Part B Operating and upgrading the building

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15 Acquisition and refurbishment

16 Maintaining the building

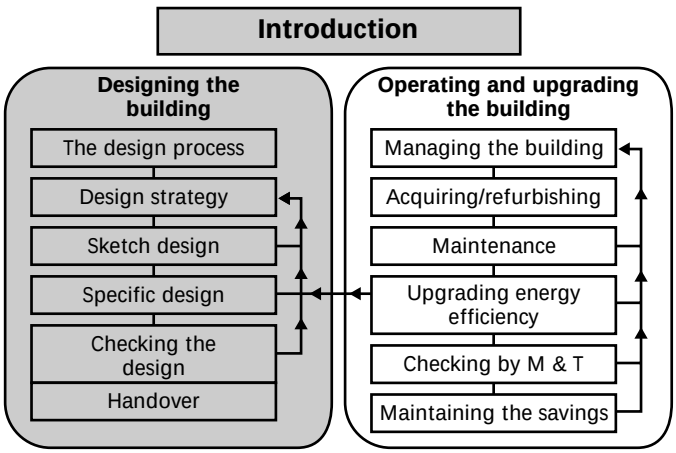
17 Maintaining for energy efficiency

18 Retrofitting energy saving measures

19 Specific energy saving measures

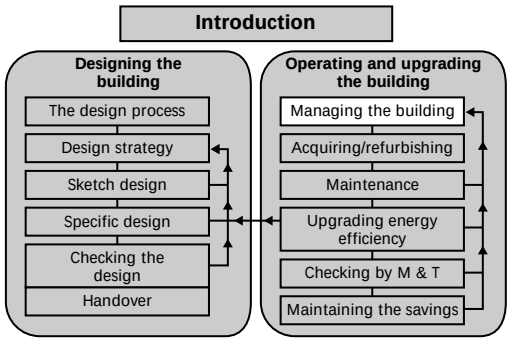
20 Monitoring and targeting

21 Maintaining the savings



14 Managing the building

14.0 General
14.1 Understanding the building
14.2 Energy policy
14.3 Management structures
14.4 Occupant involvement



This section outlines the issues to be taken into account when operating, maintaining and managing existing buildings in an energy efficient manner, in line with the principles at the front of this Guide. It provides an overview of the main policy issues underpinning the energy efficient management[1–3] of existing buildings, and is primarily aimed at the facilities manager or building operator.

14.0 General

The energy used by a building is broadly determined by the building fabric, the building services and the management of the building. The influence of management on energy consumption is commonly underestimated[1]. Although improvements may be made to the fabric and services, the management of the building often has the biggest impact on the day-to-day energy consumption. It is common to find well-designed buildings operating badly due to poor management. Conversely, poorly designed buildings can be optimised to a great extent through good management practices[4].

Even where all the technical measures have been fully considered and implemented, there is often considerable scope for improved energy efficiency by adopting changes in the management, operation and maintenance of the building. The key to energy efficient management of existing buildings is to:

— gain a sound understanding of how the building is meant to work, both at a strategic and detailed level

— set out a clear energy management policy alongside a clear maintenance policy for the building and the building services, and implement these policies rigorously

— put into place organisational structures to ensure that responsibilities are clear, regular reporting/ feedback is appropriate and the necessary resources are made available

— encourage occupants to use the building correctly and motivate them to reduce energy consumption

— set energy targets and continually monitor performance in order to keep consumption under control (see section 20).

The energy management matrix shown in Figure 14.1 can be used to review the current state of energy management and to identify areas for improvement.

14.1 Understanding the building

The key to understanding an existing building is to:

— gain a strategic overview of the design intent

— ensure that the building is well documented

— identify the current status of the building

— identify and address problem areas.

Problems experienced in operating buildings are often due to misunderstandings about how the building design was originally intended to work. Designers intentions are not always fully communicated to the building operator and, sometimes, designers have not necessarily appreciated the operational requirements. This can happen when the client is not the ultimate occupant of the building, or when occupants or operational staff change.

14.1.1 Gaining an overview

The engineer managing specific items of plant often finds it difficult to form a strategic overview of the building and, in particular, an overview of the design intent. It is essential, therefore, to establish how the building is intended to be used and how this relates to the overall heating, lighting, ventilation and control strategies. This strategic understanding is important in providing a framework within which the building can be operated efficiently.

