CHAPTER 8: EVALUATING THE ENERGY MANAGEMENT ACTIVITIES

"Good enough, is the enemy of all progress"

John H. Patterson

8.1 INTRODUCTION

In chapter 2 the philosophy behind a complete energy management programme was introduced. This approach sees a close relationship between the energy policy and the energy strategy. The energy strategy is based on four areas-of-activity and each one of these areas was explained in chapters 4 through to 7.

In reference to figure 2.5, all areas have been covered elsewhere in this thesis except for the programme feedback link between the energy strategy and the energy policy. This link is vital if the energy management programme is to be considered complete. In chapter 2 it was said that the energy policy determines the destination of the energy management programme and the energy strategy determines the route. If this is truly so, then it is imperative that the goals of the programme are evaluated to ensure that they are applicable. For example, if a target has been included in the energy policy, it should be ammended or removed when that target is reached.

This chapter will look at methods of firstly evaluating the energy strategy, then the energy policy and finally the energy management programme in its entirety. In conclusion to this chapter, discussion is focussed on the issue of acquiring funding and the employment of savings that have been realised as a result of the energy management programme.

8.2 EVALUATING THE ENERGY STRATEGY

The energy strategy is deemed as the starting point because it is here that faults are found with the electrical energy on campus and addressed through various projects in terms of load management, maintenance management or awareness and education. If the projects are successfully planned and implemented then the benchmarks will improve. If this is achieved then the energy strategy is successful and, if suitably selected, the goals of the energy management policy will have been achieved leading to a successful programme.

In terms of evaluation, it is firstly necessary to evaluate the energy performance of an academic institution against itself and secondly it is useful to evaluate the energy performance of the institution against other institutions both locally and abroad. Both of these internal and external evaluations will be discussed.

8.2.1 Internal Evaluation: Intra-Institution Comparison

The most significant part of the evaluation process is the evaluation of the benchmark performance of the institution against its historical performance. This is after all the purpose of the energy management programme and improved benchmarks, that relate the cost of electricity to the students and business functions on campus, naturally imply a reduction on the energy cost per student or academic facility.

The benchmarks were introduced in section 4.3 and note must be made of the possible fluctuations in the benchmark values due to seasonal swing, tariff rates and the academic calendar. For this reason it is advised to only react on poor benchmark performance that has been observed over a longer time period or at the conclusion of each energy management project that has been initiated under the Energy Load Management, Energy Maintenance Management and Energy Awareness and Education areas-of-activity.

To assist in analysis of the energy benchmarks and energy management projects, the flowchart in figure 8.1 can be used as a guideline.

Question 1: Has the cause of the poor benchmark been established in terms of equipment or people? If not, this is the first problem and use should be made of the various types of audits covered in section 4.4 and the processing of this information in section 4.5 in order to find the cause. If this has already been done, proceed to question 2.

Question 2: Has the cause been ascribed to a specific area-of-activity? If not, this is the second problem and use should be made of the guidelines in section 4.6 in order for the problem to be addressed through the correct area-of-activity. If the information has been ascribed to a specific activity area, then proceed to question 3.

Question 3: Has a solution to the problem commenced or started to be implemented? If a solution in the form of an energy management project is underway, then proceed to question 4. If not, it is necessary to determine the cause for the project not commencing by proceeding to question 6.

Question 4: Has the solution, or project, been concluded? If the project has not been concluded then it is still in progress and the result will be unknown until such time as the project has indeed been completed. If the project has been completed, then proceed to question 5.

Question 5: Was the project successful in the sense that it altered the load shape, increased the efficiency of electrical equipment, created awareness or imparted energy management skills on campus? If not, then proceed to question 7. If the project was successful then there are no problems with this specific project and the overall fault lies elsewhere with other projects.

