CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

"My sole collateral was my own faith in my ideas"
John H. Patterson

9.1 INTRODUCTION

In chapter 1, the main objective of this dissertation, along with a subset of specific objectives, was listed. In this chapter referral will be made to these objectives and the content of this dissertation in general. The value of this work will be discussed and the chapter will conclude with recommendations regarding areas of future work based on this dissertation.

9.2 CONCLUSIONS ON THE OBJECTIVES

The main objective of this study was to present a systematic and structured approach for the management of electricity cost within an academic institution.

A structured energy management programme utilises the financial and human resources available on campus better. Adopting a systematic approach helps to ensure that all energy management projects add their full effect to the energy management programme in general and each is implemented at the most beneficial time. The energy management programme has to fit into the other activities on campus and should compliment the output of these activities.

In chapter 1 the theory and history behind energy management was covered and a complete energy management programme was outlined as having to look at reducing the energy cost within the context of environmental harmony in order to enhance competitiveness and maximise profits. In other words, the goal of the energy management programme is to reduce the electricity cost per product (students and personnel) or business process (faculties, departments etc.) and not simply to reduce the electricity cost. The title of this dissertation is focussed on the management of the electricity cost and not the reduction of the electricity cost.

In this dissertation the complete energy management programme was given structure by firstly creating an energy policy on campus and then linking this to an energy strategy comprising four areas-of-activity, namely Energy Diagnosis, Energy Load Management, Energy Maintenance Management and Energy Awareness and Education. The four

activity areas provide the energy management programme with its content and ensure that the often-neglected areas of maintenance, and awareness and education are not overlooked. The main objective was achieved by addressing a series of specific objectives.

- *Conclusion on the Energy Management Programme Model*

  In chapter 2 the goal of energy management programme was graphically represented through figure 2.1. This figure, when combined with the activities of an energy management programme in figure 2.2 provided the complete energy management programme presented in figure 2.5. This model is well structured with the energy strategy receiving direction from the energy policy and then providing feedback to the energy policy in order for it to remain focussed. This highlights the sentiments in chapter 1 regarding the ongoing activities of an energy management programme whereby energy is a continual issue on campus and not a temporary one. Energy deserves constant attention because it is a recurring business expense of sizeable proportions.

- *Conclusion on an Energy Policy*

  An energy policy was introduced in section 2.3 that comprises three parts, namely a declaration of commitment from the top management of the institution, a mission statement that defines the focus of the programme and finally a set of programme goals to be worked towards. The energy policy determines the destination of the energy management programme.

- *Conclusion on an Energy Strategy*

  An energy strategy was introduced in section 2.4 as being made up of the four areas-of-activity. The energy strategy determines the route that must be taken in order to arrive at the destination that was focussed on in the energy policy. In other words, the energy strategy is the plan that deals directly with the activities and projects of the energy management programme. The activities of the energy management programme are grouped under 4 areas-of-activity within the energy strategy.

- *Conclusion on the Areas-of-Activity*

  The interaction between the areas-of-activity is covered in section 2.6. By defining specific activity areas, all the projects and activities in the energy management programme are systematically implemented ensuring the optimal use of financial and

human resources as well as ensuring that there is no loss of information. This is achieved through increased communication levels and meticulous attention to documentation.

- *Conclusion on the Interaction between an Energy Policy and Strategy*

  The interaction between the energy strategy and policy is covered in section 2.5. This interaction is usually misunderstood and the terms "policy" and "strategy" are used fairly loosely without understanding their correct place and contribution towards the energy management programme. This dissertation has made the link very understandable and this will help to clear all misconceptions regarding these two vital elements of the energy management programme.

- *Conclusion on the Key Energy Management Tools and Concepts*

  Many of the common energy management terms have been explained in chapter 3 as well as the areas of electricity tariffs and financial analysis tools. Other items that have been addressed include energy auditing (chapter 4), maintenance management (chapter 6) and energy awareness and education (chapter 7). All of these terms and concepts have been put into their correct place within the energy management programme which makes it easier to understand them because the reader can now see where they should be used and how they contribute to the overall programme structure.