Level	Energy Policy	Organising	Motivation	Information Systems	Marketing	Investment
4	Energy policy, action plan and regular review have commitment of top management as part of an environmental strategy	Energy management fully integrated into management structure. Clear delegation of responsibility for energy consumption	Formal and informal channels of communication regularly exploited by energy manager and energy staff at all levels	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking	Marketing the value of energy efficiency and the performance of energy management both within the organisation and outside it	Positive discrimination in favour of 'green' schemes with detailed investment appraisal of all new-build and refurbishment opportunities
3	Formal energy policy but no active commitment from top management	Energy manager accountable to energy committee representing all users, chaired by a member of the managing board	Energy committee used as main channel together with direct contact with major users	M&T reports for individual premises based on sub-metering, but savings not reported effectively to users	Programme of staff awareness and regular publicity campaigns	Same payback criteria employed as for all other investment
2	Unadopted energy policy set by energy manager or senior department manager	Energy manager in post, reporting to adhoc committee, but line management and authority are unclear	Contact with major users through adhoc committee chaired by senior departmental manager	Monitoring and targeting reports based on supply meter data. Energy unit has adhoc involvement in budget setting	Some adhoc staff awareness training	Investment using short-term payback criteria only
1	An unwritten set of guidelines	Energy management the part-time responsibility of someone with only limited authority or influence	Informal contacts between engineer and a few users	Cost reporting based on invoice data. Engineer compiles reports for internal use within technical department	Informal contacts used to promote energy efficiency	Only low cost measures taken
0	No explicit policy	No energy management or any formal delegation of responsibility for energy consumption	No contact with users	No information system. No accounting for energy consumption	No promotion of energy efficiency	No investment in increasing energy efficiency in premises

Figure 14.1 Energy management matrix[3] (reproduced from DETR General Information Report 12. Crown copyright (1993))

The key to gaining an overview of the building is to establish:

— occupancy levels, including cleaners, late working etc.

— a breakdown of the building into areas with different uses

— the gross and treated floor area and a breakdown of this in relation to use

— the key items of plant, what they supply and which areas they serve

— the means of heating/cooling, the areas served and how these systems are controlled

— how the building is ventilated (see section 6) and how ventilation is controlled

— the types of lighting, the areas they serve and how these should be controlled, particularly in relation to available daylight

— the means of managing, maintaining and monitoring the operation of the building.

The above can be gained using a combination of operation and maintenance (O&M) manuals, drawings, surveys and inspection. The most important aspect is to establish the design intent, alongside what is actually happening in the building. Comparing the two can help to identify energy inefficiency.

14.1.2 Documentation

Good documentation is necessary to support the efficient operation of the building. This is usually in the form of O&M manuals (see section 13), architectural and building services drawings, plant details, manufacturers' information and commissioning records, together with a detailed maintenance schedule.

Energy-efficient buildings are inherently designed within tighter parameters, the result being that they tend to be particularly sensitive to changes in use or layout. Therefore, the documentation should also provide a convenient means of logging changes that are made to the building. This also helps avoid changes that may contradict the original design intent since these can have major consequences for energy use and comfort.

A written explanation of the occupants' involvement in the operation of the building should be provided for distribution to staff. This should give guidance on practical matters such as:

— use of windows for ventilation

— use of local heating controls

— use of lighting/shading to maximise the use of daylight.

A written explanation of the overall design intent may also be helpful, e.g. the ventilation strategy, as this could deter occupants from adopting bad practices such as placing books on top of fan convectors.

14.1.3 Identifying the current status

Identifying the current status and operation of the building compared with the design intent will help building managers understand the building better, particularly when they are new to a building. Initially, this can be achieved through overall performance indicators, such as £/m^2 for energy[5] and maintenance. The approach should gradually become more detailed, establishing performance indicators for specific services etc., as shown in section 12, Figure 12.1[6]. A qualitative measurement of the building can also be established through detailed assessments by:

— floor area surveys

— energy audits and surveys (see section 18)

— an analysis of monitoring and targeting (M&T) data (see section 20)

— condition surveys of fabric and plant

— reviewing maintenance contracts and practices (see sections 16 and 17)

— occupant surveys, to establish comfort and satisfaction levels

— monitoring plant operation and energy consumption.

14.1.4 Problem areas

Problems should be investigated promptly and the root causes sought. Many energy problems develop from poor interaction between fabric, services and occupants. Conflict can prevent the building operating in a coherent manner. For example, partitions may prevent natural cross ventilation and cause heating/lighting sensors to become separated from their respective zones.

