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Abstract: This report presents guidelines for a successful energy management project. It acquaints the manager with the project management tools that have been found to work well in energy management projects. Furthermore, the roles of the project manager, the tasks he or she must perform and the sequence of these tasks in such management projects are explored.

ENERGY MANAGEMENT

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EMP - P8810

MANAGING

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EXECUTIVE SUMMARY

If you are reading this you may be asking yourself "What does energy management have to do with my business strategy?" This paper makes the argument that whatever your business is, you may have an opportunity to improve the efficiency with which you turn labor and materials into goods and services. Presumably this provides your business with a competitive advantage and your customers with more service at less cost.

Once you realize how energy management ties to your business strategy, the next steps you take are crucial. Beyond the technical issues of how to reduce energy costs are the management issues of how to go about your energy management process. This paper prescribes a process that, if followed, will assure a successful and cost effective effort. The following questions are answered:

a. Who should be involved?

b. What needs to be done and in what order?

c. How are the various energy management options prioritized?

d. Where are the risks and how can I avoid these potential problem areas?

We encourage you to seriously consider including an energy management program as part of your business strategy. Your customers' perception of your products' value will increase.

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1.0 INTRODUCTION

1.1 Purpose

A successful energy management project tends to cut across many organizational lines. It requires that the manager be able to prioritize technical alternatives, make use of economic analysis tools, and employ project management techniques. Although the issues involved in an energy management project may be technical in nature the responsibility for these projects often belongs to a non-technical manager. This manager may have good line management skills but no exposure to project management skills.

The purpose of this paper is to present guidelines for a successful energy management project. It will acquaint the manager with some project management tools that have been found to work well in energy management projects. To accomplish this we explore the roles of the energy management project manager, the tasks he or she must perform, and a proposed sequence for these tasks. Each project is different. Large projects may involve many organizations. Small projects may be accomplished with only two people. This paper puts forth some generic guidelines that may be used in either situation. Once we have discussed and defined these guidelines, we illustrate them with four actual energy management case studies. These case studies were selected to illustrate how different types of organizations approach the energy management project. Although this paper is not technical in nature, we have also included some basic technical tools in the appendices. These tools are summarized in Section 4.0 of the paper.

1.2 Part of the Overall Business Strategy

Ask yourself, "Why am I in business?" As any budding student of management would tell you, your purpose is to provide maximum value to your business' stockholders[1]. An energy management program is often one of the most cost effective options available that add value to the business. As discussed further in Section 4.5 and demonstrated in Appendix E.2, a cost reduction effort that yields a dollar of savings is often a better investment that an effort which yields an additional dollar of sales. Once the project manager for an energy management program internalizes this truth, it is the most effective argument available for selling the program. Tieing the program to effects on profitability and stockholder value is a very convincing link to the business strategy and will help assure support for this type of endeavour.

How did the cost of energy become such a major factor in the financial success of organizations? For many years, energy was taken for granted. Until the early 1970's, most people did not give energy a second thought. It had always been abundant. People assumed that it always would be available. The low cost and seemingly endless supply appeared to justify the assumption.

Then came the petroleum embargo of 1973-74. For the first time, fuel oil, gasoline and other petroleum products became scarce for consumers around the world. With this scarcity came a substantial rise, on the order of four hundred to five hundred percent, in the price of these products. Although the embargo seemed to indicate that the energy problem was something that developed overnight, it actually was the result of a problem that began 20 years before. The United States produced all the energy it and much of the rest of the world needed until the early 1950's. After that time, the rapid growth of the U.S. economy, and its increased affluence accelerated the demand for petroleum beyond the nation's capacity to meet it.

The success of an energy management program revolves around several factors (Section 2 provides more detail on this subject):

i. Involving the right people at the right time;
ii. Assuring effective communication between these people;
iii. Obtaining funding, successfully selling the program;
iv. Encouraging "ownership" of the process by these people;
v. Building credibility with the stockholders and senior management thus assuring ongoing support;
vi. Providing for ongoing control of the effort through proper management, training, motivation and energy measurement.

Today many utilities, energy conservation companies and private industries promote energy efficiency in retrofit and new construction. Utilities offer many programs to assist companies in using their energy systems more efficiently. Engineering and consulting companies assist them in recognizing possible waste areas.

Energy management provides the most cost effective method available to minimize the continually rising costs of energy consumed in the world today. By applying effective energy management practices, energy waste can be eliminated. In addition to saving money, eliminating energy waste will help to build a stronger and more stable position for any organization and nation as a whole.

1.3 Energy Management Defined

Energy Management is a program initiated by management or other personnel to obtain maximum energy efficiency in a business. It requires a company to initiate, design, analyze, and implement an effective program which maximizes company profits by minimizing energy costs. This is done by making the most use of a building's structure, energy consuming equipment, operating methods, and personnel. The techniques used in an effective energy management program are similar to that used by any business which has an effective administration, finance, marketing, or production department. It may require the active involvement of management, engineers, consultants, vendors, operating and maintenance personnel, and utility representatives.

1.4 Research Method

The authors of this paper bring approximately 20 years of experience in the field of energy to this paper. Their perspectives include that of a consultant, vendor, utility and an end user. Their exposure includes both successful energy management projects and dismal failures. This diverse knowledge was pooled to develop an outline for a successful energy management program.

The outline was broken into tasks, and responsibilities were assigned. A schedule was developed to ensure completion of this research project within the time constraints of the class. The schedule was used to show progress during class presentations, but is not included in this paper.

The research began with an on-line literature search to compile articles that others have written on the subject of managing an energy management program. Interestingly, this search uncovered a number of articles and books written in India and England, which provides an international perspective. In addition, most of the articles were written between 1978 and 1984, following the energy crisis in 1973. The on-line literature search was supplemented by searches in business and technical literature indexes. Most of what has been written on the topic of energy management addresses the technical nature of energy conservation. However, several articles provided important information on the management issues.

The information found in the literature search and that gained from the authors' experience were used to develop a model for a successful energy management program. The model discusses the necessary players, tasks and timing. A flow chart was developed to show the prescribed method. A responsibility interface matrix (RIM)[2] was developed and is suggested as a tool for starting an energy management program. Technical tools were gathered which are meant to be references for evaluating energy saving projects. These technical tools are summarized in Section 4.0, and supporting information is contained in Appendices B,C,D and E.

Finally, management case studies were selected to illustrate the model. The case studies are projects in which the authors were involved. The projects were selected to represent a wide range of organizations, management structures and levels of success. Energy managers and key players were interviewed, using a pre-determined interview format. The interview form was developed with the intent of gathering information on the selected case studies' energy management programs. A copy of the interview form can be found in Appendix A. The completed forms were not included in this paper to preserve the anomynimity of the participants. The management case studies are presented generically in Appendix A, and discussed in Section 3.0.

2.0 PRESCRIPTION FOR MANAGEMENT SUCCESS

2.1 Success Defined

There several ways to define success with respect to projects. The first mode of success is in avoiding projects that do not have a good chance of being successful. That is, by careful study of the possible alternatives, one can eliminate projects that do not fit well with the goals of the organization. Once a project is selected it will be deemed a success if it is on time and within budget while achieving all of its objectives. At this point a project's success can be measured both quantitatively and qualitatively. Quantitative success can be measured using energy accounting techniques. Qualitative success is a measure of the human issues involved in running a project. These issues will contribute to the quantitative success of the project. This paper will address both types of issues. Many things can contribute to a successful project. We will concentrate on those elements whose absence will make the project's success problematical. There are four major requirements for a successful project.

1 First, it is important that the project have a clear goal and that this goal is closely aligned to the organization's goals. If the project is not clearly in support of the organization's goals, it will be difficult for it to compete for the time and attention of those who authorize and fund projects. If the goal is not clearly stated it will be difficult for the project team to work together toward its achievement.

Second, the project team must be composed of the right mix of people and skills to plan, implement, and maintain the project. The team must include as a minimum four basic elements: a high level sponsor, a project champion to take responsibility for the project, people with the necessary skills to actually implement and maintain the project, and, lastly, people who will be affected by the project though they will not actively participate in it.

The high level sponsor is necessary to generate cooperation across organizational lines. According to one manager associated with energy management, "I can't stress enough the necessity and importance of top management support. Everybody in the plant has to know that whomever is running the operation is behind good energy management." [3]

The project champion provides the energy and enthusiasm needed to see the project through. Jack Meredith refers to this person as the "entrepreneur who sells the the idea throughout the firm".[4] This role may be played by the high level sponsor or may be the project manager.

Often the skilled people required to do the energy management project exist in the organization. They are the operators, maintenance, or facilities people. These people have an important contribution since, though they may not realize it, they know the facility better than any outside group can. If however, some additional expertise is required or, if these people cannot be spared to work on this project, additional expertise can be enlisted in the form of consultants and contractors. Use of external help increases the importance of involving and educating the people in the organization who will be living with the results of the project. If these people are not involved with the project they will have a tendency not to take ownership of the completed project (Not Invented Here syndrome). At best this results in their ignoring the changes (i.e. not maintaining the project) or at worst, there may be active sabotage.

The fourth group of people to be included in the project are those who are not required to actively participate but who will be affected by the implemented project. Whenever there is a change made in equipment or routine, the people who are affected will react to the change. Typically, even if the affect of the change is good, the reaction will initially be opposed to that change. The goals and intent of the project should be made clear to all levels that might be affected. Meetings, training, and publicity are three ways of accomplishing this. [5] Once the information is supplied to this group of people careful listening to their concerns and suggestions will help avoid serious problems with the implementation and success of the project. Even if this group cannot actively contribute to the success of the group they can effectively sabotage or even kill the project.

(3) Finally, there must be a well thought out plan based on accurate information. The steps the manager should take in getting this information and in formulating the plan are detailed in the following sections.

Where is the "fourth major requirement" (see p. 7)

2.2 Prescribed Project Sequence

The first part of the model is a flow chart, Figure 2.1. This flow chart shows the events that are common in Energy Management projects. The flow chart has two purposes. The first is to acquaint the manager with the tasks that must be done in any energy management project. The second is to show the order in which these tasks should take place to best ensure the success of the project.

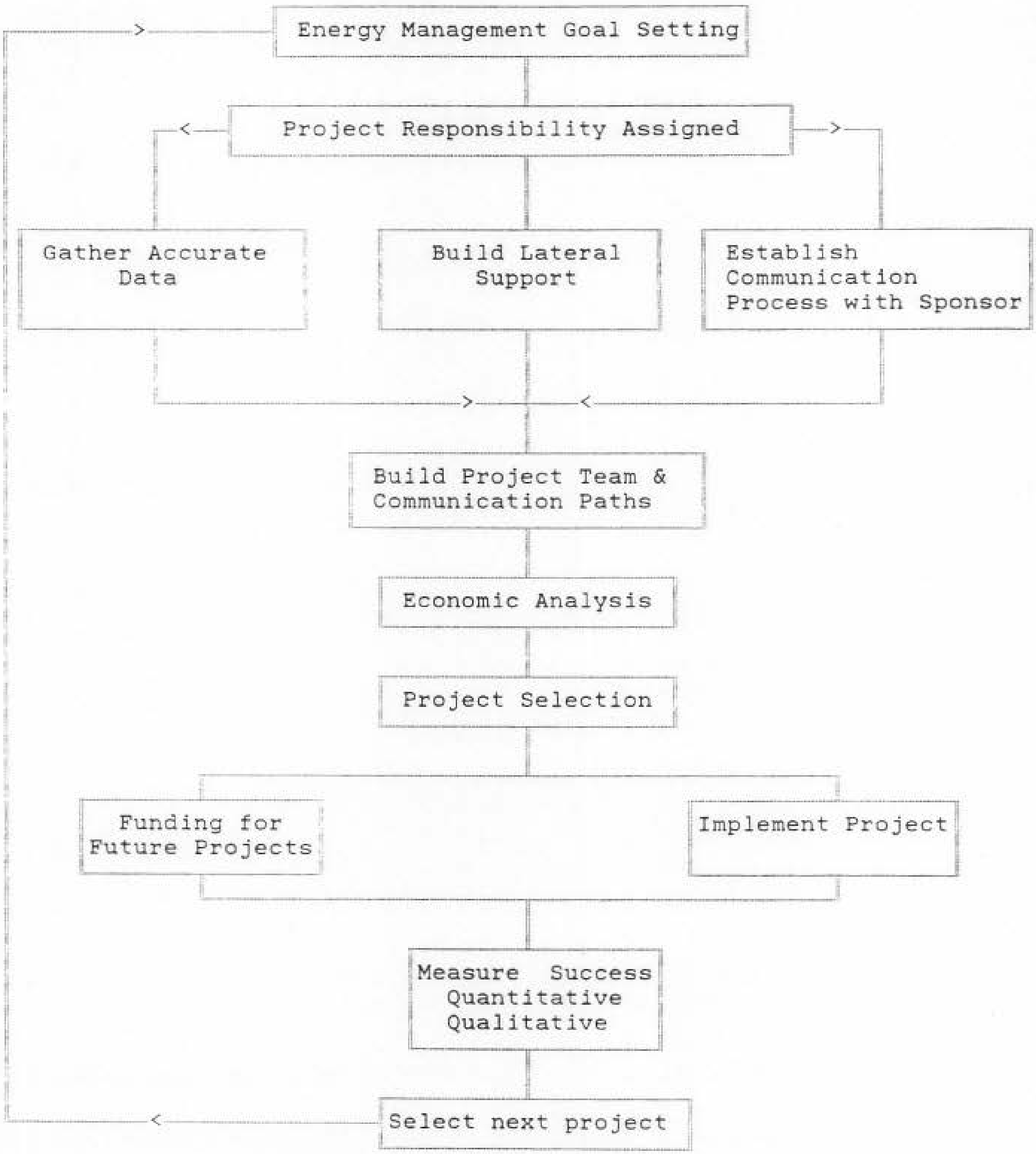
What is the difference in other types of projects?

Energy Management Goal Setting

The push for an energy management project can come from the rank and file of an organization. If this is so, an effort will have to be made to attract the attention of a high level sponsor. This is done by first selling the idea to your manager, who in turn sells it to his manager and so on. This is the normal procedure for getting any project approved. It is important at this point to check the proposed project to be sure it is in accordance with the organization's goals. If it is not then it will be very difficult to find a sponsor.

More commonly, the project goal is set in response to a directive from management to cut energy costs. In this case the manager issuing the directive becomes the high level sponsor mentioned earlier. Initially, this goal is simply stated in terms of facility budget cost cuts. It is up to the assigned manager to come up with the specific way of accomplishing this goal. After the oil embargo and energy crisis of the early 1970s it was not uncommon for that appointed manager to have energy management as his primary responsibility. Corporate resource groups came into existence to

Figure 2.1
ENERGY MANAGEMENT PROJECT FLOW CHART



assist facility energy managers. In today's environment of reduced energy prices and world competition many middle management positions, including that of energy manager, have been eliminated. It is more common at the present time to find that the manager who has energy management responsibility also has other full time responsibilities (i.e. school principal or maintenance engineer).

Project Responsibility Assigned

Once the goal has been set a manager will be assigned responsibility for meeting that goal. The project has the best chance of success if the manager appointed will become the project champion. In the case study summarized in Section 3.4, the manager took the project upon himself in order to save staff positions that would have otherwise been cut. In this case the manager became the project champion and had no problem inspiring enthusiasm in his team. If the manager has too many time demands already, the project will not receive the attention it needs or will do so at the expense of the attitude of the manager. The manager's attitude toward the project is critical to its success.

Once the manager has been selected there are several tasks that must be started in order to formulate a project plan. These tasks occur at the same time frame and should be coordinated carefully.

Gather Accurate Data

In order to generate energy management projects the manager must first know where and how the energy is being used in the facility. This is normally accomplished in several steps. First the energy audit team is formed. This team must include someone that is very familiar with your facility and someone who is familiar with the concepts of energy conservation. If the necessary expertise is not available in your organization outside sources should be considered. In the case study concerning a semiconductor manufacturer (see Section 3.3) the facility expertise was supplied by an engineer who had recently retired and was brought back as a consultant. In many cases that expertise will exist in house. Utilities and consultants can provide assistance in recognizing energy project opportunities and audit procedures. (For specific information on energy usage and energy audits please see Appendices B and C.) The goals of the project should be clearly communicated to the audit team.

