CHAPTER 2: PRINCIPLES OF AN ENERGY MANAGEMENT PROGRAMME

"Man's mind stretched to a new idea never goes back to its original dimensions."

Oliver Wendell Holmes, Snr.

2.1 INTRODUCTION

From chapter 1, it can be said that a complete energy management programme must look at reducing energy cost within the context of environmental harmony in order to enhance competitiveness and maximise profits. This is the goal of an energy management programme. This goal can be achieved by addressing four areas, namely the diagnosis of the energy load, generating energy awareness and education, undertaking load management and conducting equipment maintenance.

From the case studies of energy management programmes presented in the previous chapter, it was noted that very few academic institutions have a structured energy management programme in place. Some of these institutions have highly successful programmes while others, although their effort is positive, have not adopted a structured approach towards their programme. It is not possible to merely conduct a series of retrofit projects and hope to achieve the eventual goal of the energy management programme. Naturally this approach will produce immediate results but the energy management programme, as a whole, will be a failure because other key areas such as maintenance and student and staff education will have been ignored. Very often the latter two areas are forgotten because the results that they deliver are very difficult to quantify and measure. However, attention must be paid to all four areas.

The problem facing many institutions is the limited human and financial resources available to tackle all programme areas simultaneously. Any funding procured will more often that not be used to generate the maximum amount of energy savings which invariably implies investment into new technologies and not programme awareness and end-user education. How is it possible to address all programme areas with these limited resources? The answer is the implementation or adoption of a systematic and structured approach to the energy management programme as will be presented in this chapter.

2.2 SCHEMATIC REPRESENTATION OF THE ENERGY MANAGEMENT PROGRAMME

If the purpose of an energy management programme is to reduce the energy cost per product, then the focus areas of this cost reduction must be the equipment that uses electrical energy and the people that use the equipment. This concept is illustrated in figure 2.1.

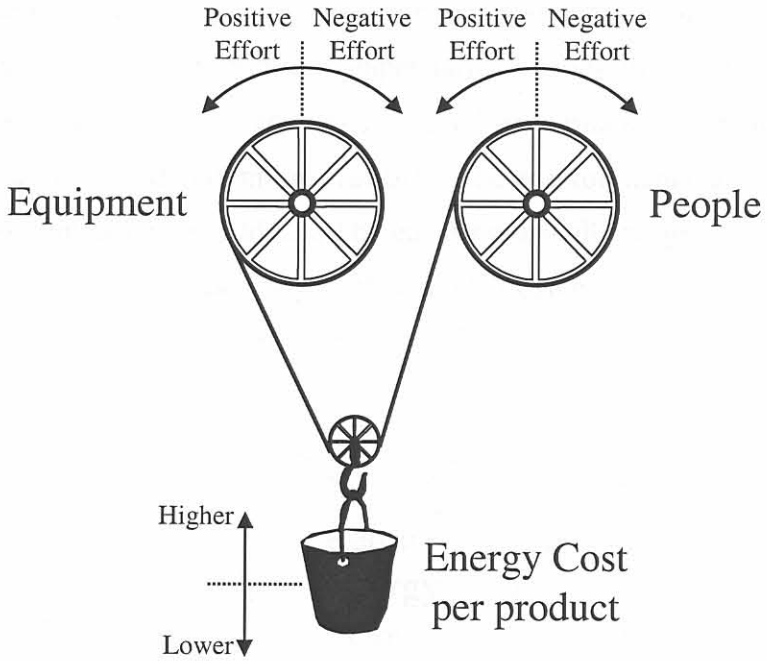

Figure 2.1: Schematic Representation of an Energy Management Programme

Without the full co-operation and support of each and every person on campus, the energy programme will fail to reduce the energy cost per product or process. In a similar vein, the energy management programme cannot only place attention on the people on campus without paying attention to the types of equipment that are being used. After all, it is this equipment which uses the energy in the first place. The human element may simply be contributing to the exorbitant energy consumption as a result of improper use through a lack of knowledge or skills.