- *Conclusion on Project Selection and Prioritisation Methods*

  A method to select between alternatives for the same project was presented in section 5.3 and this applied to the case studies of chapter 5. Section 5.7 presented a method of prioritising the energy management projects based on their Net Present Value (NPV), Internal Rate of Return (IRR) and capital investment requirements. This ensures that the best combination of projects is implemented with respect to the amount of capital that is made available for investment by the institution.

- *Conclusion regarding Project Examples*

  Key projects as examples of both the equipment and people components of the energy management programme were included in the case studies in chapter 5 and 7 respectively. Chapter 7 and the appendix provide some examples of energy awareness material and the projects where this material was used. Chapter 5

included case studies involving the electrical equipment and focus was made on projects involving direct load control, the upgrading of existing equipment and installation of new equipment. Other than these projects, many case studies and experiences from the University of Pretoria have been included to emphasize certain sections in all of the chapters. The projects and activities that have been included as examples have been selected to provide emphasis to the theories.

- *Conclusion on the Methods of Programme Evaluation*

  Chapter 8 was dedicated towards methods of evaluating the energy management programme. The evaluation process starts at individual project level and then expands this to the energy strategy and eventually to the energy policy. The evaluation process ensures that the energy management programme remains focussed by addressing the topical issues. The evaluation process also strengthens the abilities of the energy management team by expanding their experience.

Addressing all of the specific objectives has ensured that all of the material necessary to meet the main objective has been covered. This dissertation has essentially taken the enigmatic process of energy management and simply provided a logical and systematic structure to this process in order for it to be applied to academic institutions. This does not mean that the existing energy management programmes of institutions that do not follow the structure included here are failures. On the contrary, these institutions should be praised for taking the initiative in addressing their electricity costs. However, adapting their present programmes to adopt this systematic structure will ensure that their programmes produce greater results through addressing all the relevant energy issues on campus. As a final conclusion it must be said that, with the aid of this dissertation, any academic institution is capable of initiating and running an energy management programme and all institutions should be addressing their electricity costs. The case studies in this dissertation have proved that the benefits outstrip the pitfalls.

9.3 RECOMMENDATIONS AND FUTURE WORK

This section includes both recommendations regarding the management of electricity cost within an academic institution as well as defining the scope of future work based on this material.

9.3.1 Recommendations Regarding Energy Management on Campus

- *Recommendations on Starting an Energy Management Programme on Campus*

  The starting point when looking at energy management on campus must be to determine the extent of the existing programme. If no programme is presently running then the facilities department should initiate the process by setting up an energy co-ordination committee and selecting a manager within the facilities department of the institution who should be tasked with the duties of the energy manager. Naturally a dedicated post is preferable but a joint post will suffice as an interim measure. The line functions and reporting structure should be determined and formalised. The top management of the institution must take ownership for the establishment and continual support of the energy management programme.

  The next step is to draw up a plan for the energy management programme in the form of an energy policy and strategy. During this planning phase a budget should be drawn up with which to commence the energy management activities. Typically at this level the energy manager will require some funds with which to undertake the Energy Diagnosis activity area as explained in chapter 4. However, much of the diagnosis activity can be performed without requiring equipment for electrical load measurement. In other words, the energy manager can commence his or her tasks while waiting for some funds. If no funds are made available, the energy manager can attempt to arrange the loan of measurement equipment from other institutions or commercial companies. All that is required is the first breakthrough project that will not only produce savings but gain credibility for the programme. The following areas should be looked at:

  - Frequent verification of the electricity costs and negotiating for an improvement in the tariff structure and rates. This requires little effort and will help to create a working relationship with the electricity supplier. Included here is the installation of power factor correction (see section 5.6) or obtaining the benefit of diversity (section 3.2.6).
  - If the campus constitutes mainly commercial buildings, then the heating, ventilation and air-conditioning (HVAC) equipment should be looked at first. This equipment not only uses a large amount of power but adversely affects the power factor. Thereafter office equipment such as personal computers, printers, facsimile machines and photocopiers should be targeted by ensuring

that their energy efficient (or low power) settings have been set and by encouraging the users to pay attention to the way in which they use these machines. This was also covered in the case studies in chapter 7. Next the lighting should be targeted and more efficient lamps should be investigated (as in section 5.4). Finally, the direct load control of the hot water equipment should also be considered.