Build Lateral Support

As the manager organizes the collection of energy data, it should become clear that the audit team will be crossing into other managers' areas in order to acquire the data. It is important to set up good lines of communication with these managers before the audit team begins its job. If these managers are not informed of what is happening before it takes place, their initial response may well be to protect their territory. Informal communication as well as formal communication are appropriate. If the managers involved have good working relationships, their cooperation will be easily obtained. This is done by informally providing information on what the project is and encouraging their feedback on how it might affect their areas. This informal communication should then be formalized in writing. If no relationships exist or they are not good working relationships, a more formal initial communication mode such as letters and formal meetings may be necessary. In scheduling meetings it is wise to involve the high level sponsor in order to communicate the source of authority for the project. The feedback obtained from the other managers may point out possible areas of resistance that the project manager should be aware of. As the project proceeds, these lines of communication will provide valuable feedback that can prevent costly mistakes (e.g. saving energy at the cost of poor product quality).

Establish Communications Process With Sponsor

Good communication with the high level sponsor will help to ensure continued support. The sponsor has delegated some of the authority to the project manager but still retains the responsibility for successful completion of the goal. The sponsor will also be able to provide information on the timing of funding requests and any change in the organization's goals that might affect the project.

Building the Project Team

As the audit data is gathered, energy management opportunities will become evident. In order to prioritize these opportunities, it will be necessary to put together information on the total cost of implementing these ideas and to evaluate the affects of the implemented plan on the facility's operation. As each opportunity presents itself there will be people associated with that opportunity that need to be added to the project team. The right mix of people may include the manager's own staff, facility users, consultants, contractors, corporate resources, government sponsored resources, vendors, or utility resources. Please refer to the discussion of RIMs in Section 2.3 for a detailed discussion of the potential members of the project team.

Is this really the project team? How large will it be?

You are describing the involvement of "stakeholders" in the Energy Mgmt. project.

Team building is more than simply assigning tasks to members of the team. It is important for the manager to communicate clearly the responsibilities of all members. This helps eliminate misunderstandings. The implementation of a Responsibility Interface Matrix (RIM)[6] can help establish what the responsibilities are and what communication is necessary. A further discussion of RIMs will be found in Section 2.3.

It is important for the manager to clearly communicate the goals of the team and keep them apprised of what is happening. In order to motivate the team it will be necessary for the manager to understand the needs of the team members (i.e. training, tools, etc.) and to provide recognition of their contributions. If good formal communications are established (e.g. regular meetings) the team will have a good understanding of the status of the project and how they are doing. If good informal communications are established, the manager will get critical feedback in a timely manner. Informal communication often uncovers information that might not make its way into formal channels until there was a serious problem. This type of problem is especially apt to happen on large projects with a long chain of formal communication. A good example of this is found in the case study in Section 3.2.

Economic Analysis

In order to proceed with project selection, the potential projects must first be analyzed economically. Information on capital costs, installation costs, and maintenance costs must be obtained. Probable savings resulting from the project must be estimated. It is very important, especially on the first project, not to underestimate the costs and overestimate the savings. If the project looks reasonable using conservative information it will stand a good chance of being successful. It is important to use the economic analysis tools that are appropriate within your organization. The high level sponsor can assist the manager by acquainting him with the types of analysis normally used to get funding. Financial justification methods are discussed in Appendix E.

Project Selection

Once the project opportunities have been examined the project manager will be able to prioritize them. The projects can be separated into short-term, medium-term, and long-term strategies.[7] In order to insure cooperation on future projects the first energy management project selected should be quickly achievable and have a strong chance of success.

How projects are prioritized will be a function of many factors. Obviously a good economic payback is often important. However, the best investment of the organization's funds may be a project that requires more capital and personnel resources than are available to the manager in the current fiscal year. Starting with a project with less economic appeal can get the energy management program off the ground and allow the manager to prove his abilities to upper management. It is important to get the input of the upper level sponsor when the manager is doing the prioritization. More detailed discussion of issues in project prioritization can be found in Appendix E.

Funding Future Projects

After the manager selects the initial project, work can be started on funding of future projects that could not be accomplished in the current fiscal year. The upper level sponsor can supply information on the process of applying for resources in the next fiscal year. The success of the initially selected project will have a strong affect on funding for the next project.

Implementing The Project

This paper is not meant to discuss the nature and tools of project management. Our purpose here is to touch on some of the management issues involved in implementing a project. The interested reader can find a variety of information available on the subject of project management.

In order to implement the project in an organized manner, a detailed schedule of events and the time allowed for their completion should be drawn up. This allows the project team to know what is expected of them and gives the manager an impartial way of evaluating their performance. This project schedule should be reviewed at regular meetings (formal communication) and as problems or opportunities arise (informal communication).

Even if the project is being run by an outside engineering firm the responsible manager must still monitor the project's needs. Are the right people available? Do they have the time and tools required for successful completion of the job? Is the project staying on schedule and within budget? There will be times when the user's authority is needed in order to get the project back on schedule. It is important to remember that while authority can be delegated, the responsibility for the projects successful completion still rests with the manager assigned to the project.

It is important to allow time and resources for the transfer of knowledge (i.e. as-built drawings, operation and maintenance manuals, etc.) to the end-user. The transfer of this knowledge is critical to the qualitative success of the job. Good communication is extremely important at this stage. Progress reports should be communicated to the upper level sponsor, the parties who will be affected by the project implementation, as well as those actively involved in the project. On large projects involving many contractors, engineering firms, and suppliers the manager will need to keep in constant touch in order to evaluate the performance of the project engineering firm.

News of the project's completior and success should be communicated throughout the organization. This is the time for formal recognition of those who made the project a reality through their efforts. Recognition of those who have gone through training in order to use or maintain the new facilities or procedures should also be recognized.

Measuring Success

As was mentioned earlier, success can be measured both quantitatively and qualitatively. As the project is implemented the manager should also be setting up mechanisms to assess the results. It is important to measure the success of the project for several reasons. Energy accounting allows the payback of the project to be verified. This is useful information when applying for future funding. Energy accounting allows the manager to apportion rewards and recognition based on actual energy savings. (Energy accounting is discussed in

Appendix B.)

Reviewing the accuracy of estimates allows the manager to make better estimates on future projects. These are quantitative measurements of success.

In addition to these the manager should also review the qualitative success of the project. Identifying where the roadblocks were in this project can help the project team avoid or minimize them on the next. One of the best measures of the qualitative success of the project as seen by the project team is whether or not they would be interested in doing another project. The manager should also evaluate how the project is being accepted by the people who now use the implemented project. This could be done informally if good communication lines exist or formally through anonymous surveys.

2.3 Prescribed Project Organization

The Problem

In order to be successful, an energy management project is distinguished from many other projects by some key differences:

i. Participants in the project must be from all levels of an organization's hierarchy and from a wide base within the organization's various functional groups;

ii. The project will continue over several years and entails not only a flow of new activity, but a need to maintain that which has been completed.

better term than "project team members", which has a specific meaning.

The essential requirement for a large number and variety of people to actively participate over a long period of time, presents a challenge to the project manger. In order to assure eff-ctive communication among the project participants, clarity of project responsibilities and formalization of project planning and prioritizing, special care must be taken. A tool has been developed which addresses each of these needs: the Responsibility Interface Matrix[8] (RIM).

The Solution

The purpose of the RIM is to overcome the barriers which may prevent required communication and the active participation of team members from occurring. This is accomplished by formalizing and documenting the work to be done, who is to do it, who needs to see it, who needs to approve it and so on.

As a method of providing the energy manager with a framework for a successful project, an example RIM is shown in Figures 2.2 through 2.4. This framework is illustrated in more detail in Appendix A through the use of four case studies. The three figures together constitute the entire RIM. It was broken up into three figures in order to fit them conveniently in the report.

Notice that each sheet has the same organizational labels in the left column. These are the descriptions of the organizations and people who may participate in the project. The labels across the top of each figure describe the major project activities shown on the project flow chart, Figure 2.1, also called work packages. Not every project will necessarily include all of these organizations or work packages. However the RIM proposed here should be used as a starting point to assure that key organizations and work packages are not overlooked.

Work Package Definition

Set Goals:

The manager has the responsibility to be sure that clear objectives are set for the project team. These can be both general ("To make our facility energy efficient.") and specific ("The selected project will be implemented by this date.") Once the general objectives are known, the group will be able suggest possible projects to reach those goals.

Select Project:

The project team will easily be able to generate a list of potential energy saving projects the will assist in meeting the objective. They will need to be analyzed and prioritized.

Figure 2.2
Responsibility Interface Matrix
Management Work Packages

		Set Goals	Select Project	Build Project Team	Implement Project	Measure Results
End User						
Off-site:	Management					
	Engineering					
	Purchasing					
On-site:	Management					
	Engineering					
	Purchasing					
Government						
Utility						
Consultants						
Project Management						
Engineering Staff						
Construction Group						
Vendors						
Sales Representatives						
Technical Specialists						
Service Organization						
Contractors						

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Required
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure 2.3
Responsibility Interface Matrix
Financial Work Packages

	Budgetary Estimates	Economic Analysis	Selling Project	Authorize Resources
End User				
Off-site: Management				
Engineering				
Purchasing				
On-site: Management				
Engineering				
Purchasing				
Government				
Utility				
Consultants				
Project Management				
Engineering Staff				
Construction Group				
Vendors				
Sales Representatives				
Technical Specialists				
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure 2.4
Responsibility Interface Matrix
Technical Work Packages

	Identify Projects	Energy Audit	Information on Technologies	Measure Results
End User				
Off-site: Management				
Engineering				
Purchasing				
On-site: Management				
Engineering				
Purchasing				
Government				
Utility				
Consultants				
Project Management				
Engineering Staff				
Construction Group				
Vendors				
Sales Representatives				
Technical Specialists				
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Build Project Team:

In order for the project to be successful the right mix of people must be brought together into an organizational structure that promotes good communication and productivity. A project team is formed of people who have the necessary skills, roles, interests and authority to accomplish the project.

Implement Project:

In order to ensure project success, the needs of those working on the project, those in authority supporting the project, and those affected by the project must be met. Good communication between these groups will bring to light their needs. Some examples are:

Project team:
Recognition, incentives, training for the job;

Sponsor:
Frequent two way communication of progress and satisfaction;

Those affected:
Input on the project to minimize adverse affects, information about the project to promote good affects, training on new procedures and equipment for maintenance.

The RIM process is particularly well suited to address the communication issues and encourage participation by the variety of people who need to contribute. Their roles have been formally sanctioned thus they have been empowered to take an active role in the project.

Some of the work to be carried out includes:

- Access to the plant for surveying, testing, balancing, adjusting, and retrofitting the mechanical and electrical systems;
- Preparation of plans and specifications for operating procedures and/or construction programs;
- Preparation of an operating manual for use by operations and maintenance personnel;
- Training the permanent energy management coordinator and operating personnel to monitor, operate, and maintain the systems and structure in accordance with the developed energy management program;
- Regular testing and servicing of equipment;
- Cleaning activities to maintain maximum efficiency of filters, louvers, heat transfer equipment, lighting fixtures windows,etc.;
- Re-establish operating parameters in accordance with the intent of the program as changes occur in building;
- Set up and maintenance of a data collection system to include a description of all systems, their operating characteristics, maintenance performed and monthly fuel and energy usage.

Measure Results:

One of the contrasts between an energy management project and many others is that many of the measures of success are visible to many people and very easily quantified. The project manager can use this to advantage by having those who did the work participate in the ongoing operation and having them constantly exposed, literally, to the profits from their work. The RIM clarifies the "users" (read maintenance technicians, custodians and production operators) need to know about the results of the project.

Budgetary Estimates and Economic Analysis:

This portion of the project has an obvious place to everyone early in the project. As mentioned, one of the unique traits of an energy management program is its long term nature. The economic analysis process needs to be understood by all of the active participants so that they feel comfortable with the project selection method. In addition, the analytical process needs to be updated periodically to assure a constant flow of projects that contribute towards the organizations success. The RIM can help to institutionalize this process and assure an understanding of it.

Factors which need to be understood and accounted for during this phase include:

- Information on prevailing lease agreements as they cost sharing agreements and the likelihood that a tenant will work with the building manager on new operating methods;
- Calculate loads and flow characteristics to determine the potential energy savings for each system or building component;
- Analysis of utility rates.

Selling the Project:

No matter how good the project is, ultimately if funding is not approved it will fail. The RIM sets up a mechanism so that early in the project the project manager has the opportunity to identify an upper level management sponsor. This person then needs to be "sold" on the idea so that labor and capital will be available as necessary to assure success.

Authorize Resources:

Nothing will cause any project to end faster than a lack of labor or capital. The project manager needs to use the RIM to first identify the requirements and then use it again to communicate what is behind the need for resources. Of course at this point, the economic implications need to clearly be to the advantage of the organization. Once the need and the benefit are clearly communicated the chances for success are great.

Identify Projects:

The prescribed RIM shows a large variety of people potentially involved in this work package. The reason is that there are so many opportunities for cutting energy costs in a variety of applications. The larger the group of people who participate in the identification and selection of projects, the greater the chance of these projects being accepted as meaningful and thus being implemented and maintained over the years.

Energy Audit:

Typically this work package is performed by someone with technical training specifically in the field of energy. They can collect and tabulate operating costs, fuel and energy use totals and other pertinent details. It is one of the most important phases of the program. The large opportunities for savings often become easily identified. It is crucial to openly share the results of this phase with all members of the project team so that the data can be verified by people who live with the systems daily and be accepted as realistic and useful results.

Information on Technologies:

Qualified contractors and vendors can provide information on the latest technology, products, and materials. The cost to purchase and install them, their actual performance in the field, and their relative ease of operation and maintenance can also be provided.

Utility company representatives should be contacted to obtain energy consumption data, utility rates and possibly weather data. Depending on the policy of the utility company, utility representatives may or may not wish to be involved in an on-site inspection. However, the utility companies should:

i. Provide information on existing and anticipated utility rates;

ii. Loan or rent meters to measure flow rates to test, balance, and adjust systems for optimal performance.

Summary of the RIM Process:

At least as important as the RIM documents themselves is the value gained by putting the organization through the process. The communication and motivational benefits from the participatory approach are tremendous. Of course the clarity of responsibility is a great benefit and will help to assure success.

2.4 Summary of the Prescribed Model

One of the key challenges is successfully selling the program to management. Before an energy management program gets started it will fail if sufficient funding, both capital and labor, is not obtained. A very well thought out and polished effort that ties energy management to the business strategy is a requirement of a successful funding effort. As has been discussed earlier in this section, it is imperative that funding be planned for and obtained at appropriate points during the business planning cycle to assure availability. The prescribed sequence of activities and the RIM process provide a proven route to success.

The next section of this paper illustrates how the recommended process, described thus far, has been used in four different types of organizations. In addition, each of the cases has been included in detail, in Appendix A, with a RIM to further clarify the use of the model.

3.0 ILLUSTRATION OF THE MODEL

Management case studies provide excellent vehicles for demonstrating actual experiences in management, leadership, delegation of responsibilities, and implementation of an energy management program. Case studies demonstrate actual experiences in energy management. As such, they serve to illustrate the model presented in this paper and to encourage others to engage in energy-orientated modernization activities.

There are four case studies summarized on the following pages. Each case study was chosen to represent a wide range in organizational structures. Information from these case studies was obtained through a personal interviews. A detailed description of each case study, its respective RIM diagrams, and a blank copy of the interview form are attached in Appendix A. The four case studies are:

3.1 Grocery and Variety Store Chain

3.2 Municipal Government

3.3 Semiconductor Manufacturer

3.4 Public School District

3.1 Illustration : Grocery and Variety Store Chain

In 1978 this grocery and variety store chain developed an energy management program which was initiated through top management. The intensions of the company were to save money on operating costs and promote energy efficiency. The company looked at all energy using areas to minimize energy consumption without compromising product integrity or client satisfaction.

Management assigned the in house engineering department the responsibility for the project.

The engineering department established a detailed energy data base of monthly energy consumption with the assistance of the accounting department and local utilities

Goals were set to reduce the consumption at each location.

Management approved a budget to implement energy conservation opportunities which showed a payback within three and one half years.

A team was formed consisting of engineering, accounting, maintenance and outside sources like utility representatives, consultants and vendors and government agencies.

In-house engineering expertise provided a thorough analysis of possible alternatives

Good communication between team members insured the project's success. Energy conservation opportunities with little or no investment were the first to show immediate project success.

In summary, the key points which assured success for this company are:

- Management's support to reduce operating costs and provide a budget for energy conservation opportunities;

- In-house expertise in the engineering department;

- Project team members commitment to upper management and company prosperity;

- Project team members open communication channels;

- Employment of all resources within and outside of the company;

- Ongoing project activity and success through careful selection of projects.

The key areas that lessened the project's success were:

- The maintenance department's unwillingness to accept new technological advances;

- Maintenance departments or non-technical people maintaining the more sophisticated equipment.