However, according to the definition of an energy management programme in chapter 1, focusing on the equipment and people on campus must be brought into an environmental context if the energy management programme is to be complete. Environmental concerns are presently focussed on the reduction of non-renewable energy consumption. Non-renewable energy sources are those obtained from the burning of fossil fuels whereas renewable energy sources include, amongst others, solar, wind, wave and animal power.

The burning of fossil fuels contributes to the degradation of the environment and affects the climate through global warming. In other words, reducing energy consumption assists the environment. In chapter 1, the concept of reducing energy cost without necessarily reducing energy consumption was introduced. For example, using energy during different times of the day could reduce costs if you were billed on a time-differentiated tariff structure. Although it would seem as though an energy management programme orientated towards cost could counteract the environmental concerns, it should be remembered that using energy during cheaper tariff periods in order to reduce overall product cost does help because it ensures improved performance from an energy supply point-of-view (i.e. improved system load factor). The environmental aspect of the energy management programme can be addressed by ensuring that all energy reliant processes and sub-systems on campus are operating with a high degree of efficiency. Figure 2.2 illustrates the activities that form part of the energy management programme.

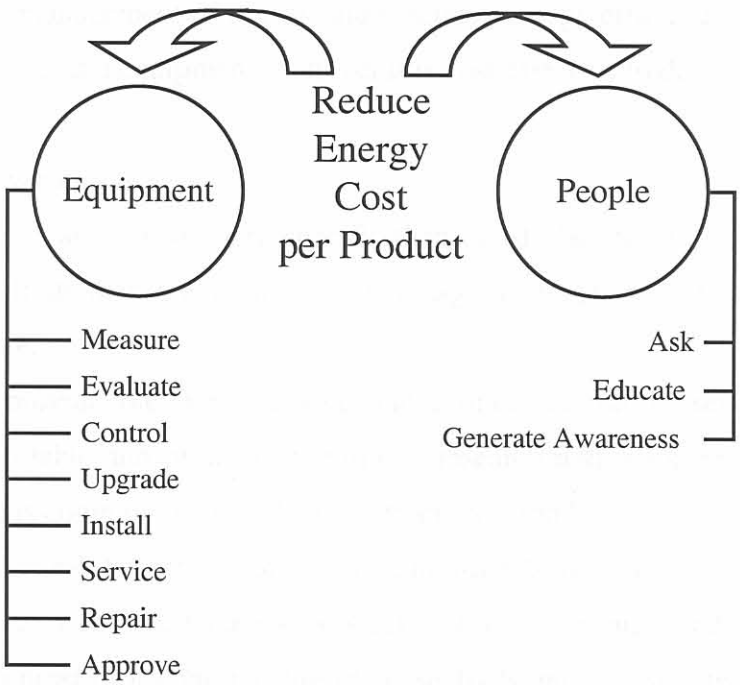

Figure 2.2: Activities of an Energy Management Programme

2.3 AN ENERGY POLICY

An energy policy is a formal statement that is made by a government, party or person through which the course that is being adopted with respect to energy is defined. The energy policy defines the direction of the energy management programme and is specific to each institution. Energy policies ensure the sustainability and transparency of the energy management programme and are statements of corporate commitment towards

environmental harmony through the activity of reducing energy costs per product or business process. More simply put, an energy policy states what an institution intends doing about energy management and the goals they hope to achieve. An energy policy should not be confused with an energy strategy. The policy defines what the institution intends doing regarding energy whereas the strategy determines how it will be accomplished. An energy policy has three essential components and should not be longer than a single page in order to maintain programme focus:

- *Declaration of Commitment*

  The written support of top management sets the tone for the energy policy. As the name implies, it is a declaration that ensures that the management of energy will be sustained and supported as one of the many vital activities within the institution. For example:

  "As part of its environmental strategy, the University of Warwick is committed to the responsible management of energy and practices energy efficiency throughout all its premises, plant and equipment wherever it is cost-effective to do so."[21]

- *Mission Statement*

  The mission statement is more specific than the declaration of commitment in the sense that it defines the focus of the energy management programme. Some examples are:

  - "To provide the most reliable and economical utility services for a safe, comfortable and productive learning, research and work environment for the campus community at the University of Houston."[17]
  - "To control the energy consumption in order to avoid unnecessary expenditure, improve cost-effectiveness, productivity and working conditions, protect the environment, prolong the life of fossil fuels and investigate and promote the use of renewable fuels."[25]
  - "To guard in a responsible manner over energy usage on campus as a scarce, necessary and expensive resource and to provide maximal benefit to the users in return for the minimum energy consumption and cost."[31]

- *Programme Goals*

  The goals of the energy management programme determine the specific objectives of the institution in order to achieve the mission statement. The goals will eventually

determine whether the energy management programme has been successful or not. For example [25]:

- To ensure that commitment is obtained from staff at all levels within the University on aspects of energy efficiency
- To purchase fuels and energy sources at the most economic costs
- To reduce the amount of pollution caused by energy usage, particularly emissions which are the main contributor to global warming
- To annually invest 50% of the previous energy saving costs in order to further reduce energy usage across the University
- In order to ensure its effectiveness, this policy will be reviewed and amended annually.

Occasionally a quantifiable target may also be included in the goals. Once a set target has been reached, a new target can be set either along the same line or towards another objective of the energy management programme. For example:

- To achieve a 2% energy saving each year for the next 3 years by good housekeeping supplemented by a capital spend not exceeding £50,000 per year. [21]
- Reduce energy consumption by 20% in the next fiscal year. [19]

The interaction of these three components is illustrated in figure 2.3. If all the goals have been achieved, the mission statement will have been satisfied.

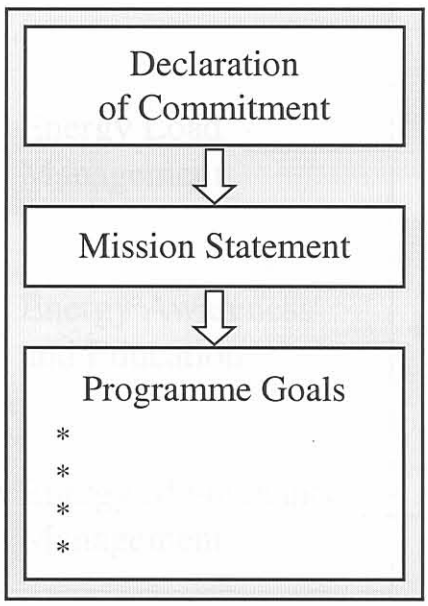

Figure 2.3: Components of an Energy Policy

2.4 AN ENERGY STRATEGY AND AREAS-OF-ACTIVITY

If the energy policy determines the destination of the energy management programme, then the energy strategy determines the route. The energy strategy is the working plan that is put in place in order to achieve the programme goals and eventually the mission statement. At this point it is evident that the goal of the energy management programme is to reduce the energy cost per product or process and that this can be achieved by addressing both the equipment and people on campus as illustrated in figures 2.1 and 2.2. However, the problem lies in ensuring that all the programme activities listed in figure 2.2 are addressed in a systematic manner in order to optimise resources.

The answer lies in the four areas that were first introduced in chapter 1 and these are now included and defined as areas-of-activity as follows:

- Energy Diagnosis
- Energy Awareness and Education
- Energy Load Management
- Energy Maintenance Management

These areas-of-activity are the links between the goals of the energy management programme and the activities that are undertaken as part of the programme as shown in figure 2.4.

