contact:
Enquiries Bureau
BRECSU
BRE
Garston, Watford WD25 9XX
Tel 01923 664258
Fax 01923 664787
E-mail brecsuenq@bre.co.uk

Industrial projects contact:
Energy Efficiency Enquiries Bureau
ETSU
Harwell, Oxfordshire
OX11 0RA
Tel 01235 436747
Fax 01235 433066
E-mail etsuenq@aeat.co.uk

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy-efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R&D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Introduction to Energy Efficiency: helps new energy managers understand the use and costs of heating, lighting, etc.