3.2 Illustration: Municipal Government

In the early 1980s a city council was faced with the requirement that they build additional waste water treatment facilities. The goal of an energy efficient plant was important since the city was small and needed the most cost affective plant possible. The goals were set by the city council.

Responsibility and procedure for a municipal project is governed by law. The project engineer is selected via a closed bid process. The selected firm became the project management team for the city's project. Meetings were held with the city and the existing plant to establish formal communication paths and build lateral support.

In order to build the project team the engineering firm prepared specifications and bid documents. The closed bid process was used to solicit the team members. The general and sub contractors were hired by the city. The engineering firm set up project schedules and milestones for use in determining the progress of the project.

The project was implemented over a two year period. In the course of project implementation the schedule often slipped due to misunderstandings between different subcontractors. These differences of opinion often had to be cleared up in formal meetings with all affected parties in attendance. The time required to gather all the parties together on a construction project can easily result in weeks of delay. This is common in any construction project and requires vigilance on the part of the project engineer and end user to keep it to a minimum.

Although training was required by the specification for all equipment and procedures, some of the equipment used in the energy management portion of the plant was neglected while time was spent on learning the process equipment. This was a sensible choice at the time, however, the neglect was not corrected until the equipment was out of warranty and the maintenance crew was unable to work with it.

The project is now in operation. The contract calls for the project management team to evaluate the operation of the plant one year after operation has begun.

Key points:

Expertise was required that did not exist within the city. This was obtained by hiring a project engineering firm to act as project managers and advisors for the project. The city retained final decision making authority.

Municipal projects require special attention to the communication requirements. The long formal communication chain can result in significant delays. This project had a minimum of such problems since the engineering firm had a good relationship with their general contractors.

Formal assignment of responsibility is required by law on a municipal project. It is done by the signing of contracts. In other organizations there may not be a formal mechanism for assigning work package responsibility. In these cases use of a tool like the RIMs will aid the process.

It is easy to lose sight of the training needs of the end user, especially on a large project. Failure to train the user on the operation and maintenance of equipment will result in lower performance by that equipment. The problem is particularly acute when dealing with equipment that is new to the end user.

3.3 Illustration: Semiconductor Manufacturer

In 1985 this supplier of application specific integrated circuits (ASIC's) found itself spending ten percent of its annual expense budget on utilities (excluding telecommunications costs). There was a consensus among the division's senior management that this was far too high and that opportunities existed for significant cost reductions.

Goal Setting/Gather Accurate Data

A consulting engineer was contracted by the engineering manager to look for further opportunities and confirm the results of the studies which had been done. When the consultant concluded his work he presented it to all of the maintenance technicians and engineers.

Project Selected/Responsibility Assigned/Implement Project

By the end of the day after the presentation the maintenance technicians had completed over half of the work on the first priority item. This one item has netted an ongoing operating cost reduction of over one million dollars per year! This initial project action required no capital investment and minimal cost.

Build Lateral Support/Establish Communication with Sponsor

The division general manager strongly supported the utility cost reduction effort from the beginning. In fact he was the initiator. Because of this, ongoing communication with him was easy to maintain. Obtaining support from the necessary managers in the organization was fairly easy. They all saw this as an opportunity to have an effect on the division's success.

Build Project Team

As a result of the quick start before much had been formally done to build the project team, a large percentage of the first priority item had been completed. Nonetheless, in order to keep the project successful over the long term people and funds were approved for the remaining project activities. Engineers, managers, maintenance technicians, custodians, and production operators were included to assure long term maintenance of the procedures and equipment.

Measuring Success

Each month utility costs are tabulated and posted in the building cafeteria to keep people aware of the project's continued progress and success. Annual utility costs to the division have been reduced by forty percent. It is expected that within the next two years the fifty percent mark will be reached.

Summary

In summary, the key points which assured management success were:

- Team members who felt ownership of the problem and the solution;
- Strong, early support from senior management;
- Employing the necessary technical expertise to clearly evaluate and explain the alternatives and teach the principles of energy management to the entire department;
- Choosing an initial project which required minimal investment but showed quick and easily measured results;
- Publicity for the success and rewards for the team members to further encourage them;
- Credibility for the program from the quick results and ongoing utility cost measurement;
- Ongoing project success through careful selection of activities.

3.4 Illustration: Public School District

This case study describes the energy management program that a school district started in 1982. Faced with budget constraints, the Maintenance Manager decided to reduce operating costs rather than cutting personnel. With support from the School Board, an energy management program was started. During the next six years, help was solicited from principals, teachers and students, resulting in energy cost reductions of almost fifty percent. The following paragraphs describe the school district's energy management program in the context of model developed in this paper.

Goal Setting

Goal setting was enhanced by a district wide energy policy. The policy lists four measurable goals for which the Maintenance Manager is responsible. See Appendix A4 for a copy of the energy policy. While many capital intensive projects were delayed due to budget constraints, the formal program mandated by the energy policy ensures that they will be implemented when budgets allow.

Planning

The planning function is performed by the Maintenance Manager. An Energy Committee was formed for this function, but according to the Maintenance Manager, "it was too hard to achieve a consensus, and nothing ever got done." The Maintenance job description lists six specific tasks to achieve the goals of the School District's Energy Policy. Four of these tasks involve planning. The documentation of these tasks in the job description gives the Maintenance the formal authority and responsibility for planning energy conservation strategies.

Team Building

Team building started with the School District's energy policy, which states, "An effective energy management program requires a strong commitment from all school district employees. Staff support is important to the success of an energy management system." It was further enhanced by the Energy Committee, which got commitment and awareness beyond the school board and maintenance department. In addition, monthly energy bulletins heightened awareness and prompted calls from principals asking, "what can we do to reduce our energy usage?" Finally, the fact that 16 to 20 staff positions were saved due to the first year of energy cost reductions, contributed to the team spirit.

Communication Process

Communication was both formal and informal. The Maintenance Manager was required to present district annual energy reports to the school board. In addition, monthly energy bulletins were sent to the school board and to the principals, which rated schools on their energy usage and conservation efforts. It also listed projects that were underway and ideas for future projects. Teachers developed an energy curriculum, which by the nature of an educational institution aided the communication process. Informal communication was handled with an open door policy. The Maintenance Manager talked with teachers, parents and principals,"until they understood, or at least stopped complaining."

Project Selection/Prioritization

The Maintenance Manager used two governmental programs for technical assistance and funding. Both programs require a professional engineer or architect to perform energy audits, identify energy energy conservation projects and prioritize the projects identified using a simple payback analysis. Once the projects were prioritized, the programs required design documents to be prepared so that it can go out to bid. The governmental agencies then funded the energy audit, analysis and a specified percentage of the cost to implement the energy conservation projects. While the programs involved a lot of paperwork and tight deadlines, the Maintenance Manager said that, "the hassle was worth it."

Energy Accounting

Energy accounting is performed district wide. The energy accounting program totals energy consumption, compares the total to a base year, and totals the energy cost reductions since the base year. Graphic results are sent to the school board and principals with the monthly energy bulletins. According to the Maintenance Manager, "This program aided significantly in gaining the support of the school board."

4.0 SUMMARY OF TECHNICAL TOOLS

4.1 Energy Usage

Energy use in buildings is determined by climate conditions, the working environment, and the equipment required to carry out the business functions. Each business has its own specific needs, including people, equipment, and operating conditions. Therefore to understand the energy requirements of a particular business or building, it is essential to understand the business function, equipment involved, and human factors. An evaluation can then be done to minimize the energy consumption.

The efficiency of a business or building is comprised of three basic systems. These are: energized, nonenergized, and human systems. The energized systems consists of the mechanical and electrical equipment like the heating, ventilating and air conditioning (HVAC), lighting systems, electric motors, business equipment, and so on. Nonenergized systems are the floors, walls, ceilings, windows, doors, etc. Finally, human systems are those comprising maintenance, operating and management personnel, as well as tenants and other users. Each of these three systems must be analyzed and modified to achieve the necessary savings in energy. Therefore, effective energy management requires that the entire pattern of energy consumption be analyzed so that changes made will be integrated into the full light of the interrelationships which exist and the various effects which will occur.

To measure the effectiveness of the building energy efficiency, the benchmark normally used is the normalized annual energy use (kbtu/sf/yr), also known as the Energy Utilization Index (EUI). The EUI indicates how efficient a business or building is relative to other businesses or buildings. The relative range of the EUI depends on the factors stated above and vary greatly. A list of EUI's for various businesses, building types and HVAC systems are provided in Appendix B.1.

Energy Usage Analysis by System Type.

Once the total energy usage is analyzed and the EUI determined, the next crucial area to determine energy required by each system type. The system types described here refer to the energized systems stated above. System types include the HVAC, lighting, domestic hot water systems, electric motors, office equipment, etc. The energy consumed by each one of these variables must be analyzed individually and interactively. Once this has been done, the business or building can then be analyzed by a descriptive chart known as a pie chart. The pie chart is often referred to as the energy usage breakdown diagram. A number of pie charts for various business types are included in the Appendix B.3. Caution should be taken in applying these directly to a particular business since they were obtained from an existing business based on its specific weather and business conditions.

Modeling Energy Usage

Although it is possible to estimate the energy usage of each type of equipment described above, manually, the most actuate and preferred method is with the use of a computer. A computer program provides a valuable tool in establishing what and how much energy is used by each energy system. The computer software available today accounts for weather and the interactions that exist in each piece of equipment.

Most of the the simulation programs available receive initial input in the form of data relating to installed systems and climate conditions. The print outs should provide a reasonably accurate estimate of monthly and annual energy consumption. A comprehensive list of simulation software has been published by ASHRAE, called Bibliography of Computer Programs.

4.2 Energy Audit

Performance of an energy audit is absolutely fundamental to the successful development and implementation of an energy management program. It is essential that the audit is made by qualified personnel in an unbiased manner. Whether the audit is conducted in house or by a consultant, they must be able to recognize all possible areas where energy is being wasted.

Energy audits are normally separated into three distinctive levels. All three levels of energy audits begin with same basic procedure, but the complexity of the audit will depend on a number of factors. Each level requires the energy auditor to develop the energy management team, evaluate previous energy usage, analyze energy using equipment, business operations, conduct an economic analyses, and implement a plan. A detailed description of each energy audit level and the analysis procedure in Appendix C.

Evaluation of Energy Usage

An important step in the vary early stages of an energy audit is to evaluate previous energy usage. This is done by obtaining at least a three year history of electrical and fossil fuel (natural gas, oil, Propane, etc.) energy usage. This information can be obtained easily through the utility company. This information should then be logged and graphed to analyze the variations in consumption and to compare it to estimated goals.

Then it is important to:

Establish a base year against which to compare;

Set a month by month energy budget or target, one year in advance;

Record all energy purchased or used on a monthly basis, in both energy units (btu) and dollars;

Report performance against your target or budget on a monthly basis to your financial department. Include both energy units and dollars.

4.3 Energy Accounting

An energy accounting system provides an opportunity to verify predicted savings. By producing regular energy reports, the energy manager can enhance awareness of the cost reduction program. Monthly energy reports, comparing energy usage to targeted amounts, and total energy savings since the inception of the program, will ensure senior management's attention the next time an energy budget is submitted.[9] Monitoring the success of the first projects increases the excitement and commitment for subsequent projects. This was especially true in the case of the Public School District, where reducing energy costs by 35 percent in the first year saved 16 to 20 staff positions and gained the commitment of the School Board, principals, teachers and maintenance staff.

While energy costs can be totalled and graphed by hand, several computerized energy accounting programs are available. A list of programs and some literature on two of the programs can be found in Appendix D. Two of the programs were developed by government energy offices and are available at no cost to other government facilities. Most of the programs allow energy usage to be normalized by any variable that is appropriate to that facility. Each program has the ability to report and graph total energy usage, targeted energy usage and total energy cost reduction. Once the program is set-up, all that is necessary is the input of the monthly energy consumption. One vendor even provides this service and returns the monthly energy use reports. It should be noted that this information can also be analyzed using a personal computer spread-sheet program.

These reports are valuable tools for monitoring energy usage in order to spot and correct problems before they get out of hand. "Questions concerning who should collect [and input] the information, compile and issue the reports will depend on the company structure, but the responsibility for reading, analysing and initiating follow up action must rest with the appropriate line manager."[10] When management is familiar with the facility energy goals and the report format, problems can be identified with a cursory glance at the energy accounting reports. Energy measuring and accounting "...alters the function of management because the problems of correcting faults after they happen are alleviated by ensuring that potential errors are avoided in advance."[11] For example, one large grocery chain has over 60 stores on an energy measuring and accounting system.[12] The Director of Operations can tell by a store's kilowatt demand profile that the refrigeration compressors are cycling, which shortens the effective life of the equipment. He can dispatch a refrigeration repairman to the store to fix the problem before the compressor fails, preserving the quality of the food, and increasing the life of the equipment. However most importantly, energy accounting allows management to track progress toward energy goals.

4.4 Additional Resources

Many resources are available for assisting with an energy management program. From trade literature to vendor information, from federally funded energy studies to societies of energy managers, these resources are available if you know where to find them. This section will summarize the available resources and how they may be of use. More detailed information can be found in Appendix D. Some of the resources are specific to Oregon or Washington, but similar programs can be found in most states.

Financing and Technical Assistance

Federal, state and local governments, as well as utilities, offer many programs which your organization may be able to take advantage of. While there were more programs available in the late '70s and early '80s, the programs that remain are worth investigating.

Technical Assistance, in the form of technical information and programs that provide energy audits or modeling, are available through the U.S. Department of Energy (for schools and hospitals only), Bonneville Power Administration, Oregon Department of Energy, Washington State Energy Office, Oregon State Extension Office and most utilities. Most of these agencies have knowledgable people willing to talk to energy managers and help them get started in the right direction.

There are resources that offer grants, tax credits and low interest loans for energy conservation projects. While there was more money available ten years ago, there are still ways to reduce your capital investment costs if you can document the energy conservation potential. The U.S. Department of Energy Institutional Conservation Program will fund up to 50 percent of approved energy conservation measures for schools and hospitals. Oregon Department of Energy provides business energy tax credits and low interest loans for energy saving or producing projects, and Washington State Energy Office offers grants and low interest loans to schools.

Professional Societies

Joining professional societies allows energy managers to hear what others are doing in the field. There are some societies that specifically address energy management, such as the Association of Energy Managers, and there are some societies that address the technical side of energy conservation, such as the Energy Division of the American Society of Heating, Refrigeration & Air conditioning Engineers. A lot of good information is exchanged at society meetings and conferences; typically, there are speakers or tours which allows one to get the information first hand.

Trade Journals

Most professional societies have journals. In addition, there are many journals which address specific industries, such as "Semiconductor International". Finally, there are journals that specifically address energy, such as "Energy User News". This literature offers examples of what others are doing, annual or monthly lists of vendors who carry specific equipment, and address changes in the technology. It is recommended that an energy manager subscribe to trade journals to stay current in his field.

Shared Savings Companies

There are still a few companies that offer shared savings programs. A shared savings company pays for the initial capital investment and receives in return a specified portion of the energy savings. This is a very risky venture because of variable energy costs, and variances in energy consumption. For example, if the energy savings are based on a period of low energy rates and low production, and both energy rates and production increase in subsequent years, there may be no energy savings, which has caused many companies to go bankrupt. For this reason, surviving shared savings companies have written their contracts to allow for all contingencies in order to protect their investment. As a result consumers are suspicious of the long contracts and use shared savings as a last approach to financing. This is unfortunate, because shared savings can benefit both the shared savings company and the consumer, who may not have any other method of financing.

4.5 Prioritization

Whatever prioritization method you choose to use, energy cost reduction projects are attractive methods for reducing the cost of sales. "In a typical paper company it would take a 20% increase in sales to realize the same increase in profits that would be achieved by a 10% reduction in energy usage."[13] In other words, energy projects just may have the edge in the competition for resources, but you'll never know until you analyze the opportunities. (This is discussed further in Appendix E.2.)

Once a list of potential energy cost reduction opportunities has been generated, they need to be prioritized by considering the available resources and the company's strategic posture. Since top management typically approves capital expenditures, it is important to present the information in terms that they are familiar with. An energy cost reduction opportunity is competing with other projects for a limited amount of resources. Depending on the company's strategic posture, the best opportunity may be the one with the greatest short term gains. If this is the case, a simple payback analysis may be all that is warranted. On the other hand, if the corporate strategy is oriented toward the long term, a life cycle cost analysis may be more appropriate. It is important that a manager know the format used and the analysis necessary for budget approvals, and the implications of the company's strategic posture. If a project manager is not familiar with these items, consultation with the high level sponsor is warranted.