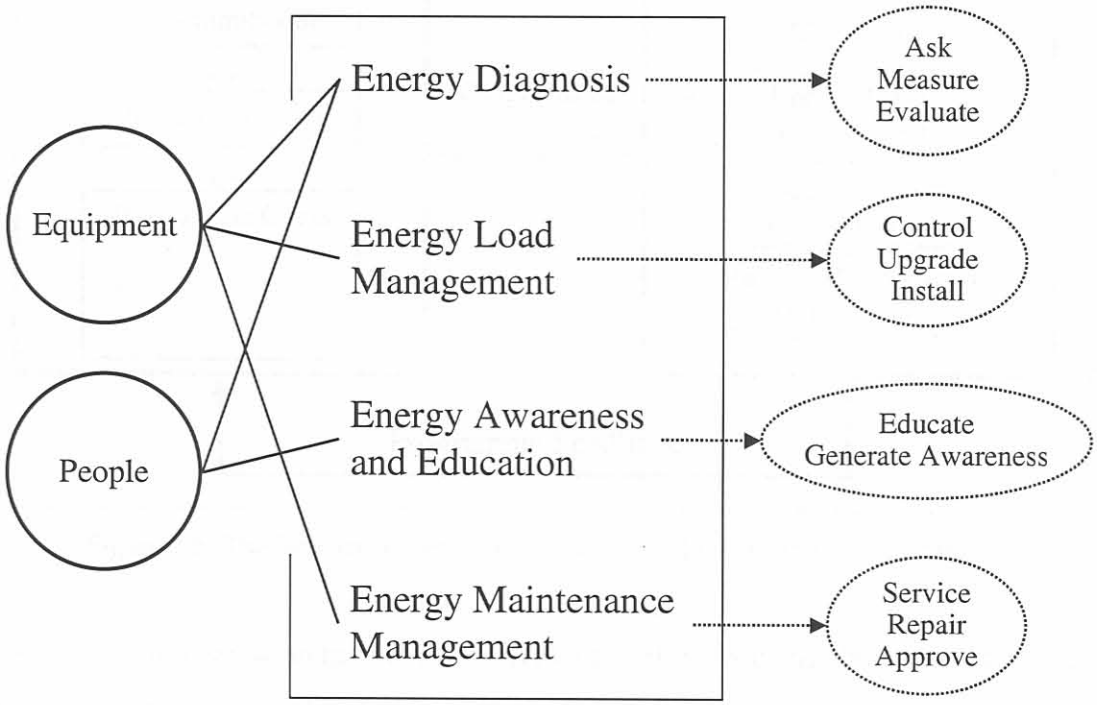

Figure 2.4: The Areas-of-Activity as part of the Energy Strategy

Each area-of-activity is not a stand-alone component of the energy management programme and relies on a high level of interaction with the other areas. The energy strategy could therefore be defined as a series of tasks vital towards achieving the goals of the energy management programme, grouped under different areas-of-activity. Examples of these tasks could include the installation of a campus-wide energy management system under the energy diagnosis area-of-activity or re-scheduling lecture timetables in order to optimise the occupancy as part of the energy load management area-of-activity. The flow of communication between the areas-of-activity will be dealt with later on in this chapter.

2.5 ENERGY POLICY AND STRATEGY INTERACTION

The energy policy and strategy are the primary planning elements of the energy management programme. They determine the goals of the institution with regards to energy and the structured plan to achieve those goals. As mentioned in chapter 1, an energy management programme is not a process that can only be implemented once off. In other words, without feedback creating a communication closed-loop, the energy planners are unable to learn from past experiences on their campus. This closed-loop approach is illustrated in figure 2.5.