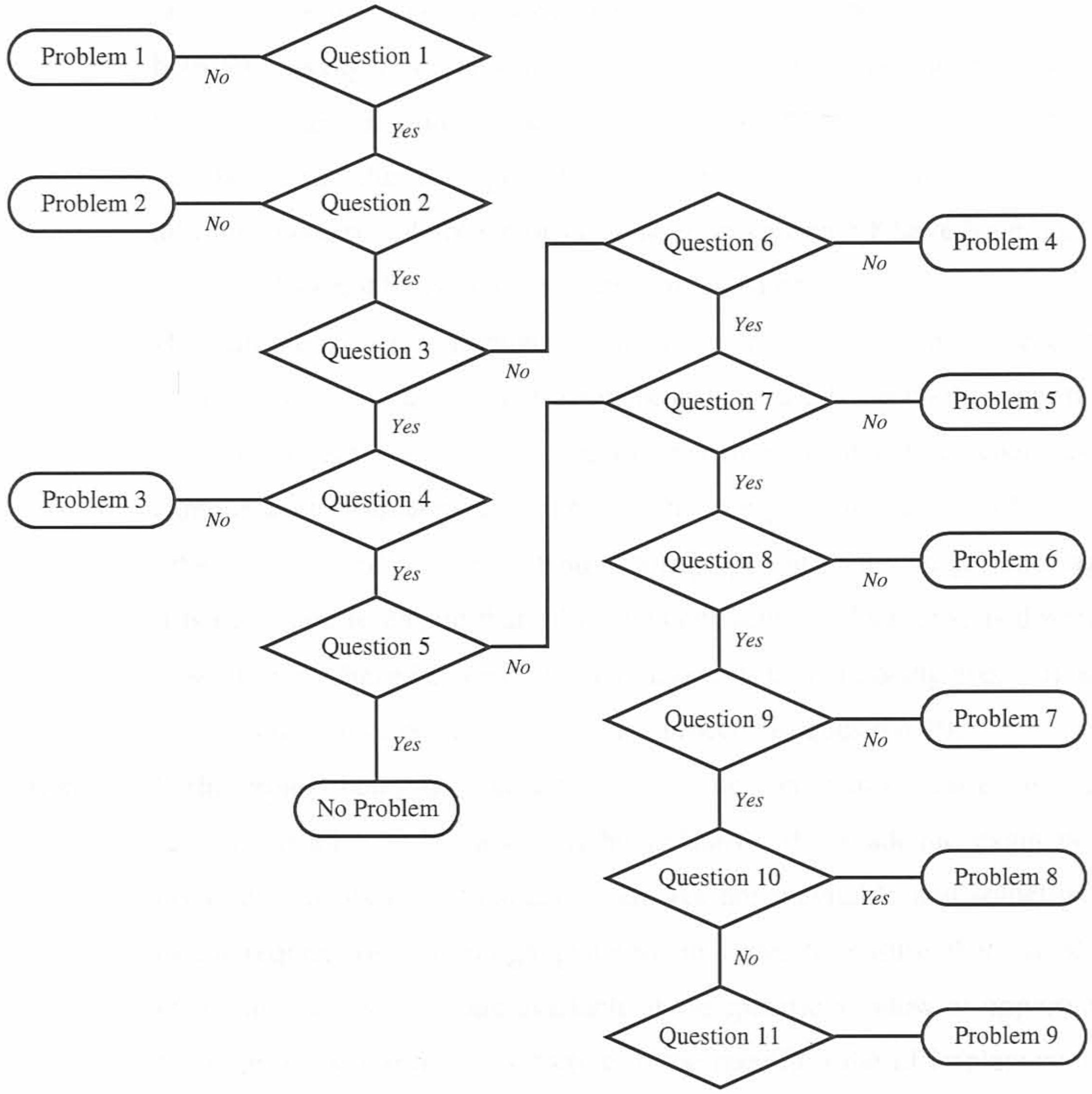

Figure 8.1: Benchmark Evaluation Flowchart

Question 6: Is the project deemed financially viable? The methodology for the economic analysis of projects was discussed in section 5.3 using the economic formulas from chapter 3. If the project is deemed as not being financially viable for the energy management programme, then no further inquiry is necessary. On the other hand, if the project is indeed financially viable, then proceed to question 7 in order to determine the cause of poor project performance.

Question 7: Have all of the funds for the project been made available? A lack of funding for material and labour is an obvious component of poor project performance. Included here is all of the initial capital required as well as other funds that may be required throughout the project such as maintenance costs etc. If the funds have been available, then proceed to question 8.

Question 8: Have all the materials and equipment been made available? For example, all of the funds might be available but there will be delays in the time between placing an order with a sub-contractor and expecting delivery as a result of scheduling on the part of the contractor or because equipment must first be manufactured, imported or acquired. In any event make sure that all of the contractual obligations discussed in section 5.8 have been met. If the fault does not lie here, then proceed to question 9.

Question 9: Have all the necessary human resources been available for the project either internally or externally if contractors have been used? It could occur that a specific project needs to fit into the existing maintenance schedules on campus as discussed in section 6.5 or that the personnel are still busy with other projects and can only attend to this project at a later stage. Once again it is necessary to ensure that all of the contractual obligations, as discussed in section 5.8, have been met if external contractors are being used. If all of the resources have been available, then proceed to question 10.