It is also important that an energy manager understand the company's budget approval process. Typically, the process will include three basic steps. First, the idea must be evaluated for preliminary feasibility. If the idea looks good on paper, but is not practical because it increases maintenance costs or lowers productivity, it will not be accepted. Secondly, the idea must be evaluated economically. Companies usually have a standard financial criteria for evaluating capital expenditures. The costs and savings must be well documented in order to justify the investment. It should be noted that on the first few projects it would be wise to check the savings and cost estimates with a few resources. It is important that the savings are not overestimated and the costs are not underestimated, because this would negate any kind of economic justification or prioritization method, and jeopardize the success of the energy management program. Resources for estimating energy savings may be found in Appendix B, and a discussion on estimating first costs may be found in Appendix E.

Finally, assuming the company's financial criteria is met, two elements will be considered in the approval decision making process: available capital and available manpower. The available capital is a function of the companies cash flow at the time the capital is requested. The cash flow is determined by the company's profitability, and by other capital expenditures which are being requested. The second element, the available manpower, will also depend on the competing capital requests. The limitations of available manpower can be overcome by contracting the work out, rather than having it done in-house, but this will also increase the cost of the investment.

This competition for the company's resources further complicates the decision making process. For example, if two requests for capital are equally attractive investments, which should be chosen? Many criteria should be examined such as tax advantages, life of the investment, maintenance impacts, and of course how it supports the corporate strategy. If the company has an energy conservation policy, it will be necessary to prioritize this policy against the generally accepted goal of providing the maximum value to your company's stockholders.

The next section will summarize the various economic justification methods (more detailed information on these methods can be found in Appendix E). The final section of this paper will discuss a method for analyzing the relative effect on profitability of investing in an energy cost reduction project and investing in increased sales.

Prioritization Methods

Simple Payback Analysis: A simple payback can be defined as the amount of time required for the savings generated by an option to equal the cost of implementing the option. A three year simple payback is the standard criteria for evaluating investments in the commercial sector.[14] Simple payback analysis is good for screening investments. It is easy and well understood, but it "fails to consider the time value of money, the impact of inflation, or the differential escalation (the difference between the general rate of inflation and the higher rate of inflation expected to affect energy prices in general)."[15] It is also can not be used to decide between two mutually exclusive projects which have different lifetimes. For example if one piece of machinery pays back in one year, but only lasts five years, and another piece of machinery pays back in three years, but lasts twenty years, which is the most economical? Simple payback analysis will not necessarily indicate the best investment.

Return On Investment Analysis: The rate of return on investment analysis is often referred to as an ROI. ROI analysis measures the efficiency in using available resources. Since the available resources are limited, management must try to get the most out of those resources that are available. The ROI can be defined as "...the interest rate at which the present worth of the cash flows is zero."[16] This method accounts for the time value of money and the effective life of the equipment, and is commonly used to evaluate alternatives.

Present Worth Analysis: The present worth analysis uses the time value of money to translate future cash flows into terms of a present worth. The present worth analysis can only be used on projects with equal lives unless some other criteria is provided, such as a service period of comparison, or that the asset with the lowest annual cost replaces any asset with a higher annual cost. The "present value is a more frequently used measure of economic merit than the comparable annual amount, probably because it provides a better grasp of the total commitment to, or potential of, a course of action."[17]

Savings to Investment Ratio: The savings to investment ratio is commonly referred to as SIR, or the benefit to cost ratio. " A SIR compares the present worth of savings to be obtained over an energy management investment's economic life, to what it costs today to make that investment."[18] Since the SIR is a ratio of the savings over the life of the project to the cost, a SIR greater than 1.0 indicates that the cost exceeds the value of the savings, and that it will not be a good investment.

Life Cycle Cost Analysis: Life cycle cost analysis is an accurate method for prioritizing energy conservation opportunities with different effective lives. It was adopted by U.S. Government agencies in the 60's as a means of enhancing the cost effectiveness of equipment procurement. This method incorporates the time value of money over the effective life of the energy cost reduction project. This method assumes that the equipment will be replaced with exactly the same equipment at the end of the effective or useful life over a common period of study. The common period of study is based on the effective lives of all of the alternatives. For example if one option has an effective life of 5 years, another option has an effective life of 10 years, and the last option has an effective life of 15 years, a common period of study would be 30 years. This assumes that six of the first option, three of the second, and two of the last alternative would be purchased during this time period. Of course, technologies may have changed during the first piece of equipment's effective life, prompting management to use the life cycle cost analysis again based on the new technologies. Life cycle cost analysis allows an alternative to be selected based on the minimum cost over the life of the investment instead of just the first cost.

Other Important Considerations

Other considerations in the prioritization of energy cost reduction opportunities, are the experience, skills and goals of the energy management program. If the energy management program is just getting started, one of the easier projects would start the program on the right track toward success. This would allow staff to acquire the necessary skills for the more challenging projects. Typically, the low cost changes in operation or maintenance can have the most dramatic effect in cost reduction.

For example, in the Semiconductor Manufacturer case, a change in operating heating water valves took one day to initiate, and netted an ongoing energy cost reduction of over one million dollars per year. This first energy project gave the confidence necessary to look for more challenging opportunities.

Subtle differences in the goals of the energy management program mandate different prioritization methods. If the main goal of the program is to minimize energy usage and reduce the impact of the unpredictable swings in utility rates, then the opportunity which saves the most energy may be the best option. The first step in this case would be to identify the sources of energy consumption and rank them from largest to smallest, and focus on the largest energy users first. On the other hand, if the goal of the energy management program is to reduce operating costs, the focus needs to be on the energy consuming systems which represent the largest energy costs. The difference between minimizing energy usage and reducing energy costs stems from the fact that cost for the same amount of energy is different for electricity and fossil based fuels.

Typically, the cost for electricity per Btu is higher than that for fossil based fuels. This has prompted many organizations to switch from electricity to fossil fuel, or from crude oil to natural gas. While for periods of time one energy source will be more attractive than another, care should be taken not to solely base the energy management prioritization methods on market sensitive conditions, because the market will change. The focus of the energy management program needs to be on selecting the most efficient source of energy for the application.

For example, natural gas burns more efficiently than crude oils and is more appropriate for producing heat than electricity. This is because electricity is a higher quality of energy which has greater losses associated with generation and transmission. These losses are passed on to the consumer in the form of higher utility rates.

By focusing on selecting the most appropriate energy source, the program will be successful, regardless of the fluctuations in the energy market.

Before you begin considering energy management as a key business strategy, the relative portion of your energy expense to other expenses must be understood. The question to be answered is, where can I get the best return on my efforts? If energy expense is relatively insignificant, then this program may not be the best place to expend a portion of the limited available resource.

Appendix E.2 demonstrates a method for analyzing the relative effect on profitability that two alternatives may have:

i. Invest in energy cost reduction projects;

ii. Invest in increased sales.

Although increasing sales seems to be most consistent with the entire purpose of the business (provide goods and services to a customer), remembering that the real purpose is to provide the stockholders with maximum value may lead to selecting the energy cost reduction route.

Without getting into detail (see Appendix E.2 for detail), the basic concept is as follows:

> The generation of additional sales will cause an increase in costs for three primary reasons: the incremental cost to produce an increment of output, the possible cost of increased promotional activity and the additional income tax due to added net income. The reduction of energy expense will cause an increase in costs for primarily two reasons: the depreciation charge due to capital investment, increased income tax due to added net income. Conceptually, the analysis is simple. Does after tax income increase more using one method or the other?

Because the mathematics get involved, the most attractive choice often is not intuitive. Rigorous analysis will assure an economically sound choice and contribute to overall project and business success.

One last point for discussion. How do other cost reduction programs compare with energy cost reduction? In many aspects the two alternatives can be treated as very similar. Financially, the analytical procedure is the same for both and their comparison to increasing sales is similar.

The primary differences, if they exist, will be:

i. What is the overall life of the savings? Often energy cost reductions are effective for the life of the plant. This is not usually the case for other cost reduction efforts.

ii. Energy is likely to become an increasingly scarce commodity. The implication here is that, unlike most financial analyses, the effects of inflation may not affect all components of the analysis equally. Energy costs may climb at a disproportionate rate thus making the energy cost cutting option more attractive long term.

iii. Energy cost reduction efforts may have long term survival effects for the business. As energy resources become more scarce, the less energy a business requires, the less the risk of loss of ability to produce due to rationing or other factors that might limit availability.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This paper has illustrated some of the complexities involved in managing an energy management project. The results of the literature search demonstrated that management issues in energy management have been neglected. The existing models tended to focus on the technical issues involved in an energy management project. While technical issues are important, their mastery is insufficient for the success of an energy management project. A project without proper funding, without the involvement of all the necessary people, and without a clear understanding of goals and responsibility assignments will fail regardless of the technical correctness of the approach.

There are many tools available to aid the project manager in running a successful project. We have discussed some of these tools and illustrated their use with actual case studies. In particular the manager will have a good chance of success if he employs both the flow chart and RIMs suggested in this paper.

Energy management as an issue will only grow in importance as time goes on. For the first time since the oil embargo of 1972 the OPEC countries are close to signing an agreement to limit production in order to raise prices. As energy resources become scarce prices will increase. Organizations that have minimized their use of energy resources while getting the best productivity from those resources will be in the best position to survive.

6.0 REFERENCES

FOOTNOTES

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TABLE OF CONTENTS

A.1 MANAGEMENT CASE STUDY #1

Type of Organization: Grocery and Variety Store Chain

In 1978 this grocery and variety store chain developed an energy management program which was initiated by top management. The intension of the company was to save money on operating costs and promote energy efficiency. The company looked at all energy using areas to minimize energy consumption without compromising product integrity or client satisfaction.

Management approached the in-house engineering department to take on responsibility of the project. The engineering department then contacted local utilities for assistance in analyzing the energy consumed by each store. A detailed data base was then established and and the engineering department began working with the accounting department. Monthly energy consumption was logged and goals were set to reduce the consumption at each location.

The engineering department then began to look at the energy consumed by each store by system type. Equipment at each location was identified and energy conservation opportunities (ECO's) were then analyzed to determine possible energy savings, cost of retrofit, and Economic analysis. It was determined by management that energy conservation opportunities which show a payback of 3 and 1/2 years or better, based on a discounted cashflow analysis, were economically feasible. However, a longer payback was allowed if a major remodel of the store was to occur. Then the payback period extended to 6 years.

The team normally incorporated in their energy management projects include engineering, accounting, maintenance and outside sources like utility representatives, consultants and vendors and government agencies. Tax credits are obtained through various programs to offset the cost of each project. The communication procedure is normally an open door policy between these groups. The team members worked together to define the goals of the company evaluate all aspects of each ECO and implement each ECO in a scheduled timely fashion as budgets are available.

The ECO's providing the fast rate of return with no or low cost investments were normally implemented first. Energy systems which were the highest energy requirements are then evaluated and the ECO's which appeared the most feasible from an economic and maintenance standpoint are implemented. The highest energy consuming devices in this type of facility is refrigeration followed by HVAC and lighting equipment. Outside sources are used to assist the company in determine new alternatives and options available as well as the cost required to install the equipment.

The energy management program in place at this company is one of the best in the northwest. Managements commitment, Constant evaluation of the energy usage and alternatives by the engineering department, and the open communication makes this project so successful.

In summary, the key points which assured success for this company are:

- Managements support to reduce operating costs and provide a budget for energy conservation opportunities;

- Inhouse expertise in the engineering department;

- Project team members commitment to upper management and company prosperity;

- Project team members open communication channels;

- Employment of all resources within and outside of the company;

- Ongoing project activity and success through careful selection of projects.

The key areas which lessened the project's success were:

- The maintenance department's unwillingness to accept new technological advances;

- Maintenance departments or non-technical people maintaining the more sophisticated equipment.

Figure A.1
Responsibility Interface Matrix
Management Work Packages

	Set Goals	Select Project	Build Project Team	Implement Project	Measure Results
End User:Variety Store					
Off-site:Management	P	P	A/R	A/R	A/R
Engineering					
Purchasing					
On-site: Management				N	I
Engineering				N	I
Purchasing					
Government	I	R			O
Utility			I		I
Consultants					
Project Management					
Engineering Staff			I		I
Construction Group			I		I
Vendors					
Sales Representatives				I	
Technical Specialists				I	
Service Organization				I	
Contractors				W	

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Required
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.2
Responsibility Interface Matrix
Financial Work Packages

	Budgetary Estimates	Economic Analysis	Selling Project	Authorize Resources
End User: Variety Store				
Off-site: Management	O		P	P
Engineering	W			
Purchasing	W			
On-site: Management				
Engineering				
Purchasing				
Government		O	O	
Utility		O	O	
Consultants				
Project Management		P	I	I
Engineering Staff	W			
Construction Group	I			
Vendors				
Sales Representatives	I			
Technical Specialists	I			
Service Organization				
Contractors	I			

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authoriy
N - Notification Required
I - Inputs to Work Package

Figure A.3
Responsibility Interface Matrix
Technical Work Packages

	Identify Projects	Energy Audit	Information on Technologies	Measure Results
End User: Variety store				
Off-site: Management				
Engineering	A/R	W	P/A	P/A
Purchasing				
On-site: Management				
Engineering				
Purchasing				
Government			I	R
Utility			I	
Consultants				
Project Management				
Engineering Staff	W			
Construction Group				
Vendors				
Sales Representatives	I	I	I	
Technical Specialists	I	I	I	I
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here
A - Approval Authority
N - Notification Required
I - Inputs to Work Package

A.2 MANAGEMENT CASE STUDY #2

Type of Organization: Municipal Government

This case study addresses some of the issues present on a municipal government energy management project. This particular case concerns a waste water treatment project. There are formal constraints imposed by the organization on how any project is run. In the case of a municipal project, where public money is spent, the project is run much more formally.

Goal Setting

This project was initiated when DEQ informed the city of their need for a new facility. The city had the option of building it themselves with 75% government funding, or having DEQ build it totally at the city's expense. The issue became fairly hot in the city's politics but was eventually approved as a bond issue.

Project Selected/Responsibility Assigned

Often the municipality will not have the manpower or experience to run a technical project. In this particular case the energy management project was only one part of a much larger new facility project. This project started with a request for proposal for the design. This request was responded to by engineering firms. The successful low bidder was selected by the municipality in question.

Gather Accurate Data

Once the successful engineering firm was selected they acted as the project engineer and manager for the city. They put together a detailed design for the project. They also put together very accurate estimates on what the project would cost (to build and to run and maintain) as well as what it would cost to replace the system when it became obsolete. This information was used to set costs for customers using the facility.

Build Lateral Support/Establish Communication with Sponsor

The engineering firm began to build relations with the city managers and the managers at the existing plant. Since the government was funding 75% of the project, the project engineer set up meetings with the funding agencies to support the funding effort.

The facility design and estimates were used to apply for government funding of the project. The rest of the funding was supplied by the municipality, in this case, through bonds. The engineering firm assisted the city in meetings with federal funding agencies.

Build Project Team

The engineering firm wrote all the documents associated with going out for bid on the equipment and services associated with the project. Once the bid documents are accepted by the city, the engineering firm went out for bid on the equipment and services for the project. They evaluated the returned bids and made recommendations to the city as to who the lowest acceptable bidders were. The city then hired a general contractor who in turn hired subcontractors to fulfill the requirements of the contract. At this time the city was required by law to go out for bid on the administration of the construction. It is common for the project engineering firm to be successful if they bid. In fact, unless they have done a poor job in the first part of the contract, they are the firm of choice. It has been the city's experience that changing firms in the middle of a project can be the source of major problems. The engineering firm was maintained for the contruction administration, the second part of the project .

Implement Project

The communication on a project of this type is complex. The city relies on the project engineering firm for all formal communications. The project engineer's primary contact is the general contractor. The general contractor maintains communication with all subcontractors and direct vendors. The subcontractors are in communication with their vendors. Because of the length of the communication chain it is important to get all concerned parties together in one room for meetings to resolve problems. If this is not done the time it takes to resolve a problem can go on for years. In this particular case, one piece of equipment failed to operate properly for over a year before the problem was resolved. It's resolution was made difficult by the fact that the parties involved were not local, were no longer on the job site, and did not have the technical knowledge required to get the job done.

It is also important for the duties of each party to be very clear. The project scheduling on this job was done using computer software to keep track of all the tasks.