Building services controls are often the key to solving energy and comfort problems. Poor controls can result in under or over provision and conflict between services, e.g. simultaneous heating and cooling. Improving the function, location and set points of controls can help to avoid such problems.

14.2 Energy policy

14.2.1 General

Adopting an appropriate and realistic energy policy delivers increased and sustainable performance improvements and provides a clear sense of direction. Any new policy should review current practices and provide a good starting point to an energy campaign[7].

Figure 14.2[8] shows a framework for developing an energy policy. The process will educate the decision-makers and secure financial approval for investment. For most organisations, a policy document will comprise a few pages. It should be reviewed annually. It is important that the energy manager gains the support and agreement of all his colleagues, particularly senior management, at each review.

An energy policy will:

— establish senior management commitment to energy efficiency

— improve the overall approach to energy management

— help to keep the main objectives in full view

— maximise the use of resources, both in time and money

— provide goals against which to monitor

— provide a clear direction for the energy team

— give senior management a way forward.

The long-term policy document is likely to cover five years, but would almost certainly be supported by other documents providing more detail on a shorter time scale. One such supporting document might be an annual action plan[2] showing specific energy saving projects with target dates and costs, together with the staff charged with the actions.

The energy policy should ideally be developed in conjunction with the maintenance policy (see section 16).

Energy management and policy should be reviewed regularly[1]. Using a management matrix[2,3,9–11] to help draw an 'organisational profile' of the current position will highlight strengths and weaknesses in policy, communication, investment, information, planning and audit. Senior management should also complete the matrix from their own perspective in order to secure their commitment and identify any differences between their view and that of the energy manager.

14.2.2 Energy policy checklist

The following checklist[8] provides a starting point for energy management. It is by no means exhaustive and needs to be tailored to suit the organisation. However, this skeleton checklist poses some of the key questions that need to be addressed in formulating a policy document.

(*a*) *Overall objectives*:

- Energy saving or cost cutting.
- Attempt to save on all sites?
- Attempt to save on all fuels?
- Attempt to conserve water?
- Overall target saving?
- Over what time-period?

(*b*) *Management reporting structures*:

- Who is responsible overall?
- Duties/responsibilities of the energy manager?
- Who is accountable in each cost centre?
- Who implements savings?
- Management structure/lines of reporting?
- Who needs to meet and when?
- Lines of reporting.

(*c*) *Manpower resources*:

- Total man years invested?
- At what levels of seniority?
- Use of external consultants?
- Use of contract energy management?
- Who monitors consumption/cost?
- Who checks the bills?

(*d*) *Financial resources*:

- Total funds to be invested?
- Separate energy budget?
- Capital versus maintenance?
- Mechanism for reinvesting savings?
- Use of contract energy management?
- Allow reinvestment of savings?

(*e*) *Financial criteria*:

- Maximum acceptable payback period?

(*f*) *Monitoring*:

- What management information is required?
- Use of energy statistics to raise staff awareness?
- What needs trend logging?
- Use of performance indicators?
- Construct a league table of buildings to assess priorities?
- Need for a bill checking mechanism?

(*g*) *Targets*:

- Cost or consumption?
- Targeted percentage savings over one and five years?
- Targets for individual cost centres?
- Targets for individual fuels?

(*h*) *Motivation*:

- Publicity campaigns?
- Competitions?
- General staff training to raise awareness?
- Staff suggestion schemes?
- Incentive schemes?

(*i*) *Training*:

- Investigate staff development/training needs.
- List of planned course attendance (technical and managerial).