Question 10: Is the project being delayed due to any time constraints such as not being able to install high voltage switchgear during the academic exam period because students need to study? Delays are inevitable and sometimes it might require very thorough planning in order to ensure that all of the materials and resources are available at the specific window of opportunity. Some projects will not be sensitive to the specific time of implementation, as they do not disrupt the normal activity on campus. If there are no delays, then proceed to question 11.

Question 11: If not covered with the previous questions, what are the other reasons for the project not being successful? Included here are items such as poor planning, unrealistic goals or inefficient project implementation.

The benchmark evaluation flowchart should only be used as a guide when attempting to evaluate the energy management projects. Finding fault should not be done on the basis of persecution but rather on improving fault areas and learning from experience. In this way, the probability of success of all of the projects in the energy management programme is increased.

8.2.2 External Evaluation: Inter-Institution Comparison

In the introduction to this section it was said that the comparison of an institution to other local and international institutions was useful. The word useful was used and not necessary because there are a couple of issues that must be considered.

Firstly the value of the comparison to other institutions must be considered. If your performance is better than theirs it does not mean that your programme is successful because it is your electricity costs that are the issue and not theirs.

In the first chapter it is recognised that every institution is unique in terms of its facilities, geographical location, resources, personnel and history or culture. While history or culture does not play a part in terms of energy benchmarks, all of the others (including varying electricity tariff structures and rates) do affect the calculation of benchmarks in terms of energy cost per product or business function. The benchmarks are not only affected by seasonal swing but by climates too where comparison between institutions in different climates will need to consider the difference in the types of load equipment. In this thesis focus is made specifically on electrical energy but the evaluation between various institutions is made difficult when comparing institutions who make use of electricity only and others who use a combination of fuels. Where possible, contact should be made with an institution that has the following characteristics:

- Similar climate to yours
- Similar types of electrical loads e.g. HVAC, lifts, pumps etc.
- Similar facilities e.g. hostels, laboratories, lecture halls, sports facilities.
- Similar percentage mix of fuels
- Same tariff structure
- Similar tariff rates

From this list it becomes evident that the most suitable option would be to evaluate your performance against that of another institution in the same country as you. Unfortunately it is not that simple because the tariff structure needs to also be considered. For example, the Durban campus of the University of Natal is billed according to a time-of-use tariff structure with two demand charges, one for the maximum demand during peak and standard periods and one for the maximum demand for the entire month (these two could occur at the same time) [29]. It becomes difficult when comparing this to the University of Pretoria which is billed according to a demand tariff structure where a charge is levied for the maximum demand in the month as well as the energy consumption.

Using energy alone is not sufficient. For example, during 1998 the University of Bordeaux 1 [57] consumed a total of 7,636,417 kWh. The University of Pretoria, on the other hand, consumed a total of 45,194,648 kWh during the same period. These two values are of no use unless they can be put on the same base. In terms of electrical energy per hostel resident per year, the University of Bordeaux consumes 753 kWh whereas the University of Pretoria consumes approximately 2,584 kWh. Once again these figures are of not much use because the climates of each university are different and the University of Bordeaux makes use of natural gas in their central heating plant to supply heating to all buildings and residences.

In section 4.3.1 it was noted that benchmarks based on the electrical energy unit (kWh) are not satisfactory in an energy management programme where the goal is to reduce the energy cost per product or business function. The focus here is not on the amount of electrical energy but rather on the cost of that energy. For this reason, there can be very little value attached to evaluating your energy benchmarks against other institutions unless both institutions are very similar to each other in respect of the items listed earlier. It does however make for interesting marketing information.

8.3 EVALUATING THE ENERGY POLICY

According to the National Examining Board for Supervision (NEBS) workbook on managing energy efficiency [58], the organisation, in this instance the academic institution, will need to:

- Reaffirm its commitment to energy management
- Reappraise the levels of understanding and co-operation within the institution
- If necessary, revise the energy policy in the light of what has been learned, resetting targets and objectives as required
- Take heed of the comments and criticisms of stakeholders.

For this review to be systematic it should take the form of a management audit. Essentially we want to know how well we are performing with our policies, targets and objectives. In section 2.5 it was recommended that the energy policy be evaluated on an annual basis during which time the points listed above can be evaluated and addressed.