Measuring Success

As the project neared completion the city employees who were to run the new facility were brought over from the older facility. Training on how the new facility was to be run was done. Since this facility had several new processes that the older facility did not there was a large amount of training to be done. On a project of this size it is easy for this training to require several years. Some of the more automated items in the plant were ignored until they were out of warranty and in need of maintenance. Since these items were beyond the expertise of those running the plant they were not "adopted" by the employees. An example of the type of problem this can lead to is demonstrated by a conversation I had when out working on a piece of equipment. I asked the head of maintenance what their plans for maintaining these pieces of equipment were. The head of maintenance replied that he had a rifle in the truck that ought to do the job. Lack of training will cause failure of the equipment simply because it won't be maintained. The installation will save energy until the equipment is in need of maintenance. The staff without training may well decide to run the equipment without the automation which will result in the loss of energy savings seen originally.

Fortunately, it was part of the engineer's contract to evaluate the running of the plant one year after commission. The need for training in these areas has been noted and arrangements are being made to correct the problem. Measurements of plant operation are now being taken for submittal to the city and the federal funding agency.

Figure A.4

Responsibility Interface Matrix
Management Work Packages

Municipal Government
Waste Water Treatment Plant

	Set Goals	Select Project	Build Project Team	Implement Project	Measure Results
End User					
Off-site: Management	P	P	A/R	A/R	A/R
Engineering					
Purchasing					
On-site: Management				N	I
Engineering				N	I
Purchasing					
Government	I	R			O
Utility					I
Consultants					
Project Management	O	I	P/W	P	P
Engineering Staff	N	W		R	W
Construction Group	N			R	
Vendors					
Sales Representatives				I	
Technical Specialists				I	
Service Organization				I	
Contractors				W	

P - Primary Respnosibility
R - Review Responsibility
O - Output of Work Package Required
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.5
Responsibility Interface Matrix
Financial Work Packages

Municipal Government
Waste Water Treatment Plant

	Budgetary Estimates	Economic Analysis	Selling Project	Authorize Resources
End User				
Off-site: Management	O		P	P
Engineering				
Purchasing				
On-site: Management				
Engineering				
Purchasing				
Government	A/R		O	A/R
Utility	I			
Consultants				
Project Management	P	P	I	I
Engineering Staff	W			
Construction Group	I			
Vendors				
Sales Representatives	I			
Technical Specialists				
Service Organization				
Contractors	I			

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.6
Responsibility Interface Matrix
Technical Work Packages

Municipal Government
Waste Water Treatment Plant

	Identify Projects	Energy Audit	Information on Technologies	Measure Results
End User				
Off-site: Management	A/R		A/R	A/R
Engineering				
Purchasing				
On-site: Management				I
Engineering				W
Purchasing				
Government			I	R
Utility	I		I	I
Consultants				
Project Management	P			
Engineering Staff	W		P	R
Construction Group				
Vendors				
Sales Representatives	I		I	
Technical Specialists	I		I	
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

A.3 MANAGEMENT CASE STUDY #3

Type of Organization: Semiconductor Manufacturer

In 1985 this supplier of application specific integrated circuits (ASIC's) found itself spending ten percent of its annual expense budget on utilities (excluding telecommunications costs). There was a consensus among the division's senior management that this was far too high and that opportunities existed for significant cost reductions.

The operation of the facility had been recently turned over to the division general manager. This occurred as part of a corporate effort to remove as many staff functions as possible from the centralized corporate staff and place them in those divisions who required the service.

The division general manager took advantage of the decentralization to select a management team for the building operations group which would, in addition to other key goals, successfully reduce utility costs. A key point to make here is that not only were these managers hired with their project management skills being an important selection criterion, but the general manager strongly supported the utility cost reduction effort from the beginning (in fact he was the initiator).

Once the new management team was in place they set about defining the project's goals and schedule. All of the people in the building operations department were asked to volunteer their ideas for reducing utility expenses. These ideas were compiled into a single list. The engineers in the department estimated the cost to implement each option and its annual savings. A consulting engineer was contracted by the engineering manager to look for further opportunities and confirm the results of the studies which had been done.

The consultant brought some expertise regarding modeling of energy consumption which was not available within the department. This expertise turned out to be crucial to the project's success. Through the use of this modeling the consultant was able to more accurately estimate the savings that would result from various strategies.

When the consultant concluded his work he presented it to all of the maintenance technicians and engineers. He was able to show very clearly why he recommended prioritizing the options the way he did. All personnel who witnessed the presentation came away with a clear understanding of what was to be done.

By the end of the next day the maintenance technicians had completed over half of the work on the first priority item. This level of motivation was a result of the consultant's ability to communicate effectively how energy was being wasted and how simple is was to change the situation. By the end of the next week ninety five percent of the work on the first item was complete and the cost reduction was well underway. This one item has netted an ongoing operating cost reduction of over one million dollars per year!

How was such a dramatic and quick result possible? Several factors played an important part:

1. Turning the building over to the division provided a sense of ownership and control of destiny to the general manager and the members of the building operations department.
2. Members of the department were openly encouraged to participate in the idea generation, analysis and decision making portions of the project. Data was available to all department members as it was compiled.
3. The previous managers of the facility had not been motivated to maintain it very well. This is often the case with people who belong to a large corporate bureaucracy. As a result extreme energy waste was occurring in the heating, ventilating and air conditioning (HVAC) system.
4. The consultant's ability to communicate clearly to everyone in the department how much energy the HVAC system was wasting and why gave these people a "cause".

The degree of the reduction was quickly apparent to every budget center manager in the building. Their monthly expenses suddenly were significantly lower. The utility cost reduction project manager made sure through presentations and cash awards that everyone in the division knew the magnitude of the savings and who the technicians and engineers were who worked on the project.

As a result of choosing an inexpensive project which showed quick and dramatic results, a degree of credibility was achieved with the division's senior management. This allowed the building operations department to continue to work on the next highest priority items with full management financial backing as necessary.

The project has continued over a three and a half year period of time and is still underway.

The initial project action required no capital investment and minimal cost. Subsequent activity has required some capital investment. As a result of the initial success, the building operations department has been able to plan for some capital investment each fiscal year for utility cost reduction projects. Planning these projects in concert with the fiscal year financial planning process has assured that funds have been available as needed.

Tax credits have been sought, as part of the State of Oregon's incentive for this kind of work, to offset the cost of each project as appropriate.

Funds have been set aside each year for continued training of personnel in the area of energy management as a result of the success.

Each month utility costs are tabulated and posted in the building cafeteria to keep people aware of the project's continued progress and success.

Annual utility costs to the division have been reduced by forty percent. It is expected that within the next two years the fifty percent mark will be reached. Each of the actions taken so far have yielded a return on investment in excess of one hundred percent.

Needless to say this has had a dramatic effect on the division's profitability. Because the largest utility costs have tended to be independent of production operations, the cost reductions have reduced the fixed costs of doing business. This of course directly shrinks the break even point for the business and makes the operation much more attractive to the corporation.

In summary, the key points which assured management success were:

- Project team members who felt ownership of the problem and the solution;
- Strong, early support from senior management;
- Employing the necessary technical expertise to clearly evaluate and explain the alternatives and teach the principles of energy management to the entire department;
- Choosing an initial project which required minimal investment but showed quick and easily measured results;
- Publicity for the success and rewards for the team members to further encourage them;
- Credibility for the program from the quick results and ongoing utility cost measurement;
- Ongoing project activity and success through careful selection of activities.

Figure A.7
RIM: Semiconductor Manufacturer
<u>Management Work Packages</u>

	Set Goals	Select Project	Build Project Team	Implement Project	Measure Results
End User	W	W	W	W	R
Off-site: Management					
Engineering					
Purchasing					
On-site: Management	A/O	A/O	A	O	A/O
Engineering	P/W/O	P/W/O	P/W	P/W	P/W
Purchasing		O		W	
Government					
Utility		N		N	N
Consultants					
Project Management					
Engineering Staff	W	W	W	W	N
Construction Group					
Vendors					
Sales Representatives				W	
Technical Specialists				W	
Service Organization				W	
Contractors				W	

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Required
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.8
RIM: Semiconductor Manufacturer
Financial Work Packages

		Budgetary Estimates	Economic Analysis	Selling Project	Authorize Resources
End User		W			W
Off-site:	Management				
	Engineering				
	Purchasing				
On-site:	Management	R	R	A/O	A
	Engineering	P/W	P/W/O	P/W	P/W
	Purchasing				
Government					
Utility		W			
Consultants					
Project Management					
Engineering Staff		W	W	W	
Construction Group					
Vendors					
Sales Representatives		W			
Technical Specialists		W			
Service Organization					
Contractors					

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.9
RIM: Semiconductor Manufacturer
Technical Work Packages

		Identify Projects	Energy Audit	Information on Technologies	Measure Results
End User		W	N	W/R	R
Off-site:	Management				
	Engineering				
	Purchasing				
On-site:	Management	A	R		A/O
	Engineering	P/W	P/W/A	P/W	P/W
	Purchasing			O/W	
Government					
Utility		N		I	N
Consultants					
Project Management					
Engineering Staff		W	W	I/W	N
Construction Group					
Vendors		O		I	
Sales Representatives		O		I	
Technical Specialists				I	
Service Organization				I	
Contractors					

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

MANAGEMENT CASE STUDY # 4

TYPE OF FACILITY: SCHOOL DISTRICT

LOCATION: WASHINGTON STATE

DESCRIPTION AND BACKGROUND

This case study describes the energy management program that a School District started in 1982. In 1982, the School District maintenance budget was cut by 30 percent. Included in the maintenance budget were the School District's utility costs. It was decided that instead of cutting maintenance personnel, the utility costs needed to be reduced by 35 percent. The Maintenance Manager met with the School Board and presented his plan to reduce the utility costs by $225,000 with $2,000 capital. The School Board unanimously decided to adopt the plan and to draft an energy policy. With the support of the School Board, the Maintenance Manager met with his staff and presented the plan, and the alternative of cutting personnel. The staff responded enthusiastically and volunteered ideas to cut costs. The individuals who volunteered the idea were labeled "idea champions", and they were responsible for developing the idea into a workable plan. The crews worked after hours to implement the plan and took pride in their progress. Every month, they all got together to graph each school's energy costs. In the first year, the school saved $250,000 by cutting the energy consumption by 37 percent.

When the Maintenance manager went back in front of the School Board, he received a standing ovation for his staff's accomplishments, and he also received a directive in the form of an energy policy. The energy policy stated that "...energy usage shall be accounted for and minimized without compromising the comfort of the students." It was decided that annual plans be presented to the School Board itemizing capital expenditures and paybacks for approval. It also became a tradition that before the presentation of the annual energy plan, the energy savings for the past year were summarized.

During the second year, the Maintenance Manager contacted the Washington State Energy Office (WSEO) to request assistance and to try to get an idea of what other school districts were doing. WSEO assisted by suggesting the school district participate in the Institutional Building Program (IBP) and Institutional Conservation Program (ICP), and also provided the names of contact people in other school districts and promised a copy of the WSEO energy accounting program as soon as it was finished. Bonneville Power Administration (BPA) started the Institutional Building Program to aide institutions in conserving electricity. The program provides a free walk through audit to access potential for conserving electricity, followed by a full energy audit and finally, funding for eligible measures. The Institutional Conservation Program (ICP) was developed by the United States Department of Energy and is similar to the IBP program except that it looks at total energy usage rather than just electricity. All of the schools participated in one of these programs to some degree. The audits allowed each school to be compared, and energy conservation measures to be quantified.

The Maintenance Manager contacted the other school districts, and they compared strategies and energy use indexes (a measure of energy use per square foot). A lot of good information was exchanged, and the manager set a 5 year plan to cut the energy consumption by another 12 percent. The first 37 percent was relatively easy, but the next 12 would take more capital and effort.

During the next five years, many innovative plans were implemented. First, he started a system for recognizing the "idea champions", where they were awarded certificates for their efforts at an annual dinner. Each school's principal was involved by allowing one percent of the energy savings to be added to the school's budget. The students were involved by having contests to identify ways to save energy. The teachers developed an energy curriculum. A training budget was established for all personnel. Finally, the WSEO energy accounting program was used to report each school's progress and to help identify areas that needed work. These monthly reports were sent to each school and graded each school on overall energy consumption as well as on improvement. Resulting from these reports, the Maintenance Manager received calls from principals who asked, "what can we do to improve our energy consumption", and "how can we minimize the effect of increased after hours usage?". These questions prompted individual consultation to maintain the awareness and excitement. Communication was also handled on an individual basis. The Maintenance Manager said that he would "...talk to the person until they understood, or didn't resist anymore." He attributes the success of the program to the support of the School Board, and to the open lines of communication. The School District suceeded in saving the projected 12 percent; a total of 50 percent in six years due to the team spirit and support and commitment of the School Board.

Section: BUSINESS MANAGEMENT

Policy Title: Energy Management

The Board of Directors of the [redacted] School District recognizes the need for a comprehensive energy management program and it is committed to the development and maintenance of programs that support the conservation of energy and natural resources.

An effective energy management program requires a strong commitment from all school district employees. Staff support is important to the success of an energy management system.

The district's energy management program is expected to achieve the following goals:

1. To enhance awareness of energy conservation methods;

2. To encourage the efficient use of energy;

3. To institute effective energy management; and

4. To maintain energy usage and energy costs at a reasonable level.

It is recognized that each district facility varies somewhat as to its users and programs and that energy saving methods appropriate to one facility may not be appropriate to others. Therefore, the energy management program of the district is to be implemented with consideration for the unique conditions of each facility.

Adopted: September 9, 1987

Figure A.10
Responsibility Interface Matrix
Management Work Packages

	Set Goals	Select Project	Build Project Team	Implement Project	Measure Results
End User					
Off-site: Management	P,W	R,A	N,I	R,A	R,A
Engineering	I,R	I,R	P,W,O	I,R,A	P,W,O
Purchasing			N	N	I
On-site: Management	N	N	N	N	N
Engineering	N	N	N	N	N
Purchasing	N/A				
Government		I,A	N	R,A	R,A
Utility					I
Consultants					
Project Management		R	N	R,A	
Engineering Staff		P,W,O	N	I	
Construction Group				P,W,O	
Vendors					
Sales Representatives		I	N	W	
Technical Specialists		I			
Service Organization				N	
Contractors					

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Required
W - Work Done Here
A - Approval Authority
N - Notification Required
I - Inputs to Work Package

Figure A.11
Responsibility Interface Matrix
Financial Work Packages

	Budgetary Estimates	Economic Analysis	Selling Project	Authorize Resources
End User				
Off-site: Management	R,N	N		A,O
Engineering	R,N	N	R,W	R
Purchasing				N
On-site: Management				
Engineering				
Purchasing	N/A			
Government	R,N,A	R,N,A		A,O
Utility				
Consultants				
Project Management	R	R	R	
Engineering Staff	P,W	P,W	P,W	
Construction Group				
Vendors				
Sales Representatives	I		I	
Technical Specialists				
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authoriy
N - Notification Required
I - Inputs to Work Package

Figure A.12
Responsibility Interface Matrix
Technical Work Packages

	Identify Projects	Energy Audit	Information on Technologies	Measure Results
End User				
Off-site: Management	R	R		R,A
Engineering	I,R,A	I,R	R	P,W
Purchasing				
On-site: Management	N	N	N	
Engineering	N	I	R	
Purchasing	N/A			
Government	R,A	R,A	R,A	R,A
Utility				I
Consultants				
Project Management	R,A	R,A	R,A	
Engineering Staff	P,W	P,W	P,W	
Construction Group				
Vendors				
Sales Representatives			I	
Technical Specialists	I		I	
Service Organization				
Contractors				

P - Primary Responsibility
R - Review Responsibility
O - Output of Work Package Needed
W - Work Done Here

A - Approval Authority
N - Notification Required
I - Inputs to Work Package

KEY CONTACT INTERVIEW

This interview is part of a project for EAS 541 in PSU's Engineering Management Program. The project's goal is to develop guidelines for a successful energy management program. It will take approximately 10 minutes of your time.

NAME____________________ POSITION________________________

FIRM__________________________ PHONE #____________________

1.Please describe your energy management program. __________

2.When and how was the program started? ____________________

3.What were some of the barriers that were encountered in starting the program?______________________________

4.Does your company have an Energy Policy? ________ What is it and when was it stated. ____________________________

5.When the program started, how was communication handled?