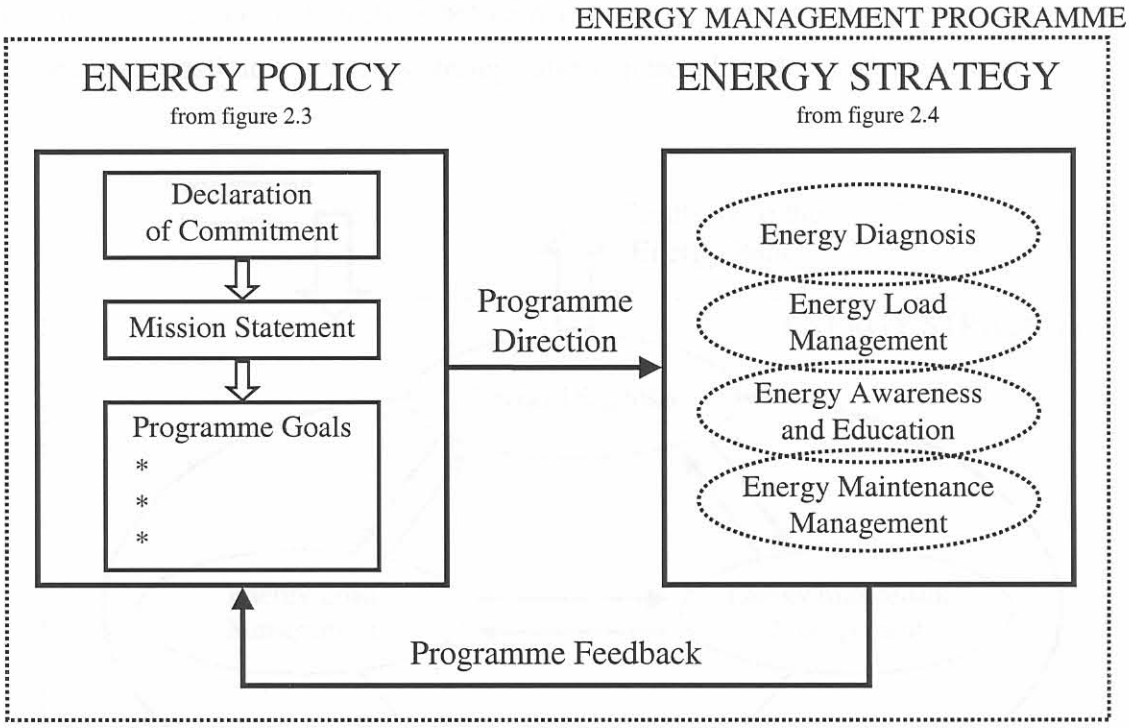

Figure 2.5: The Interaction between the Energy Policy and the Energy Strategy

For example, an institution has set themselves a target of reducing their consumption, by a percentage within a couple of years, as one of their programme goals in their energy

policy. This goal, along with all the others, provides the direction of the energy management programme but does not determine how this set target will be achieved. In the energy strategy, it is determined that achieving this specific target can be accomplished through the installation of power factor correction equipment at all the infeed points and a few other smaller projects. Having reached this target, the energy policy needs to be updated and ammended to firstly remove the existing target and possibly replace it with a new one if desired. The energy policy could also be ammended to reflect changes in the declaration of commitment or the mission statement in line with other policy decisions of the institution management.

The frequency of feedback will be determined from the successes of the energy programme. It is never wise to continuously rewrite the policy. As a guideline, the energy policy should at least be revisited annually to reflect the ammendments as a result of programme successes and the growth in knowledge of the personnel responsible for the management of energy.

2.6 AREA-OF-ACTIVITY INTERACTION IN THE ENERGY STRATEGY

As with external communication between the energy policy and strategy, the areas-of-activity that constitute the energy strategy also require a high level of interaction.