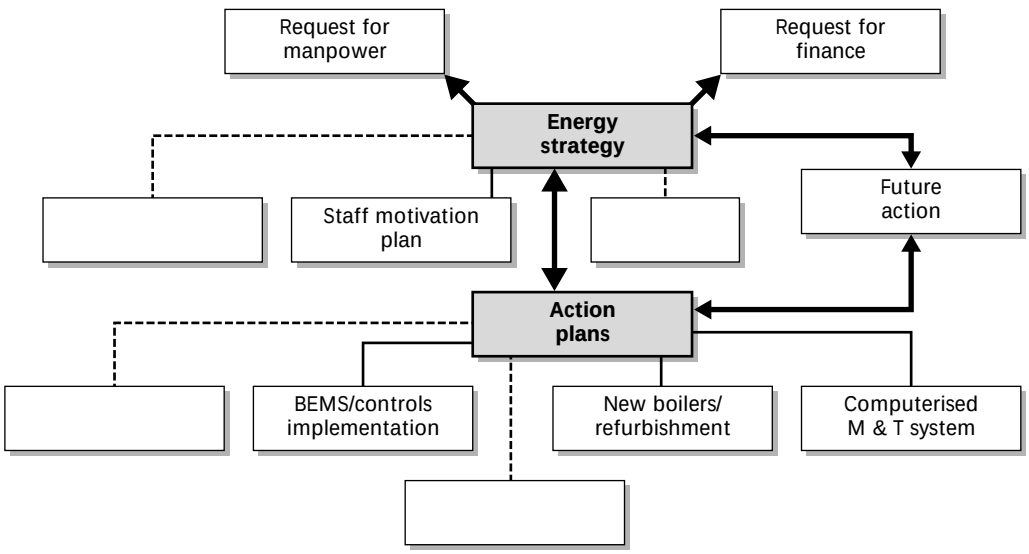


Figure 14.2 A framework for developing energy policy[8] (reproduced from *Educated Energy Management* by permission of the publisher)

(*j*) *Energy surveys*:

- List of buildings targeted for surveys
- Means of funding?
- In-house or consultants?
- Choice of consultant?

14.3 Management structures

The location, role, responsibility and reporting lines of staff involved in energy management are important issues for the success of the programme. It is important that energy managers and building operators understand the framework within which they can effect energy use. This may vary significantly from one organisation to another. Although energy management is sometimes seen as a technical discipline, the bulk of the work requires general management skills.

14.3.1 Responsibility and reporting

Allocating responsibility for energy is a major part of initiating a programme. Energy management needs to be an integral part of the general management structure with recognised reporting lines to senior management[3]. Someone needs to have overall responsibility for energy but all managers and staff have a role to play. In large buildings, and multi-building sites, it is often useful to nominate energy wardens for zones in order to act as the eyes and ears of the energy manager.

Larger organisations should consider setting up cost centres where line managers are responsible for their own energy costs. An energy committee with representatives from all departments may also be worthwhile.

Whatever structure is in place, it must be capable of implementing the energy policy[2,3]. This requires reporting on a regular basis; weekly, monthly, annually, to allow senior management to monitor energy costs (see section 20), identify savings made and make decisions on further investment. The energy manager will also need to identify opportunities for investment and prepare a financial case for consideration by senior management.

Where line managers are accountable for their own energy use, an effective method of feedback is necessary from the energy manager to occupants, as this can help to raise staff awareness and support for the campaign.

14.3.2 Roles and activities

All energy staff involved in the energy campaign should:

- improve staff awareness, motivation and commitment
- assist in collecting and analysing information
- take informed action and review the benefits that have accrued.

Senior management should:

- review energy policy
- agree and enforce targets
- agree resources and investment
- monitor progress of the energy programme
- provide recognition for success.

Without the commitment of senior management the programme is unlikely to succeed[2].

The energy manager should:

- develop the energy policy
- co-ordinate day-to-day energy management
- collate energy consumption and cost data and develop monitoring systems
- provide feedback and report on energy use
- identify and evaluate opportunities to improve energy efficiency
- prepare investment plans and implement agreed measures
- promote energy awareness and develop staff motivation
- gain the acceptance and support of staff at all levels
- educate staff in energy management techniques and efficient operating practices
- ensure adequate control and monitoring facilities are available
- review any historical energy data, allowing for changes in building use and, hence, examine the projected energy costs for a building.

The energy manager is the focal point of the energy efficiency programme and may often require specialist support to implement the programme[2].

General staff should:

- report energy waste
- suggest energy saving measures.

14.3.3 Obtaining resources

Energy managers may face difficulties in justifying why their organisation should invest in energy efficiency. Organisations often give priority to investment in their core activity and will usually demand faster rates of return on investment in energy savings.

In arguing for investment in energy savings it can be helpful for energy managers to suggest ways in which cost savings from energy management could be redeployed within the organisation. These can be shown as:

- reducing operating costs
- increasing employee comfort and productivity
- improving cost effectiveness and/or profits
- enhancing the quality of service or customer care delivered
- protecting the environment.