5.a) Was it adequate?____________________________________

5.b) Who is typically informed of changes due to the Energy Program?______________________________________

6.Did you utilize any outside assistance to identify the measures?____ State/Fed Program__________ Utilities_________ Consultant____ Vendor Info____ Seminar____ Other_____________

6.a) Did you find them helpful?______________________________

7.How do you prioritize the energy measures?_______________

8.Are there ways to implement the low cost energy measures without having to get your budget approved?_____ Are these easier to implement?______________________________

9.Was it hard to get approval on your first energy budget?__
____

9.a) Did this process improve on subsequent projects?______

10.When do you suggest that a person start the approval process on the more expensive measures?____________________
____

11.What kind of approval process is necessary for capital expenditures?______________________________
____

12.Have you received any outside funding or financial assistance?______ State/Fed Programs______ Utilities________ Other___________ How hard was it to get the $? ____________
____

12.a) Would you recommend this process to others?__________

13.How do you stay current with new technologies?__________
____

14.Do you have a budget for training maintenance personnel about energy saving techniques?______________________

15.Do you have an energy accounting program where you verify savings?______________________________

16.Has your program been successful?____ What have been the most important factors in your success?__________________
____
____

17.Is there anything that you would change?_______________
____
____

MANAGING ENERGY MANAGEMENT

TABLE OF CONTENTS

As described earlier, energy audits are normally separated into three distinctive levels. Each level of energy audit and the on-site energy survey is discussed in some detail below. It is recommended that the reader consult some of the resources mentioned in the Appendix and obtain information from as many sources as possible before conducting an energy audit.

Level I

This level of energy audit records information on energy use patterns, design characteristics, equipment, operational conditions of the business, and establishes the energy usage indices as described in section 4.1 of this report. This level of an energy audit may not require an on-site energy survey or outside assistance.

Level II

This level of energy audit identifies and estimates energy and energy cost savings from little or no cost investments. It deals primarily with operational and maintenance Energy Conservation Opportunities (ECO's). This audit requires a more on site-specific review of facilities. It contains all the aspects of a level I audit.

Level III

This is a detailed on-site energy audit that identifies and quantifies the cost effectiveness of operational and maintenance as well as those ECO's which require a capital investment. A Level III energy audit requires a detailed energy analysis of each energy system. It may require the use of special diagnostic equipment such as flow measuring devices. It normally requires the use of specialized people who are qualified at energy audits. Energy audit specialists generally consist of mechanical, electrical, illumination engineers as well as architects.

Conducting an walk-through energy audit.

A thorough systems approach to the building, equipment, operational conditions and human factors are needed. It is important to become familiar with the operating and maintenance procedures as well as the personnel. The site survey should an include investigation of the following:

The Building Envelope

The building envelope consists of the roof, walls, floor, doors, louvers and grilles. These factors have a significant impact on the buildings total energy usage. Heat gain or heat loss from the direct conduction of heat through the buildings surfaces accounts for major portion of the energy consumption. Consequently, a thorough analysis of existing conditions, possible improvements and cost/benefit ratios should be made

Characteristics of the envelope that require identification are (e.g.,built-up roof, masonry walls, double hung windows), number and size, materials of construction. and "U" values. Because heat gain and loss are functions of the building orientation, wall, doors and windows on each side of the building should be listed separately.

Heating Ventilating and Air Conditioning (HVAC)

HVAC systems represent a large portions of the total energy usage. See the Appendix B.3 for quantitative requirements. There are all types of HVAC systems found in industry, some very simple systems like a unit heater or single package air conditioner to very complex variable air volume (VAV) systems. Appendix B.1 shows a list of some of the many different types of systems. It is recommended the reader consult the ASHRAE handbooks for more information. The principal controllable variables that contribute to HVAC energy use are:

Efficiency of the HVAC system;

The condition of the equipment and the controls;

The quality of maintenance;

The length of time equipment is operated;

The environment the equipment is to maintain.

Lighting

Lighting systems also represent a sizable load. There are a number different types of lighting systems on the market, each having their own efficiency, illumination characteristics, and maintenance advantages or disadvantages. See the Appendix for the estimated loads of lighting systems on various building types. Also it is recommended to consult the Institute of Illumination Engineers (IIE) handbooks and publications for system types, efficiency and maintainability. During the site survey, each type and style of lamp should be recorded as well as the environment.

Domestic Hot Water

Domestic Hot Water (DHW) energy systems generally exist in a building as well. The DHW energy system generally is not a major consumer, but it can be in some building operations like restaurants. The site survey should record the following information:

Efficiency and type of water heating system;

Number of users;

Number of showers,if any;

Thermostat set points on all water heaters;

Condition of insulation on water haters and hot water lines.

Electric Motors

Electric motors can also be a significant energy user. Electric motors may be involved in industrial processes, refrigeration equipment, pumps, fans, etc. When conducting the walk through energy audit it is important to collect:

The size, type and function of the motor;

Operating hours;

Environment in which it installed;

The efficiency;

Miscellaneous Equipment

There all numerous types of miscellaneous equipment used in commercial and industrial environments. Some of this equipment may be used for cooking, computers, office machines, and so on. Each piece of equipment must be analyzed along with it operating conditions.

In conclusion, there are all kinds of equipment which must be analyzed. There a numerous books, workbooks, papers and publications which are available and should be obtained from the particular business of interest.

APPENDIX D

ADDITIONAL RESOURCES

TABLE OF CONTENTS

Many resources are available for assisting in the evaluation of opportunities, as well as financing or funding them. From trade literature to vendor information, from federally funded energy studies which not only identify the opportunities, but also prioritizes them, to societies of energy managers, finding the right resource is not always easy. For this reason, we have compiled a list and some literature of some of the available resources. The resources with an asterisk (*) indicate that some additional literature follows. Many of the resources are specific to Oregon, but similar programs can be found in most states. Finally, two lists have been copied with the intention of providing resources which are available nation-wide.

FINANCING AND TECHNICAL ASSISTANCE

1. The United States Department of Energy has an Institutional Conservation Program (ICP)*, which is currently in its eleventh cycle. This program is only for public institutions, such as schools and hospitals. It pays for a walk-through energy audit to assess the potential for saving energy, an energy study, and half of the cost of eligible measures. The funding cycles are very rigid, and the amount of paperwork makes this option rather cumbersome. However since its start in 1979, this program has assisted in over 700 energy audits, 500 energy studies and funded 380 projects. It is estimated that ICP clients have cut their annual energy costs by almost $20 million.

2. The State of Oregon allows business tax credits* for capital investments which save energy or produce energy. The 35

percent credit includes the costs for design, materials and labor. The 35 percent is prorated over five years: ten percent the first two years, and five percent the remaining 3 years. The credit must be applied for before the equipment is purchased or installed. A copy of an application form is included in this Appendix.

3. Bonneville Power Administration (BPA) started a design assistance program for new buildings called "Energy Smart Design" in 1988. In this program, BPA will pay for computer modeling of energy saving design features. Up to $2,500 will be allowed in this program. Call your electric utility or Jim Kehoe of Oregon Department of Energy at 1-800-221-8035.

4. The Oregon Department of Energy offers loans for energy projects. The loans pay for the energy components of new construction or remodeling projects. Design costs related to the energy aspects of a project can also be covered. The program offers low-interest, long-term, fixed-rate financing. These factors often allow energy project savings to exceed the loan payments. Call Dave Neitling toll free at 1-800-221-8035.

5. The Oregon Department of Energy offers technical assistance to Oregon cities, counties, and special districts free of charge. The service incledes energy audits, project and equipment evaluations, staff training, access to printed information, and help in starting energy management programs. Call Mike Byers toll free at 1-800-221-8035.

6. The Oregon State Extension Office is a clearing house for energy information. They also offer lunch forums and seminars on energy related topics. Call Gus Baker at 1-323-8750.

7. The Washington State Energy Office offers Public Schools loans, grants, technical assistance, energy management training and an in-house developed energy accounting program.*

SOCIETIES

1. Association of Energy Managers (AEM)
2. Association of Energy Engineers (AEE)
3. American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE) Energy Management Division
4. Washington Association for Energy Efficient Schools

TRADE JOURNALS

1. Energy Users News
2. Heating, Piping and Air Conditioning
3. Plant Engineering
4. American Society of Heating, Refrigeration & Air Conditioning Engineers Journal
5. Food Processing Journal
6. Chemical Engineering
7. Control Engineering
8. Pulp & Paper
9. Water & Wastes Digest
10. Water Engineering & Management
11. EPRI Journal

We make a difference!

OREGON DEPARTMENT OF ENERGY

F.Y.I.

OREGON DEPARTMENT OF ENERGY PROGRAMS
TO HELP THE CLIENTS OF ARCHITECTS AND ENGINEERS

Oregon architects and engineers can help their clients pay for energy projects with the programs of the Oregon Department of Energy (ODOE). ODOE offers loans, tax credits, and technical help. Customer service and simple forms are aspects of all ODOE programs.

Energy Design Asssitance

ODOE and the Bonneville Power Administration (BPA) can help building designers with a free, no-strings-attached technical assistance service. The service will use advanced energy analysis tools. And, it will help building designers save energy and lower operating costs. Often these savings come with no increase in building costs. The service is open to all new commercial buildings in the state. It is offered on a first come, first served basis. The project is funded through June 1988.

Call BPA's Jim Kehoe to learn more: (503) 230-5751.

Business Energy Tax Credits and Technical Assistance

ODOE offers businesses a tax credit for energy saving or producing projects. The credit offsets 35 percent of design, equipment, and installation costs. It is applied for after the project is designed, but before equipment is bought and installed.

ODOE's energy experts will help you evaluate proposed projects.

Call Curt Nichols toll-free at 1-800-221-8035. Curt's direct line in Salem is 378-5981.

Small Scale Energy Loan Program (SELP)

SELP offers loans for energy projects. Businesses, homeowners, and public agencies can all get SELP loans. The loans pay for the energy components of new construction or remodeling projects. Design costs related to the energy aspects of a project can also be covered. The program offers low-interest, long-term, fixed-rate financing. These factors often allow energy project savings to exceed loan payments.

Call Dave Neitling toll-free at 1-800-221-8035. Dave's direct line in Salem is 373-1032.

Technical Assistance Program

ODOE offers technical assistance to Oregon cities, counties, and special districts free of charge. The service includes energy audits, project and equipment evaluations, staff training, access to printed information, and help in starting energy management programs.

Call Mike Byers toll-free at 1-800-221-8035. Mike's direct line in Salem is 378-2856.

625 MARION ST. NE, SALEM, OREGON 97310 PHONE 378-4040 TOLL FREE 1-800-221-8035

OREGON BUSINESS ENERGY TAX CREDIT

APPLICATION FOR PRELIMINARY CERTIFICATION

WIND, BIOMASS, AND GEOTHERMAL

Oregon Department of Energy
625 Marion Street NE
Salem, Oregon 97310

378-4040 or Toll Free 1-800-221-8035

Oregon Business Energy Tax Credit
Application for Preliminary Certification

Oregon businesses that install projects to save or produce energy can get a state tax credit. Recycling projects, and research, development and demonstration projects also qualify. The tax credit equals 35 percent of the eligible project costs.

You must be an Oregon taxpayer to claim a credit. You must own or be the contract buyer of the project. The equipment must be used by you or leased to another person or business in Oregon. Work on the project must begin by December 31, 1990 and end by December 31, 1993. Projects that save energy must have a simple payback of more than one year.

Here is how to apply for and claim the tax credit.

BEFORE you start your project:

1. Fill out the attached application for preliminary certification. Send it, with the application fees, to the Oregon Department of Energy (ODOE) before you buy the equipment or install the project.

2. The application fees are based on your eligible project cost. There is a processing and a filing fee.

   The processing fee is 0.3 percent of your eligible project cost. If ODOE denies your application, we will return this fee to you.

   The filing fee is nonrefundable. This fee is $25 if your eligible project cost is $5,000 or less. If it is more than $5,000 the filing fee is $50.

3. ODOE will review your application. The review takes about three weeks. If your project is approved, ODOE will issue a preliminary certificate. This states how much of the project cost qualifies for the tax credit. You may start your project after you get preliminary certification from ODOE.

AFTER you complete your project:

1. Apply to ODOE for final certification. If the project cost is $10,000 or more, you must send a letter from a certified public accountant that verifies the project cost. If your project cost is less than $10,000, send copies of the invoices, cancelled checks or receipts that show proof of payment.

2. ODOE will review your final application. If it is approved, ODOE will issue a final certificate. In no event can ODOE approve more than 10 percent above the amount shown on the preliminary certificate.

3. The tax credit is taken over five years. You must claim it starting either the year the project is finished or the year ODOE issues a final certificate. You must include a copy of the final certificate with your tax return each year. Unused credits may be carried forward for up to three years.

Questions? Call ODOE toll-free at 1-800-221-8035. In Salem, call 378-4040.

Appl. #________________

OREGON BUSINESS ENERGY TAX CREDIT

Application for Preliminary Certification

Wind, Biomass, and Geothermal Projects

Use this form to apply for preliminary tax credit certification for a wind, biomass, or geothermal energy project. You must send this form to the Oregon Department of Energy (ODOE) before you buy the equipment or install the project.

Geothermal projects must have an installed capacity of one megawatt or less to get the tax credit.

You must enclose the required fees with this application.

ODOE is required by law to disclose information in this application to the public on request. Proprietary information may be exempt from disclosure. Mark on each page any information that you want kept confidential. The Director of ODOE will make any decisions on public disclosure of information in this application.

IMPORTANT: If you do not answer all questions that apply to your project, we will return your application.

1. Name of Business or Person(s) who will Receive the Tax Credit

   Name ______________________________ Phone ______________

   ______________________________ ______________

   ______________________________ ______________

2. Mailing Address ______________________________________

   (Street or P.O. Box)

   ____

   (City) (State) (Zip)

8. PROJECT DESCRIPTION

a. Sketch the project layout. Label major equipment, such as pumps, generators, and boilers. Use arrows to show directions of energy flow. Include flow rates in units such as gallons per minute, cubic feet per minute, or pounds per hour.

b. List model number and manufacturer of the major pieces of equipment. List the size or rating of equipment.

For a wind project with turbines of 100 kW or less, attach a test report for each type of turbine.

9. RESOURCE SUPPLY

Which resource will the project use?

/_/ Wind   /_/ Geothermal   /_/ Biomass

Attach data to show the resource can be used for the life of the project. Here is what must be included.

a. For a wind energy project: The average monthly wind speed for 12 months. Measure wind speed at the hub height of a horizontal axis wind machine, or at the equator of a vertical axis wind machine; or, measure wind speed at two heights, one at least 10 meters above ground.

b. For a geothermal energy project (except a heat pump system): A plot of well head temperature versus time at the design flow rate at steady state temperature. A heat pump shall have a coefficient of performance (COP) rating of 3 or greater for the given resource's inlet temperature.

c. For a biomass energy project: Data that show the resource is available in an amount that meets the project's fuel needs. What are the fuel's characteristics?

10. LICENSES AND PERMITS

List all federal, state, and local licenses and permits the project must have. Describe the status of your application for each one. Attach copies of those you have obtained.

12. PROJECT GOALS

Questions 13, 14, 15 and 16 may not all apply to your project. To find out which of them you may omit, check the boxes below.

What will your project do?

a. /_/ Save energy on-site. (If yes, skip Questions 15 and 16.)

b. /_/ Produce electricity. If yes, what will you do with the electricity?

/_/ Sell it to a utility only. (If yes, skip Questions 13 and 14.)

/_/ Use it on-site only. (If yes, skip Question 16.)

/_/ Use it on-site AND sell it to a utility. (If yes, answer all questions.)

13. ENERGY USE

Calculate the energy use for the past 12 months for the building or process the project will serve. Examples of process uses are boilers, industrial processes, and commercial laundry units.

Write the energy use below. You must show how you arrived at your answer. Attach copies of utility bills for the past 12 months if the building or process user is on a meter.

a. Calculate energy use here.

d. Show how you calculated the net energy savings.

15. ELECTRICITY PRODUCTION

a. Estimate the net amount of energy the project will produce each month during the FIRST FULL YEAR it runs. Net means what is left after subtracting losses and the energy needed to run the project. You must show how these amounts were calculated.

January	______________	kWh
February	______________	kWh
March	______________	kWh
April	______________	kWh
May	______________	kWh
June	______________	kWh
July	______________	kWh
August	______________	kWh
September	______________	kWh
October	______________	kWh
November	______________	kWh
December	______________	kWh

First Year Total ______________ kWh

c. List expected power sales revenues for generation sold to the utility.

Year	Annual kWh	X	¢/kWh Rate	=	Sales Revenue
1	______		______		________
2	______		______		________
3	______		______		________
4	______		______		________
5	______		______		________
6	______		______		________
7	______		______		________
8	______		______		________
9	______		______		________
10	______		______		________
11	______		______		________
12	______		______		________
13	______		______		________
14	______		______		________
15	______		______		________
16	______		______		________
17	______		______		________
18	______		______		________
19	______		______		________
20	______		______	+	________

Energy Revenue = $________

$________ Energy Revenue ÷ ______ years (above) = _______ average yearly revenue.