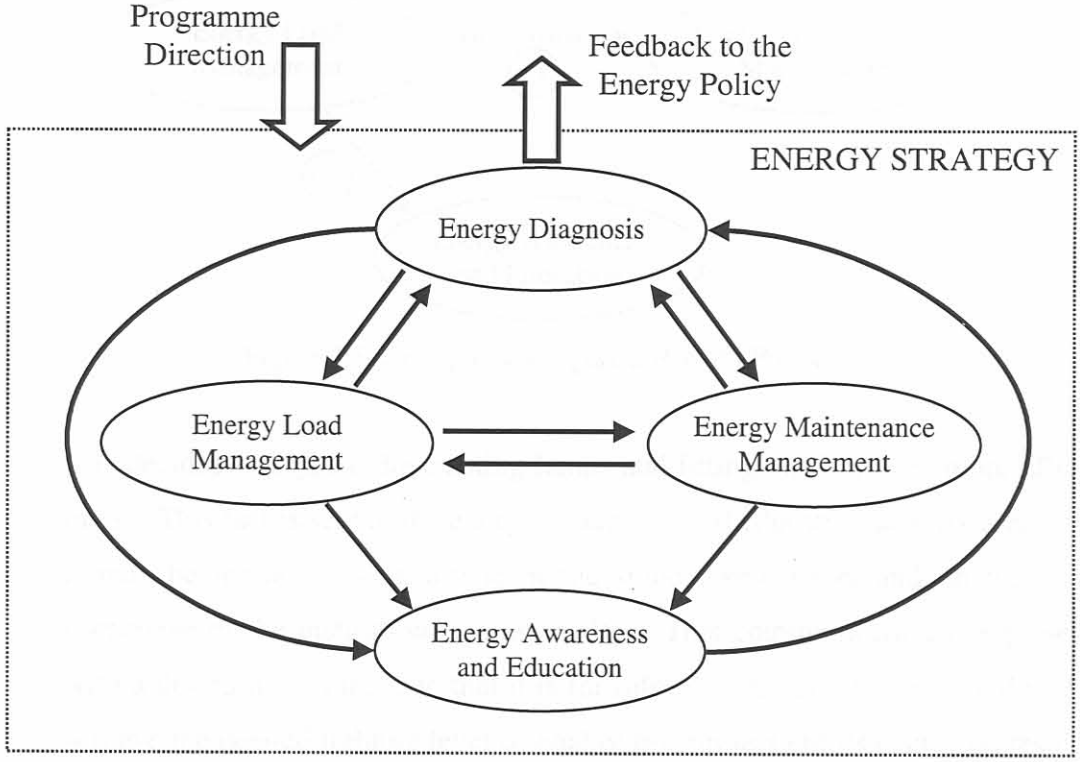

Figure 2.6: The Interaction between the Areas-of-Activity

Strong emphasis was placed on the closed-loop approach to energy management and this principle is illustrated in figure 2.6. The communication between the areas-of-activity in this diagram can best be explained with some examples.

2.6.1 Example of a Lighting Retrofit Project

In this example, the interaction between the areas-of-activity will be explained for the case where poor energy benchmarks are corrected through a lighting retrofit project.

Step 1: Energy inefficient lamps in terms of lumen/W are identified as one of the culprits of a poor energy benchmark in a building.

Step 2: It is decided to pass this problem onto the energy load management activity area, as it is a fault caused primary from poor equipment and neither as a result of human occupancy or poor maintenance (see arrow A). This communication is presented with a solid line to indicate that it is a primary activity vital towards the success of the project.

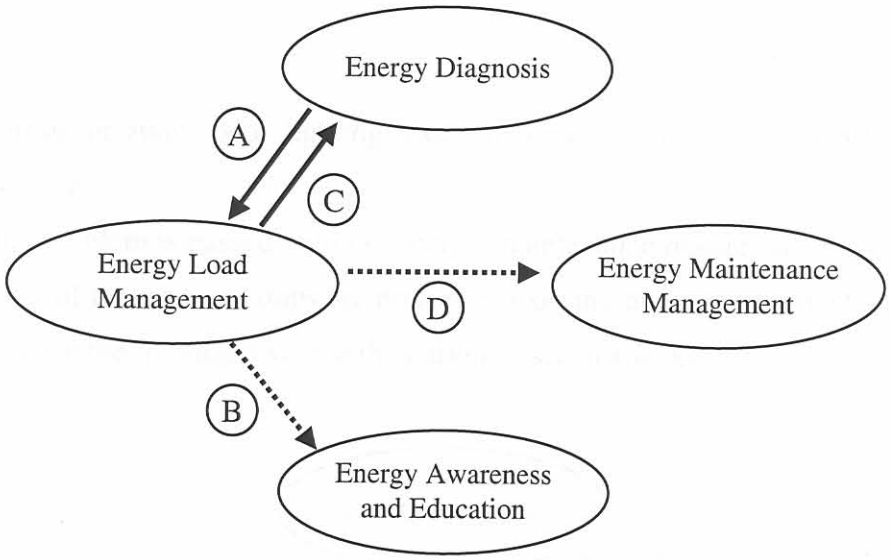

Figure 2.7: Example of a Lighting Retrofit Project

Step 3: It is decided to replace the existing lamps and fittings with newer, more efficient ones. This fact is sent to the energy awareness and education activity area so that it may be included as an article in the student newspaper and on the energy homepage of the institution (see arrow B). This communication is represented with a dotted line to indicate that it is for information purposes only and will not achieve the desired lighting level or goal of this project but its exclusion results in an incomplete programme.