It is advisable to invite commentary from all stakeholders, either through their representation on the energy co-ordination committee or directly themselves, as this will provide ample transparency and representation to the evaluation process. In this instance the stakeholders include the students, personnel members, energy co-ordination committee members, electricity suppliers, government representatives and any other person directly involved with the energy on campus. This evaluation process will be limited if only the input of the energy manager and energy co-ordination committee is considered. Chapter 7 explained how inviting input (both positive and negative) is a good method of encouraging ownership of the energy management programme.

8.4 EVALUATING THE ENERGY MANAGEMENT PROGRAMME

When evaluating the energy management programme some elements might perform better than others. For example the energy strategy as a whole might indicate sufficient progress but the energy policy might be deemed as outdated or ineffective. In this case it is difficult to get an overall feel for the progress of the energy management programme as a whole and the energy management programme matrix in table 8.1 can be used. The table has been slightly amended from its commercial origin [15] in order to be applicable to academic institutions.

Table 8.1: The Energy Management Programme Matrix [15]

Level	Energy Policy	Organising	Relating to Users	Measurement Systems	Marketing	Investment
4	Energy policy, action plan and regular review have commitment of top management.	Energy management fully integrated into management structure. Clear delegation of responsibility for energy costs.	Formal and informal channels of communication regularly exploited by energy manager and energy staff at all levels.	Comprehensive system sets targets, monitors costs, identifies faults, quantifies savings and provides budget tracking.	Marketing the value of energy efficiency and the performance of energy management both within the institution and outside it.	Positive discrimination with detailed investment analysis in order to exploit all potential projects.
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 governing body.	Energy committee used as a main channel together with direct contact with majority of users.	Reports for individual premises based on sub-metering, but savings not reported effectively to users.	Programme of awareness on campus and regular publicity campaigns.	Some payback criteria employed as for all other investment.
2	Unadopted energy policy set by energy manager or senior departmental manager.	Energy manager in post, reporting to *ad hoc* committee, but line management and authority are unclear.	Contact with majority of users through *ad hoc* committee chaired by senior departmental manager.	Reports based on supply meter data. Energy unit has *ad hoc* involvement in budget setting.	Some *ad hoc* awareness training on campus.	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 maintenance personnel and a few users.	Cost reporting based on invoice data. Reports compiled for internal use within facilities 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 costs.	No contact with users.	No information system. No accounting for energy costs.	No promotion of energy efficiency.	No investment.

Table 8.1 can be used to evaluate the performance of individual aspects of the energy management programme and when applied to the energy management programme at the University of Pretoria, delivers the following results:

- *Energy Policy*

Researchers in energy management have drawn up a draft version of the energy policy. This policy has not been formally adopted and as such has not yet received the full commitment of the top management. In terms of energy policy, the University of Pretoria is at level 2.

- *Organising*

An energy co-ordination committee has been established and an existing manager has been targeted to assume the role of energy manager. The line management and authority of the energy manager have not been finalised and at present this manager is also being utilised for other functions. The organisational structure therefore finds itself somewhere between levels 2 and 3 but also with some aspects of level 1 present. Appointing the energy manager in a formal post will boost this performance into levels 3 and 4.

- *Relating to Users*

The communication channels to end-users are not yet fully functional with the main communication flowing from the energy co-ordination committee but only to a few end-users on campus. The relationship with end-users finds itself more established than level 2 in terms of the energy co-ordination committee acting as the main channel but needs to be expanded to include the majority of users in order to remove the remnants of level 1.

- *Measurement Systems*

The University of Pretoria has a fully functional energy monitoring system and supervisory control and data acquisition (SCADA) system in place capable of performing all measurement and costing functions in real-time. Therefore, in terms of measurement systems, the University of Pretoria is at level 4.

- *Marketing*

With a comprehensive measurement system comes the availability of ample marketing material. This material in harnessed into regular monthly reports to the energy co-ordination committee and to the University community. Chapter 7 included some of the marketing material presently used at the University of Pretoria. The programme has not, however, reached its full potential partially due to its infancy. For this reason the marketing aspect of the energy management programme is at level 3.

- *Investment*

Very little investment has taken place into energy management projects. To date most funds have been used for the acquisition of the measurement system. This too can be ascribed to the infancy of the programme where it was decided to first get all the measurement tools in place before commencing with specific energy management projects. In terms of investment, the University of Pretoria is at level 1.