If applicable, what is the project's estimated sale of capacity?

________ kW X _______ $/kW-yr = $______ annual capacity payment.

Add the revenues from the electric energy and capacity.

$_______ ave. yearly revenue + $_______ annual capacity = $________

TOTAL

You must send the total fee with your application. Make checks payable to the Oregon Department of Energy.

Read the statement below. If you agree to all of the points, sign and date it.

I understand that ODOE approval and certification of my project is for tax credit purposes only. ODOE does not guarantee or in any way assure the performance of any equipment, the quality of any system, or the reliability of any dealer.

The answers I have given in this application are correct. The project will comply with all local, state, and federal requirements. I will get all needed permits. I will permit ODOE to inspect the project to make sure it qualifies for the tax credit.

I understand that if I give false information about the project, or if I refuse to permit ODOE to inspect the project, I will not get the tax credit.

BEFORE YOU SIGN -- Have you:

/_/ answered every question that applies to your project?

/_/ made a check for the fee amount payable to the Oregon Department of Energy?

If your application is not complete, we will send it back to you.

_______________________________ Signature of Tax Credit Applicant

_______________ Title

_______________ Date

GM:jf
2569J(d1,f6)
02/25/86

Energy Excellence in Public Schools

Helping school administrators achieve energy excellence in their facilities is serious business at the Energy Office. Our nine year track record of working with schools throughout Washington has improved the energy efficiency in 150 school districts--some by as much as 30 percent. To gain even higher marks, we're forming partnerships with other districts to help them reduce energy costs. Money for these services is from the federal Power Washington oil overcharge funds. Here is what we offer:

Loans - One of WSEO's newest services, school districts can now borrow up to $200,000 to finance projects with paybacks up to ten years. There is a one-time five percent administration fee, and repayment terms are five years or less. Henry Marcotte, transportation supervisor of the Enumclaw School District, states that *"...this is an excellent program - it works. We have five years to pay off the loan and then the money is available to other districts to use. It's like all the improvements we did were free."*

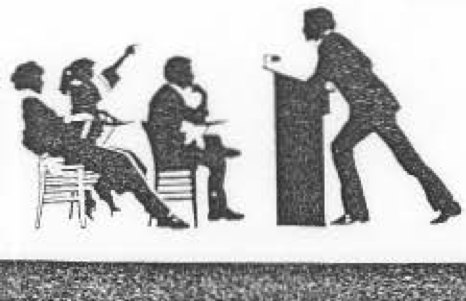
Grants - Up to $2,500 is available to each district for energy saving projects. One participant, Wahkiakum School District, installed energy efficient lighting in their gym. Superintendent John Thomas best summed it up by stating: *"Each time we turn on the lights, we have 8,000 watts of energy savings!"*

Technical Assistance - WSEO engineers are available to analyze and propose energy efficiency improvements. This analysis enables managers to make the best decisions. This technical assistance is available on a limited basis with priority given to smaller districts with no previous engineering analysis. Rich Carter, Superintendent of the Carbonado School District, stated, *"Energy Office engineering assistance has allowed us to make informed decisions."*

ENACT - This free energy accounting software tracks up to five years of energy use and cost information for 50 departments, 350 facilities, 500 utility meters, and provides weather corrections for 15 weather stations located throughout the state. Kent Martin, business manager at Port Angeles School District, rates this award-winning package as *"an excellent piece of software."* According to Martin, *"ENACT has given us the capability of identifying what areas need to be investigated and where there are opportunities to save energy and money. It has also been extremely useful for collecting and interpreting that information for other managers."*

Energy Management Training - Our objective is to improve energy management practices and help schools achieve significant energy and cost savings through the training of school personnel. *"Training in energy management is recognized as a significant need. It assures the success of any energy efficiency improvements."* - Greg Lee, Consultant, School Facilities Section, SPI.

For more information on these and other energy saving opportunities, contact:



WSEO WASHINGTON STATE ENERGY OFFICE

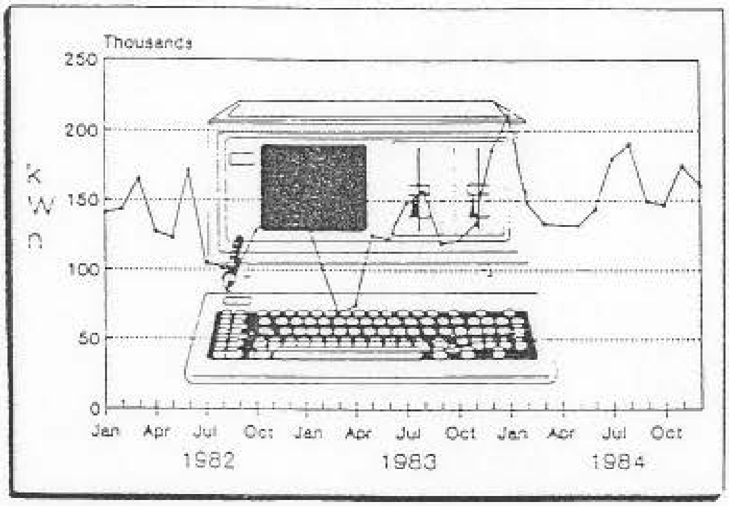
Schools Energy Program
809 Legion Way S.E., FA-11
Olympia, WA 98504-1211
(206) 586-5000 or SCAN 321-5000

WSEO STATE ENERGY OFFICE

ENACT Is Available FREE To Public Schools

ENACT, the award winning energy accounting software program, is available FREE to qualified public schools K-12 now. The fifteen schools that participated in using ENACT rate this product as superior to other products they have used.

Kent Martin, Assistant Superintendent of Business at Port Angeles, states, "ENACT has given us the capacity of identifying what areas need to be investigated and where there are opportunities to save energy and money. It has also been extremely useful for simply collecting information. The ways to communicate that information (reports and graphs) are super...an excellent piece of software."



What Will ENACT Do For You?

ENACT is a key component to any Energy Management Program. It allows you to track energy consumption, costs and allows you to comunicate your results with administrators and other decision makers.. ENACT is the report card you need to help grade the success of your conservation measures or operation and maintenance routines, and control costs!

- o ENACT can monitor up to 350 facilities and 500 meters;
- o ENACT can keep account of your fleet fuel usage;
- o ENACT weather corrects data for buildings.
- o ENACT calculates the Energy Utilization Index in Btus per sq. ft./yr., or by students/month or any other "user-defined" units and calculates the performance index; cost avoided per month for up to five years.
- o ENACT provides performance feedback with a variety of graphics and reports.
- o ENACT allows each manager to have the needed information to monitor performance and control costs.

ENERGARD CORPORATION
energy management and diagnostic services
P.O. Box 4241, Bellevue, WA 98009 (206) 881-3451

JOB I.D. ______

ENERGY SERVICES AGREEMENT

SOLD TO SJO Consulting Engineers
1500 SW 12th St.
Portland, OR 97201

BILL TO (Same)
Re: (client name)

CONTACT Mira Vowles Title Mech. Engr. Phone (503) 226-3921

Utility bill copies will be sent by: x Phone x

Send reports to: x

*ENERGY ACCOUNTING. Monthly monitoring of energy use and costs information from utility bills. Attach list of buildings. Include Building Information Survey(s) for each building if appropriate.

MONTHLY REPORTS for 1 buildings @ $ 60. per month per building,

Annual per building $ 720., total annual $ 720.

Less 10% discount for prepayment $ ______

Subtotal $ ______

First year only, add: INITIALIZATIONS for 1 buildings @ $ 290. per building $ 290.

Total $ ______

Terms: Monthly Reporting billed monthly, net 30. 10% discount for annual payment in advance. Initialization to be paid with submittal of initial data.

Indicate number of Report copies required by Level: 1) 2 2) ______ 3) ______ 4) ______

*ENERGY ENGINEERING/CONSULTING.

TECHNICAL ASSISTANCE ______ (hrs)(days) @ $ ______ per (hr)(day). Total $ ______

Terms: Billed monthly, net 30. Travel outside Seattle area and materials are not covered by this Agreement.

*ENERGY TRACKING. Regular monitoring of ENERNET Satellite data (min. one access per week per Satellite).

TRACKING for ______ Satellites, access ______ time(s) per week, @ $ ______ per month per Satellite.

Annual per Satellite $ ______, total annual $ ______

Less 10% discount for prepayment $ ______

Total $ ______

Terms: Billed monthly, net 30. 10% discount for annual payment in advance.

Effective (date) ______ the undersigned requests the indicated Energard energy services and authorizes Energard hereby to correspond directly with utility companies regarding Customer's proprietary account information.

For Energard: ______ For Customer: X ______ Date ______

Vivian T. Balascio, Corporate Sls. Mgr.

003.C.07.88

ENERGY ACCOUNTING

SAVINGS RATE
$ 35280

QUIKSTAT®

ANNUAL ENERGY USE and SAVINGS TRENDS

For: SEAVIEW MANOR
SEATTLE, WA 98109

To: PAUL JENNY

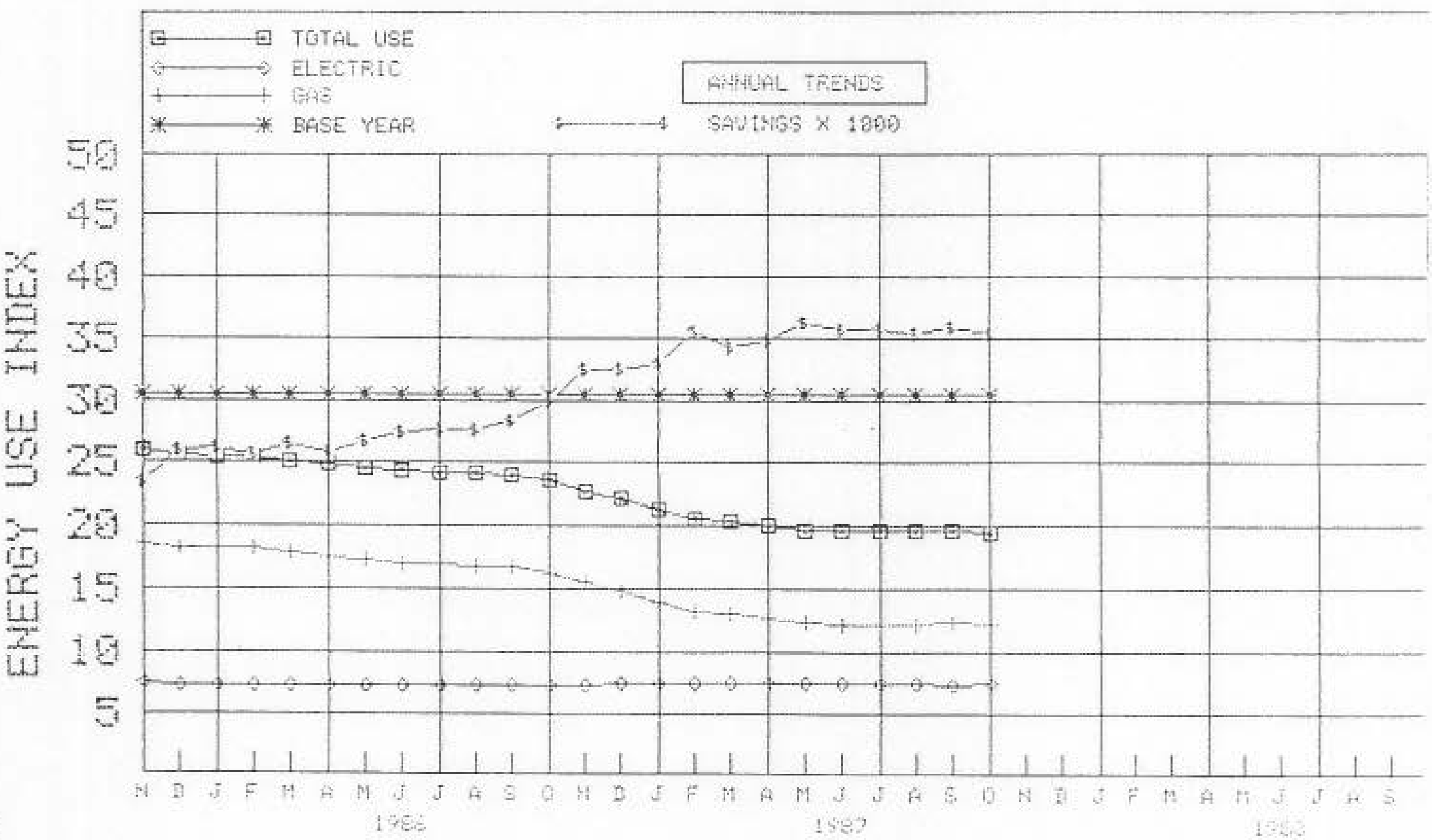
Report Current Through: 10/01/87

Base Year: 11/01/83 - 11/01/8

	ANNUAL ENERGY USE INDEX	CHANGE (from base year)	ANNUAL COST	CHANGE (from base year)
Base Year	30.47	N/A	$ 142739	N/A
Last Month	19.59	35.70 %	$ 90599	36.53 %
This Report	19.53	35.90 %	$ 89823	37.03 %

SAVINGS	TOTAL	ELECTRIC	GAS
Latest Annual	$ 35280	$ 2212	$ 33068
September Only	$ 2109	$ -24	$ 2133

Index = BTU/Sq Ft/Deg Day/Yr
.OR.
Annual energy use index is the total 12 month energy consumption in BTUs, divided by your square footage then divided by your annual degree days



ENERGARD CORPORATION

Notes : ---------------------------------------

ENERGARD® Energy Accounting
(206) 881-345
02/18

THE INDIVIDUAL FACILITY REPORT

CURRENT date. Billing information for all meters was available through this date at report time.

PREVIOUS date. The first of the month preceding the month in which the current date falls.

BASE YEAR or REFERENCE date. The ending date of the Base Year. Savings are being calculated by comparing the Current Year (365 days) to the Base Year.

Section I. ENERGY USE INDEX. The Index is a one year total of BTU per square foot divided by total annual heating and cooling degree days. The Index is calculated for each meter. The total of all individual Indexes is the Energy Use Index. The BASE YEAR INDEX is the Energy Use Index for the date from which savings are being calculated.

Section II. SAVINGS/LOSS. A dollar value is calculated for the difference between the Base Year Index and the Current Index, based on current annual cost. Knowing how much any loss is costing in dollars is helpful in judging how much to spend on solutions.

Section III. ANNUAL FUEL COST. Annual cost of fuel is an unmodified total of the actual dollars paid for the energy used in the previous 365 days.

Section IV. RELATIVE BASE LOADS and WEATHER COMPENSATION. All buildings have a certain base load of energy use that is not sensitive to weather. The RELATIVE BASE LOAD of each building is calculated based on its minimum periods of energy use, and the weather modification is adjusted accordingly.

Section V. ANNUAL FUEL CONSUMPTION. Annual use of fuel is presented in each fuel's native units, the fuel units in which the energy use is reported on the utility bills (except for Other Fuels, which are presented in Therms). BTU per square foot is a value which is additive, and these values for current and previous for each fuel are shown net, with appropriate totals. The values in this Section represent consumption without any weather modification.

SAVINGS FOR <PREVIOUS MONTH>. The values shown here are savings/loss for the specific calendar month indicated.

AVERAGE USE AND COSTS FOR LATEST BILLING PERIOD. Certain daily values have proved useful. AV DAILY USE in fuel units and AV DAILY FUEL COST are computed based on the consumption and cost from the most recent utility bill.

> CURRENT BILLING PERIOD COST per MILLION BTU is invaluable information for the energy manager faced with the responsibility for choosing between types of equipment which use different fuels.

ELECTRIC DEMAND MONITORING. DEMAND is not used in the Index computations, but since it represents a sizable portion of the cost of electricity, DEMAND for the current and previous billings are shown here for monitoring purposes. A useful comparison is made to the twelve month average DEMAND so that seasonal system loads will not be misleading.

SOURCES OF INFORMATION ON ENERGY MANAGEMENT

Here follows a list of sources from whom further information on energy management may be obtained.