- If there are student residential hostels on campus then the water heating systems should be targeted first followed by HVAC equipment and finally the multitude of appliances that the students keep in their dormitories and rooms. If hot water is going to be addressed in the residences and hostels, then similar equipment in the commercial office buildings on campus may as well be addressed in the same project.

At the University of Pretoria the hot water systems in the hostels were targeted above the HVAC equipment because the energy management staff were familiar with this type of equipment. It is planned to obtain assistance from engineering specialists on campus to target the large HVAC load next.

- *Recommendation on the Adaptation of an existing Energy Management Programme*
  If an energy management programme is already in operation on campus, it can easily be ammended in order to follow the systematic structure presented in this dissertation. The methods and tools that are included here are very novel and they will help to make these established programmes more successful.

In section 1.6 it was mentioned that the institutions with energy management programmes in South Africa fall into two categories. Firstly, those that use energy management on campus to both reinforce their energy management teaching as well as reducing costs and secondly, those that pursue energy management purely as a management function aimed at cost management.

- *Recommendation for Institutions focused on Electricity Cost Management only*
  This dissertation has included all the material necessary to create an energy management programme orientated towards the management of electricity cost. Although some historical and background information has been included, this material is important as it helps to place an energy management programme within

an academic institution in the context of energy management as an activity previously focussed on the industrial, commercial and residential sectors.

- *Recommendation for Institutions focused on Energy Management Research and Lecturing as well as Electricity Cost Management*

  All the information in this dissertation is relevant but perhaps more benefit can be extracted from the energy management programme model presented in chapter 2. This model will help students to understand the purpose and function of an energy policy and strategy. The energy management tools in chapter 3 will also benefit students in energy management as well as the case studies from other institutions presented in chapter 1.

- *Recommendation regarding the Energy Manager*

  Finally it is recommended that a person with all the necessary management traits be selected for the position of energy manager. Naturally a good knowledge of electrical energy (and other energy sources) is preferred. The energy manager must have the necessary authority to take action in the best interest of the programme and under no circumstances should the leadership be shared. Multiple authority will not allow for the energy manager to take ownership of the task of reducing the electricity cost per product or business process and this will lead to the failure of the programme. All elements of management will be required from budgeting through to marketing and this should be borne in mind during the selection process.

9.3.2 Future Work

Ideally the energy manager at an academic institution should have written this dissertation. However, all the necessary experiences of commencing with an energy management programme have been acquired and therefor solid advice in this regard can be supplied.

If this dissertation had to be rewritten based on existing knowledge and experience, nothing would be left out. The length of this dissertation may be longer than normal but none of the information should be sacrificed as it will all be of use to an energy manager at an academic institution. The purpose of the dissertation is to provide a structured and systematic approach. Naturally there are many examples of energy management projects that have not been included. The reason for this is that those examples and case studies that have been included have been done so only to emphasize the theories that have been

presented. This dissertation is not a collection of "do-it-yourself" style energy management projects.

This dissertation has built the structured skeleton for the management of electricity cost within an academic institution. There exists a great deal of scope for future work by students working towards lower degrees in the sense of specific energy management projects. In other words the solutions to specific energy management projects should be investigated and these, with the aid of this dissertation, should be used in the energy management programme as and when the time is suitable. Students working towards equivalent or higher degrees can look at expanding and adapting the energy management programme methodology presented in this dissertation to national and global levels.

One area that should be expanded upon is a method for determining the ideal ratio between the amount of capital that is made available for investment into energy management projects and the return on those projects. This may not necessarily fall within the scope of electrical engineering and could possibly be considered under engineering management. Finding the ideal investment ratio will assist the energy manager in procuring the funding while ensuring that the institution is not badly financially leveraged.

In closing it must be said that any academic institution is capable of addressing their electricity costs on campus irrespective of their geographical or political climate. Occasionally consultants will be appointed to address the management of the facilities on campus and this will include the management of the electricity cost. In this instance the methodology presented in this dissertation is still applicable irrespective of whoever is tasked with the responsibility of managing the energy management programme. Academic institutions, through their energy management programmes, can have a significant impact on the social and financial well being of the population simply because they are in the position to provide the leaders of tomorrow with energy management skills today. In this way an energy efficient, environmentally focused population is created.