From the analysis of all of these elements, it by no means implies that the energy management programme at the University of Pretoria is incomplete. The programme is indeed complete because it has the correct structure and addresses all of the areas-of-activity. This analysis simply helps to identify areas where more attention should be paid. At present the energy management programme at the University of Pretoria is not fully effective. The fact that it is not on the lowest level (level 0) for any of the elements implies that it is on the right track. It does however require more work.

8.5 ACQUIRING FUNDING

Acquiring the funds with which to invest into the energy management programme are difficult to come by. Unfortunately very little can be done without the investment of capital for equipment and material.

Funding should be procured both from within and from outside the institution. If the top management truly supports the energy manager then they will make some dedicated funds available for the energy management programme. All avenues must be exploited and other sources of funding include:

- Loans from financial institutions
- Grants from government departments (including foreign aid)
- Obtaining sponsorship from commercial companies for individual projects
- Obtaining sponsorship from various segments within the institution (for example encouraging academic departments to sponsor and adopt a real-time energy meter)

The benefit of the energy management programme is that the returns are not only fairly easy to measure but that they are almost guaranteed. Following the selection process of chapter 6, on the Energy Load Management activity area, will ensure that only the feasible projects are implemented.

A process of separate metering and billing (as discussed in chapter 7) should be employed to proportionally recover the total electricity costs of the institution from the sectors responsible for this cost.

8.6 THE EMPLOYMENT OF SAVINGS

In chapter 5 the term "savings" was quantified. In the energy management context, a financial saving is not an income but rather a reduction in the financial accountability of the institution. In other words, achieving an energy saving simply means that you are giving out less money for energy each month. It is important that only the measurable savings be considered. The measurable savings are those savings that can be calculated from the difference between the financial accountability of energy consumption after a preventive action was taken and the financial accountability if no such action were taken.

Typically the gross savings that are realised from an energy management project will be required to firstly pay back the initial investment capital outlay of that project. Thereafter the net savings amount can be employed in a multitude of ways. Ideally these should be reinvested in the resources that were responsible for creating this saving and can be used:

- To extend and maintain the tools of the energy management programme such as the measurement and control system
- As the investment capital for new equipment and other material required for the programme
- To maintain and upgrade the existing electricity reticulation systems
- To make available bursaries for the extended and specialist training of the energy management staff in order for them to acquire the necessary knowledge to create more savings
- To make available performance bonuses for the energy manager and the members of the Energy Action Team

Naturally not all of the savings need to be utilised for some or other purpose and a percentage can be apportioned to the academic institution itself.

The process of reinvesting a portion of the savings back into the energy management programme is a very powerful method of acquiring investment capital. Unfortunately, if the first suggestion is used, the reinvestment capital will only become available once all of the initial capital outlay for the project has been recovered. Based on the case studies in sections 5.4, 5.5 and 5.6, this could be any length of time from a couple of months to 5 years. In some cases, such as staff incentive bonuses or student bursaries, it may be preferred to split the savings right from the beginning of the project and not to wait until all the capital has been repaid.

If this is indeed so, then the amount that must be earmarked for capital investment recovery should preferably be determined first and the rest apportioned according to set percentages. The crucial factor is determining the length of the period of consideration. In other words, when is a saving not a saving anymore? In all honesty only the single initial difference between the old and new benchmarks is quantified as the saving and this cannot reoccur because the new improved benchmark is now the value that has to be beaten in order to realise a new saving. Financially speaking, however, this would mean that no energy management projects would be viable and as a result a certain project period is considered in order to calculate the returns and payback periods. The longer the period of consideration, the smaller the contribution of the savings that must be made to the recovery of the initial investment capital and the larger the amount that can be distributed. This concept is illustrated in figure 8.2.

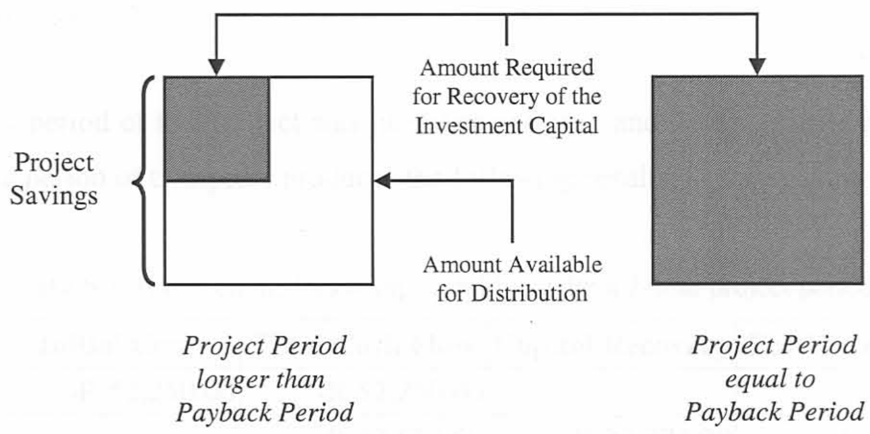

Figure 8.2: The Effect of Project Savings Period on the Employment of the Savings