14.3.3.1 Financial investment

The same criteria should apply for energy investment as in other areas of business planning. Planned capital investment can produce rapid revenue savings. If current accounting practices restrict funding, new procedures should be considered. For example by:

— re-investing some of the revenue savings in energy management

— allowing a share of the energy cost savings to be used for other purposes by those who achieve the savings

— treating some energy management costs as an overhead that contributes to staff comfort and productivity

— allowing use of revenue for capital expenditure when it can be recovered by revenue savings within the accounting period.

As a guideline, the level of investment that can be justified each year in energy management is of the order of 10% of the annual expenditure on energy[3]. This figure could be exceeded in the early stages of development, when there are more opportunities for investment. A lower figure may be considered adequate in a well-developed programme until new opportunities arise.

14.3.3.2 Manpower Investment

The specific number of staff required for energy management will depend on:

— the size of the energy bills

— the extent to which the programme of energy management has been implemented

— the required reduction in energy consumption.

The number of staff involved in energy management is likely to vary over time. However, it is suggested that there should be minimum of one full-time member of staff for every million pounds of energy expenditure up to £3 million per annum[3]. Beyond this, it is advisable to have one full-time member of staff for each additional £2 million up to £10 million and, above that, there should be one for every extra £4 million. If energy costs are less than £1 million per annum, organisations should consider appointing a part-time energy manager.

14.3.4 Sub-contracting energy management

Senior management may take the view that as energy management is not a core activity, it should be sub-contracted, completely or in part. There are three main routes for sub-contracting:

— specialist consultants

— contract energy management (CEM) companies

— contract facilities management.

14.3.4.1 Specialist consultants

Should staff lack the technical knowledge or time to perform energy audits/surveys or other energy investigations, help or advice is available from specialist energy consultants[12–14] (see section 18).

14.3.4.2 Contract energy management (CEM)

Contract energy management companies offer a range of technical and financial services, some of which include the complete operation and maintenance of plant and building services. CEM companies can also provide investment in more efficient plant and will recover their investment from the saving achieved. Different types of contract are available but most incorporate improvements to energy efficiency.

Most large buildings are suitable for CEM. Small buildings with an energy bill less than say £50,000 p.a. would not normally be appropriate, except as part of a larger group. Using CEM, companies can transfer the investment risks to the contractor, who typically assumes responsibility for delivery of energy services and relevant maintenance. Figure 14.3 illustrates opportunities for introducing third-party services.

The suitability of CEM depends on:

— the availability of in-house technical expertise

— the ability to find capital projects

— the suitability of the building

— the nature and status of occupancy

— the negotiation of an acceptable contract.

If CEM is selected as the preferred option, the client should identify and implement no-cost and low-cost measures before proceeding with the contract. Such measures can be identified by the user and by the contractor carrying out an on-site energy survey (see section 18).

There are essentially three types of CEM contract. These are based on:

— variable heat charges (heat service)

— shared savings

— fixed fees.

Careful consideration is required in selecting the most suitable contract[15], and Table 14.2 summarises the main advantages and disadvantages of the three types of contract.

14.3.4.3 Contract facilities management

Contracting out overall facilities management has become increasingly popular. If facilities management is provided by an external contractor then effective liaison on energy matters should be incorporated within the contract. The contract should set out requirements for energy management, preferably in terms of a performance specification. Specifically, this should include a range of performance indicators for specific services as shown in section 12, Figure 12.1[6].