Step 4: After installation of the new lights, the new level of energy performance needs to be determined (see arrow C).

Step 5: If the benchmark is reached or partially improved, the project was successful and no other interaction is necessary. In this instance, the final part of the project involves transferring all technical specifications regarding the lamps and their supply to the energy maintenance management activity area so that they may be included in the inventory of energy equipment and that the necessary spares may be stocked (see arrow D).

In reality, performing one single project may not achieve the energy benchmarks for a building. It will take many projects but each one of these projects interacts in the same way as this one.

2.6.2 Example of a Lighting Maintenance Project

In this example, the interaction between the areas-of-activity will be explained for the case where inefficient lighting levels are corrected through a maintenance programme. Figure 2.8 refers.

Step 1: During an audit, poor lighting levels in terms of lumen/m^2 are identified in a building.

Step 2: This problem is passed onto the energy maintenance management activity area as many of the present lamps are no longer working and correct maintenance would improve the lighting levels in the building (see arrow A).

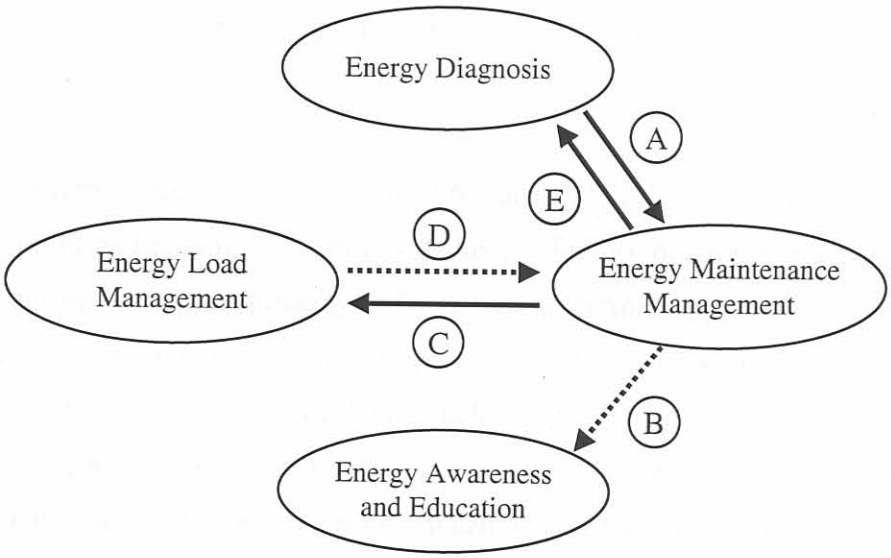

Figure 2.8: Example of a Lighting Maintenance Project

Step 3: It is decided to replace the faulty lamps. However, the existing lamps are no longer manufactured. In this instance, a plan is devised to salvage half of the existing lamps as replacements for the other half and to acquire new lamps and fittings for the stripped half. This plan allows for the gradual replacement of fittings, which ensures sustainability of existing lighting equipment and economic efficiency when purchasing new equipment. This plan is once again distributed to the energy awareness and education area to be used as marketing information (see arrow B).

Step 4: The energy load management area is tasked with the upgrade of the new lamps (see arrow C) and when completed, all equipment information is passed back to the energy maintenance area for stock and maintenance scheduling (see arrow D). Once again the difference between arrows C and D can be ascribed to their importance in achieving the goal of the project. Here arrow D is not vital but its inclusion ensures the sustainability and completeness of the project.

Step 5: Ensuring that the correct lighting levels have been reached again concludes the project (see arrow E).

In this example, the same route would have been followed if it was decided to replace all of the lamps at once on the basis that the existing ones were not only in partial working order but were inefficient too. These decisions are determined by the availability of funds.

2.6.3 Summary

Needless to say, achieving the desired level of energy efficiency or energy benchmark in a building is usually only possible with a multitude of projects that will require tasks in all three areas of energy load management, energy maintenance management and energy awareness and education.