Considering a project period shorter than or equal to the payback period is not logical if the distribution of the savings is being pursued, as there are no savings to distribute once the initial investment capital has been recovered.

The amount that must be repaid in order to recover the cost of the initial investment capital can be calculated with equation 3.7 where the project period is substituted for n and the MARR is substituted for i. Consider the power factor correction project in section 5.6. The initial investment amount was R 52,250.00 and the project was considered over 5 years. After 5 years, the amount of capital that must be repaid or allocated for the recovery of the initial investment capital is equal to R 92,082.35 based on a MARR of 12%. Spreading this over the 5-year project period will require an annual "reservation" of R 18,416.47. Applying this to the cost summary table of this project (table 5.12) produces the resultant cash flow presented in table 8.2.

Table 8.2: Resultant Cash Flow – Power Factor Correction Case Study

Year	Initial Cost	Total Cash Flow	Capital Recovery	For Distribution
0	-R 52,250.00	-R 52,250.00		
1		R 42,537.59	R 18,416.47	R 24,121.12
2		R 45,371.22	R 18,416.47	R 26,954.75
3		R 48,388.81	R 18,416.47	R 29,972.33
4		R 51,601.78	R 18,416.47	R 33,185.31
5		R 55,022.24	R 18,416.47	R 36,605.77

Using this method, the initial capital amount has been recovered (with interest based on the MARR of the institution) and the remaining R 150,839.29 can be distributed as required. Note that the running costs were automatically taken into account by considering the total cash flow from table 5.12.

The payback period of this project was just over one year and reducing the savings period to consider a period of two years produces the following results:

Table 8.3: Effect on the Resultant Cash Flow with a 2-year project period

Year	Initial Cost	Total Cash Flow	Capital Recovery	For Distribution
0	-R 52,250.00	-R 52,250.00		
1		R 42,537.59	R 32,771.20	R 9,766.39
2		R 45,371.22	R 32,771.20	R 12,600.02

In this case the amount of capital that must be repaid or allocated for the recovery of the initial investment capital is equal to R 65,542.40 and the remaining R 22,366.41 can be distributed as required. In this instance the entire initial investment amount has been recovered but less money is being earmarked for distribution and re-investment.

For projects that require no initial capital outlay, all the savings can be distributed. In this instance a savings period will need to be considered that is mutually beneficial to the institution and the energy management programme. It is recommend that a period not shorter than one year is considered in order to gain the full benefit, if any, from the variations in the electricity cost due to the factors included in section 4.3.2 such as seasonal swing.

The length of time that has been considered here must not be confused with the analysis period used to determine the viability of projects. The latter was discussed in chapter 5. Instead the period being used here is the length of time that the savings from a specific energy management project must be considered in order for them to be reinvested into the energy management programme. Irrespective of the length of the period, the institution will still recover all of the initial capital because all of the funds essentially remain within the institution and the longer the period of consideration, the greater the funds that are recovered at the MARR. As an alternative solution to determining the length of time for which the savings should be considered, a fixed amount of capital can be earmarked for reinvestment into the energy management programme and this paid off first. Thereafter all savings are not reinvested and no longer of significance.

8.7 CONCLUSION

This chapter has focussed on the evaluation of the energy management programme by firstly evaluating the activities of the energy strategy, evaluating the energy policy and finally evaluating the energy management programme in its entirety.

The evaluation process ensures that the energy management programme is complete because the correct feedback is obtained in order to ensure that the programme remains focussed on the electricity cost in an environment where constant pricing fluctuations are experienced and technical improvements are continually introduced.

The regular and complete evaluation of the energy management programme will help to ensure that the optimal use is made of financial and human resources and taking a critical look at the energy management projects on campus will provide invaluable experience leading to a dynamic and highly successful programme.

The next and final chapter will refer back to the objectives of this thesis and provide some recommendations regarding the management of electricity cost within an academic institution.