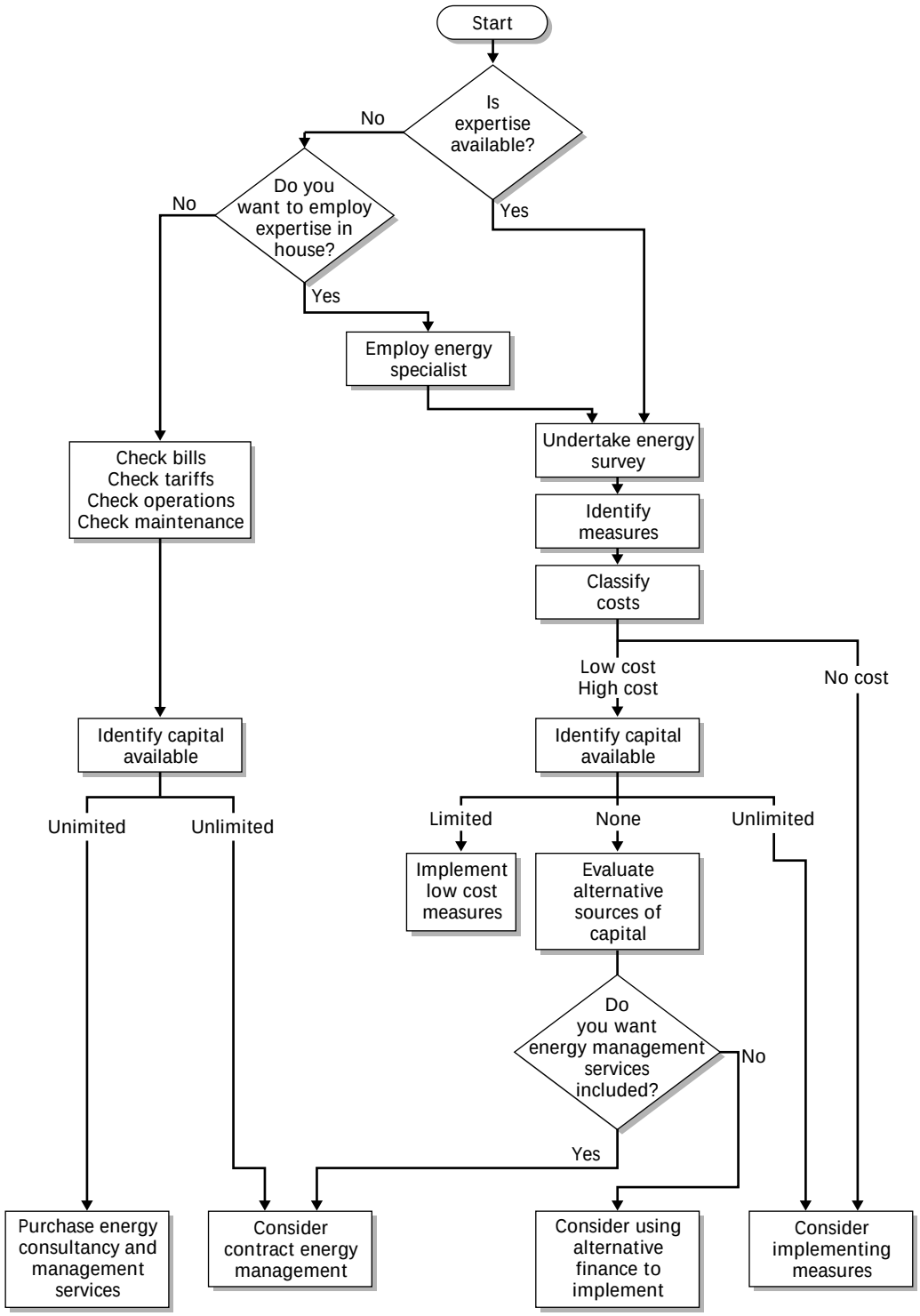


Figure 14.3 When to contract out energy management[15]

14.3.5 Purchasing policy

Purchasers of energy, sub-contracted services and equipment should be encouraged to consider energy efficiency as an important criterion.

14.3.5.1 Energy

The energy and purchasing managers should review periodically the arrangements for purchasing energy. There is a wide range of energy supply contracts available, with significant cost saving possible through judicious competitive tendering. Whilst this does not generally affect energy consumption, it can alter the energy supply tariff structures, and this can have a knock-on effect for energy management procedures.

14.3.5.2 External contracts

Where general services, e.g. catering, cleaning and security, are to be sub-contracted, it is vital to include energy efficiency in the contract. Compulsory competitive tendering and selecting the lowest cost tender rarely results in an energy efficient solution, unless it is clearly asked for in the brief. During the tendering procedure, it is advisable to check the contractor's ability to manage energy. This is particularly important when contracting:

— cleaning staff (switching lighting on and off)

Table 14.2 Advantages and disadvantages of CEM contracts

Contract type	Advantages	Disadvantages
Heat service	Simple payments based on energy use	No incentive for CEM company to reduce user's demand
	Full user control over amount of energy use	Cost savings strongly dependent on fuel prices
	User benefits directly from reduced consumption	Contracts of long duration
	Guaranteed supply	Usually limited to heat supply only
	Well established form of contract	Calculation of share of savings can be complicated
Shared savings	Performance basis encourages CEM company to achieve savings	Costs and savings not known in advance
	Some savings guaranteed	CEM companies may take unacceptable degree of control over energy supply
	Incentive for user to increase savings	Unconventional contract and finance
	Only savings achieved by CEM company's investment need to be shared	No incentive to user to reduce consumption
	Flexible contracts allow higher rewards if user accepts more risk	Control may be surrendered to CEM company
Fixed fee	Single, fixed payment	Not usually available as energy savings service on its own
	No complicated calculation	
	Cost known in advance	
	Single point of responsibility for all services included	
	Shorter contract lengths than other types	

— security staff (patrols can switch-off lighting and equipment)

— catering staff (control of ovens, hot plates and use of hot water).