In both the examples presented in sections 2.6.1 and 2.6.2, the area of energy diagnosis is the starting point and ending point of any project. Energy diagnosis plays the important role of acquiring and disseminating information, determining which area would best address the problem and finally evaluating the outcome. This function ensures that in extreme cases where solving a problem such as poor lighting levels through proper maintenance creates a new problem such as poor energy benchmarks because the maintained lamps are inefficient, the problem can be acted upon immediately.

It is very important to remember that each activity area is not a standalone function. In other words, each activity area is not a separate department that operates independently of the others. This model requires a high level of communication and each activity area must be capable of determining when a problem can be best addressed by another area.

2.7 STAFFING REQUIREMENTS OF THE ENERGY MANAGEMENT PROGRAMME

An energy management programme that has been completely represented through an energy policy and strategy is only as good as the people who manage it. To this end, three areas have been identified as follows:

- *Energy Co-ordination Committee*

  The energy co-ordination committee is made up of a representative sample of the institution community and undertakes the following tasks:

  - Ensure the energy management programme remains focussed through acting as the custodian of the energy policy
  - Review the policy annually or on the recommendation of the energy manager
  - Provide an environment in which the energy manager and his or her team can perform their function
  - Represent all components of the institution community
  - Advise the top management of the institution on energy related issues on campus

  The committee should meet regularly (i.e. monthly) during which the energy manager has an opportunity to pinpoint problem areas that need to be solved by the committee. For this reason, the membership of the committee will depend on the various facets of activities on campus. As an example, consider the composition of an energy co-ordination committee taken from James Madison University [32] where the director of facilities management chairs the committee. The committee includes representatives from the facilities management, procurement, dining services, faculty of psychology, faculty of biology, faculty of health sciences, retail services, recycling, campus life and students.

  Typically, the energy co-ordination committee would contain representatives of facilities management, energy researchers, academic staff, students, retailers on

campus, residences and hostels. The committee reports directly to the top management of the institution through the chairperson.

- *Energy Manager*

  The energy manager is responsible for achieving the goals and ultimately the mission statement of the energy management programme. For this task he or she receives assistance from an energy action team and the energy co-ordination committee. The energy manager is responsible for the design and implementation of the energy strategy. The post of energy manager should ideally be filled in a full-time capacity although occasionally it will need to be included in an existing manager's portfolio due to resource limitations. The energy manager reports to the energy co-ordination committee on the working status of the energy management programme and their function is to assist and not police his or her actions.

- *Energy Action Team*

  It is impossible for a single person to achieve all the tasks in the energy management programme. To this end, the energy manager appoints an energy action team of people who undertake the projects and tasks in the energy strategy. Typical membership includes energy researchers, academic staff, facilities technicians and students. The members of the energy action team are not dedicated positions but assist the energy manager as and when their help is required.

2.8 CONCLUSION

This chapter has explained the planning aspects of the energy management programme at an academic institution. The link between an energy policy and strategy is very often unclear and these two buzzwords are used inappropriately.

The chapter has highlighted the purpose of an energy management programme and that this programme is given direction through an energy policy. The policy is realised through an energy strategy that relies on four areas-of-activity.

In conclusion, the chapter has addressed the staffing requirements of the energy management programme through an energy manager and an energy action team. The energy co-ordination committee was also introduced as the custodians of the energy policy and the energy management programme as a whole.

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The models presented in this chapter are structured in a systematic manner in order to provide clarity in their relationships. Some academic institutions already have energy management programmes in action with a similar structure to the one presented here. On the other hand, there are many institutions that have started energy management on campus at project level without procuring vital management support or acknowledging the importance of maintenance or awareness. This in no way implies that these programmes are incorrect or that their managers are wrong. On the contrary, these institutions should be praised for efforts to date. However, for these programmes to become truly effective and balanced, a structured approach such as the one in this chapter should be adopted. It will be relatively simple for an institution presently conducting energy management projects to review their goals and mission and bring their present efforts in line with the structured programme in order to ensure the optimal use of human and financial resources.

The next chapter includes the technical and financial tools required for the subsequent four chapters that each address one of the areas-of-activity in detail to highlight their specific function and interaction with the other areas.