14.3.5.3 Office equipment

Managers should select the most efficient office equipment possible, with the energy consumption and energy saving features established before purchase (see section 11). Manufacturers should provide the average power consumed under typical conditions, the peak nameplate rating, provision to switch to standby 'sleep' modes and the consumption in these modes. It should be noted that average power consumption is not necessarily related to the nameplate rating. Modern PCs tend to have 'energy star' ratings and purchasing managers should acquire only equipment which satisfy these requirements.

Purchasing efficient equipment also applies to desk lamps and fans, vending equipment, photocopiers and printers. This is particularly important when selecting catering equipment such as ovens and dishwashers.

14.3.5.4 High efficiency motors

All new and replacement plant should be specified with high efficiency motors as they now carry little or no additional capital cost. For new applications or spares, it is always cost-effective to buy high efficiency motors (see section 10). Motor rewinding and repair policies may also require review and amendment since it may be more economic to replace older motors by higher efficiency motors (see 19.7).

The efficiencies of energy efficient motors range from 2 to 6%. Ideally, purchasing specifications should define precise performance requirements for each motor by application and size, including minimum acceptable efficiency. If this is impractical, the user should specify 'premium', rather than 'high' efficiency motors.

14.4 Occupant involvement

14.4.1 Motivation and training

The value of making energy a management issue and relying on people, rather than purely technical solutions, cannot be over emphasised. By raising awareness about the campaign, energy managers can enlist staff and management support to achieve success. For example, a good housekeeping campaign will recognise the importance of cleaning and security staff, particularly as they are often the first and last people in the building. Implementing a good housekeeping policy can also promote staff awareness of their responsibility to the environment as a whole[16,17]. Equipment will only be switched off if staff fully understand the reasons.

Whilst monetary saving is a driving factor for management it is seldom a motivator for staff in general. Therefore, it is the responsibility of the energy manager to find ways of convincing staff that energy efficiency is worthwhile. Possible motivators and de-motivators are shown in Table 14.3. The influence of these motivators on the staff will differ depending on their positions in the energy management structure. It is, of course, particularly important to communicate success at all levels in order to maintain the momentum of the campaign.

Training is essential for all those that have responsibility for energy management, particularly energy managers, wardens and those responsible for reading meters[18].

Table 14.3 Examples of motivating and de-motivating factors

Motivators	Demotivators
Individual or group achievement	Unrealistic targets
Praise and recognition of success	Lack of support
Encouragement and support	Inadequate resources
Sense of individual control	Lack of recognition
Concern for environment	Failure to reward
Strong corporate image	Imposition of directives without explanation
Savings represent additional staff/equipment	Feeling of inability to influence or control

14.4.2 Occupant satisfaction

The comfort, health and safety of the occupants are primary aims of any building manager. However, well managed buildings can be both comfortable and energy efficient[19]. Occupant satisfaction is not only about providing the right temperature and light levels, but is also associated with peoples' ability to control their own surroundings. For example, delays in switching on the cooling system in response to warm weather may persuade occupants that their local environment is unsatisfactory.

The building manager will find that there are real energy saving benefits to be gained from securing the understanding and involvement of occupants. Staff should be:

— advised how to use the building and control the local services

— informed and encouraged to improve energy efficiency

— kept informed about any problems together with the actions being taken.

Health and safety regulations based upon European Workplace Directives place new responsibilities on building managers, clients and building professionals to maintain the indoor environment for buildings in which people work. These are:

— *The Workplace (Health, Safety and Welfare) Regulations 1992*[20]: affects ventilation, temperature and lighting standards.

— *The Health and Safety (Display Screen Equipment) Regulations 1992*[21]: affects the therma1 and visual comfort of occupants using display monitors and requires the provision of adequate humidity in the space.

Guidance on complying with these regulations is available[22]. Whilst these regulations provide constraints for the building, the opportunity to install energy efficient services should not be missed where systems need to be replaced or upgraded in order to meet these regulations.

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