I. Societies, Associations, & Institutes

- Air-Conditioning and Refrigeration Institute, 1815 N. Ft. Myer Dr., Arlington, VA 22209
- Air Cooling Institute, P.O. Box 2121, Wichita Falls, TX 76301
- Air Diffusion Council, 435 N. Michigan Ave., Chicago, IL 60611
- Air Distribution Institute, 221 N. LaSalle St., Chicago, IL 60601
- Air Moving and Conditioning Association, 30 W. University Dr., Arlington Heights, IL 60004
- American Boiler Manufacturers Association, 1500 Wilson Blvd., Suite 317, Arlington, VA 22209
- American Consulting Engineers Council, 1155 15th St., N.W., Rm. 713, Washington, DC 20005
- American Gas Association, 1515 Wilson Blvd., Arlington, VA 22209
- American Industrial Hygiene Association, 210 Haddon Ave., Westmont, NJ 08108
- American Institute of Architects, 1735 New York Ave., N.W., Washington, DC 20006
- American Institute of Consulting Engineers (See American Consulting Engineers Council)
- American Institute of Plant Engineers, 1021 Delta Ave., Cincinnati, OH 45208
- American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018
- American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., 345 E. 47th St., New York, NY 10017
- American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017
- American Society of Plumbing Engineers, 16161 Ventura Blvd., Suite 105, Encino, CA 91316
- American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103
- Associated Air Balance Council, 2146 Sunset Blvd., Los Angeles, CA 90026
- Associated General Contractors of America, 1957 E. St., N.W., Washington, DC 20006
- Better Heating-Cooling Council, 35 Russo Pl., Berkeley Heights, NJ 07922
- BRAB Building Research Institute, 2101 Constitution Ave., Washington, DC 20418
- Building Owners & Managers Association International, 1221 Massachusetts Ave., N.W., Washington, D.C.
- Building Research Advisory Board, National Research Council, National Academy of Sciences-National Academy of Engineering, 2101 Constitution Ave., N.W., Washington, D.C. 20418
- Construction Specifications Institute, 1150 Seventeenth St., N.W., Suite 300, Washington DC 20036
- Conveyor Equipment Manufacturers, 1000 Vermont Ave., N.W., Washington, DC 20005
- Cooling Tower Institute, 3003 Yale St., Houston, TX 77018
- Edison Electric Institute, 1111 19th Street, N.W., Washington, D.C. 20036
- Electrical Apparatus Service Association, Inc., 7730 Carondelet Ave., St. Louis, MO 63105
- Heat Exchange Institute, 122 E. 42nd St., New York, NY 10017
- Hydronics Institute, 35 Russo Pl., Berkeley Heights, NJ 07922
- Illuminating Engineering Society, 345 E. 47th St., New York, NY 10017
- Institute of Electrical & Electronics Engineers, Inc., 345 E. 47th St., New York, NY 10017
- Instrument Society of America, Stanwix St., Pittsburgh, PA 15222
- International District—Heating Association, 5940 Baum Sq., Pittsburgh, PA 15026
- Mechanical Contractors Association of America, Inc., 5530 Wisconsin Ave., Suite 750, Washington, DC 20015
- National Association of Oil Heating Service Managers, Inc., 60 E. 42nd St., New York, NY 10017
- National Association of Plumbing, Heating & Cooling Contractors, 1016 20th St., N.E., Washington, DC 20036
- National Association of Power Engineers, Inc., 176 W. Adams St., Suite 1411, Chicago, IL 60603
- National Association of Refrigerated Warehouses, 1210 Tower Bldg., 1401 K St., N.W., Washington, DC 20005
- National Coal Association, Coal Bldg., 1130 17th St., N.W., Washington, DC 20036
- National Electrical Contractors Association, 7315 Wisconsin Ave., Washington, DC 20014
- National Electrical Manufacturers Association, 2101 L Street, N.W., Washington, D.C. 20037
- National Environmental Systems Contractors Association, 221 N. LaSalle St., Chicago, IL 60601
- National Insulation Contractors Association, 8630 Fenton St., Suite 506, Silver Spring, MD 20910
- National LP-Gas Association, 79 W. Monroe St., Chicago, IL 60603
- National Mineral Wool Insulation Association, Inc., 211 E. 51st St., New York, NY 10022
- National Oil Fuel Institute, Inc., 60 E. 42nd St., New York, NY 10017
- National Society of Professional Engineers, 2029 K St., N.W., Washington, DC 20006
- Producers' Council, Inc., 1717 Massachusetts Ave., Washington, DC 20036
- Refrigeration Service Enginners Society, 2720 Des Plaines Ave., Des Plaines, IL 60018

- Society of American Value Engineers (SAVE), 2550 Hargrave Dr., Smyrna, GA 30080
- Standards Engineers Society, P.O. Box 7507, Philadelphia, PA 1910
- Steam Heating Equipment Manufacturers Assoc., c/o Samuel J. Reid, Barnes & Jones, Inc., P.O. Box 207, Newtonville, MA 02160
- The Electrification Council, 1111 19th Street, N.W. Washington, D.C. 20036
- Thermal Insulation Manufacturers Association, Inc., 7 Kirby Plaza, Mt. Kisco, NY 10549
- Underwriters' Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062
- Water Conditioning Foundation, 1780 Maple St., P.O. Box 194, Northfield, IL 60093

2. Local Sources

- Chapters of above mentioned societies, associations and institutions
- Utilities
- Chambers of Commerce
- Construction industry organizations
- Building code authorities
- Libraries
- Architectural engineers, contractors, suppliers and others with whom you work on a regular basis.

3. U.S. Government Sources

- Department of Energy, Assistant Secretary for Conservation and Solar Applications, 20 Massachusetts Avenue, N.W., Washington, D.C. 20001
- Department of Commerce, Office of Energy Programs, 14th & Constitution Ave., Washington, D.C. 20230
- General Services Administration, Public Building Service, 18th & F St., N.W., Washington, D.C. 20405
- National Bureau of Standards, Office of Energy Conservation, Building 226, Rm. B114, Washington, D.C. 20234

General Energy

American Planning Association. *Community Energy Planning*. Washington, 1979.

Papers presented at the October 1979 APA conference including the two main subject areas of community energy management systems and the environmental impact of synthetic fuels projects. 111 pp.

Applied Research Integration. *Community Energy Management Workshop and Gaming Situation*. Boston, 1979.

A description of the game used at the October APA convention to teach planners about the intricacies of the energy management process. Mostly discussion of who are the actors and how do they make energy related decisions. A hypothetical large and small city are described in terms of their energy situations. 51 pp.

Applied Resource Integration, Ltd. *New England's Energy Future: The Impact on Public Planning Workshop Proceedings*. Boston, MA, 1979.

Speeches at an APA conference on the New England region's specific energy problems. Good reading but no specific data. 44 pp.

Argonne National Laboratory. *Community Energy Plans and Planning Methodologies: A Preliminary Bibliography*. Argonne, IL, 1979.

An excellent bibliography with both local energy management studies, and more general manuals on comprehensive community energy management planning.

Argonne National Laboratory. *Comprehensive Community Energy Management Program*. Argonne, IL, 1978.

The program is designed to allow local communities to utilize the framework for a "methodology" developed by DOE to complete a series of actions in a process that will result in an action plan to meet energy objectives as defined by the community.

Bonneville Power Administration. *Proposed Fiscal Year 1981 Program: Draft EIS*. Portland, OR, 1979.

This statement covers the potential impact of the major new facilities and maintenance programs proposed for fiscal year 1981. 210 pp.

Bonneville Power Administration. *Discussion Paper on a Pacific Northwest End-Use Energy Consumption Data Base*. Portland, 1978.

An end-use energy consumption data base is an organized body of information that describes in detail how energy is utilized at the point of final consumption. This report discusses how this data base can assist energy planning in the Pacific Northwest. 53 pp.

Bonneville Power Administration. *Environmental Impact Statement: Bonneville Power Administration's 1979 Wholesale Rate Increase*. Portland, OR, October 1979.

Bonneville Power Administration. *Time-Differentiated Pricing Analysis*. Portland, OR, 1979.

Explains Bonneville Power Administration's study of time-differentiated pricing as one of several alternatives which were considered in preparing a proposal for new wholesale power rates for 1979. 22 pp.

Bonneville Power Administration. *Power Outlook May 1980 through 1990-91*. Portland, OR, 1980.

A report that forecasts electric energy supply and demand in the Pacific Northwest region from 1980 through 1990.

Bonneville Power Administration. *Draft Environmental* Statement, Fiscal Year 1979 Proposed Program. Portland, September 1977.

Draft EIS for proposed construction of fiscal year 1979 new facility additions and modifications to BPA's electric transmission system for Idaho, Montana, Oregon, Washington and Wyoming.

Bonneville Power Administration. *Environmental* Statement – BPA 1976 Proposed Program. Portland, OR 1975.

A presentation of BPA's construction and maintenance program proposed for FY 1976. Vol. I, Vol. II.

Bonneville Power Administration. *The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System*. Portland, OR.

1. Summary Report
2. BPA power resources, acquisitions, planning and operations
3. BPA power transmission
4. The role of BPA
5. The Alumax environmental statement
6. The regional electric power supply system

5 vols.

Carroll and Nathans. *Land Use Configurations and the Utilization of Distributed Energy Technology* (Draft). 1977.

An issue paper to determine feasibility of future outcomes in which energy systems utilizing distributed technologies are employed to meet state energy demands. Studies land use.

Central Puget Sound Economical Development District. *Energy Assistance Project for the Central Puget Sound Region – Final Report, Phase I*. Seattle, WA, 1978.

This report discusses the results of an examination of the level of energy use and the pattern of that use in the manufacturing sectors of the central Puget Sound region conducted by the Central Puget Sound Economic Development District. 120 pp.

City of Seattle. *Energy 1990: Consultant's Report*. Seattle, 1976.

This study (an initial report) is designed to determine Seattle's electric energy demands and resources for the next 15 years, through 1990. 5 volumes.

City of Seattle. *Energy 1990: Final Report.* Seattle, 1976.

A final report on the City of Seattle study of a comprehensive plan of action or goals that must be undertaken for the city to become energy sufficient. 3 Volumes.

City of Tacoma. *Comprehensive Community Energy Management Program.* Tacoma, WA, 1978.

This proposal is intended to prepare a comprehensive community energy program for the City of Tacoma. 68 pp.

Cline, Ann. *City Energy Planning in a Small Scale Community.* Richmond, Indiana, 1979.

This paper outlines the steps to follow in starting energy management planning in a smaller community. Fairly elementary. 6 pp.

Commoner, Barry. *The National Energy Plan: A Critique.* Scientists Institute for Public Information, Washington, 1977.

A criticism of the President's national energy plan; points out defects, effects on consumers vs. industry, effects on economy and environment, long-term effects. 17 pp.

Congressional Quarterly. Energy Policy. Washington, April 1979.

An analysis of President Carter's energy program, reorganization of energy agencies, major energy legislation, background on energy issues, 1973-78 energy legislation. 249 pp.

Congressional Research Service. *Update – Energy.* Washington, 1979.

Reports, issue briefs, papers and studies by the Congressional Research Service. 13 pp.

Electric Power Research Institute. *Energy, Economic Growth and Human Welfare.* Palo Alto, CA, 1978.

An energy economist examines the relationships between energy and prosperity and calls for policies to achieve energy supply and environmental goals. 20 pp.

Environmental Information Center, Inc. *Energy: A Buyer's Guide to Environmental Media.* New York, 1974.

A directory of books, magazines, films, and information sources dealing with energy. 57 pp.

Energy Research and Development Administration. *Choosing an Electrical Energy Future for the Pacific Northwest: An Alternate Scenario, Final Draft.* Washington, 1977.

This report proposes an "alternate scenario" which shows the feasibility of meeting the region's electrical needs without constructing any additional nuclear or coal-fired power plants in the next 20 years beyond those already approved or under construction. 177 pp.

Environmental Research Center, Washington State University; Washington State Energy Office. *Washington State Energy Use Profile 1960-1978.* Olympia, 1979.

This report contains base data and information concerning the pricing of various forms of energy, as well as supply and demand data for all consuming sectors in Washington State. Also documented are energy flows into, within, and out of the state. This report is part of the currently expanding energy information system at the Washington State Energy Office.

Ford Foundation. *Energy: The Next Twenty Years.* Ballinger Publishing Co., Cambridge, Mass., 1979.

A study which looks into the field of energy and projects what the energy outlook will be in the next 20 years. 628 pp.

Energy Research Group, Inc. *Mirror, Mirror on the Wall.* Waltham, MA, 1979.

Self-perceptions and the geopolitics of energy. 24 pp.

Hartman, Richard. *What Regional Councils are Doing in Energy.* National Association of Regional Councils: Washington, 1977.

This report describes energy programs that are being implemented by regional councils. 17 pp.

League of Women Voters of Washington. *Energy Sources for Washington State.* Olympia, WA, 1976.

A basic, easy to understand assessment of energy resources in Washington State. 29 pp.

Levins, Amory. "Energy Strategy: The Road Not Taken? *Foreign Affairs*, Oct. 1976.

One of the standards in the energy policy field. Presents two basic options: the "soft" path, which includes conservation and changing values, and the "hard" path, which includes nuclear power and intensive use of electricity with highly centralized control. His bias is clearly in soft technologies, and he presents a very strong case. 33 pp.

Mathematical Sciences Northwest, Inc. *Energy Use Inventory, Puget Sound Area. City Light R&D Project 73-16.* Seattle, WA, 1973.

Study of energy consumption in King, Kitsap, Pierce and Snohomish Counties during 1972; residential and commercial, transportation, industrial. Many tables. 53 pp. and appendices.

Mechanical Engineering Department of Washington State University. "Symposium on Prequalification of Thermal Power Plant Sites in the Pacific Northwest." For the Power Planning Committee of the Pacific Northwest River Basins Commission. Pullman, WA, 1979.

A report on the inherent problems of siting large thermal power plants. 78 pp.

Multi-Social Agency. *Electricity 1979.* Seattle, WA.

A pamphlet that provides balanced information on the critical electrical energy decisions facing the Pacific Northwest region. 10 pp.

National Electrical Contractors Association. *Total Energy Management.* Washington, 1979.

A voluntary, flexible program for saving energy. The Total Energy Management approach is based on the premise that each building should be looked at in terms of its total energy consumption rather than the separate and discrete components of the building.

National Research Council. *Energy Modeling for an Uncertain Future*. 1978.

A study to assist the American people and government in formulating energy policy. A very technical assessment of all alternatives for energy in the U.S. with much emphasis on nuclear power. 225 pp.

Northwest Air Pollution Authority. *Environmental Impact Statement – Proposed Addition of Combustion Turbine Units 2 and 3 at Whitehorn Generating Station*. Mount Vernon, WA.

Volume I – Draft EIS
Volume II – Final EIS

Oregon Department of Energy. *Community Energy* Planning. Salem, OR.

A publication to assist communities in conservation, energy efficiency, and to encourage renewable resources. 65 pp.

Pacific Northwest Regional Commission. *Pacific Northwest Innovation Group – 14 Month Progress Report*. Vancouver, WA, 1979.

A progress report on the Pacific Northwest Innovation Group work in gathering and disseminating information, technological and scientific innovations to assist governmental entities in the Pacific Northwest. 95 pp.

Pacific Northwest Regional Commission. *Northwest Energy Policy Project*. Vancouver, WA, 1977.

The study describes possible energy futures of the Pacific Northwest and the likely impact of plausible policy alternatives available to the region. 9 Vols:

1. Executive summary – energy policy analysis
2. Energy conservation policy – social aspects
3. Energy demand modeling and forecasting
4. Energy supply and environmental impacts (conven.)
5. Energy supply and environmental impacts (unconven.)
6. Contingency planning
7. Institutional constraints and opportunities (A)
8. Institutional constraints and opportunities (B)
9. Integrating policy analysis

Pacific Northwest River Basin Commission. *Review of Power Planning in the Pacific Northwest*. Vancouver, WA, 1977.

This report contains summary information on the whole Pacific Northwest electric power planning process. Load forecasts, existing and planned capacity, alternative technologies, shortfall projections, and environmental considerations are all covered in the report. It would be good to find a more current edition. 112 pp.

Pacific Northwest River Basins Commission. *Power Planning Organizations in the Pacific Northwest*. 1978.

An inventory of power planning organizations and the areas they serve in the Pacific Northwest. 50 pp.

Pacific Northwest River Basins Commission. *Review of Power Planning in the Pacific Northwest Calendar Year 1978*. Vancouver, WA, 1979.

Includes chapters on new activities, continuing activities, load estimates for the future, power resources existing and feasible research and development. Many useful tables. 104 pp.

Pacific Northwest Utilities Conference Committee. *Econometric Model – Electric Sales Forecast*. Portland, OR, 1978.

The report describes the PNUCC econometric sales forecast, the econometric model and the input values which were used in developing this year's forecast. 220 pp.

Puget Sound Council of Governments. *A Proposal for a Comprehensive Community Energy Management Program*. Seattle, 1978.

A proposal for the Snohomish County Subregional Council to undertake a multi-sector countrywide comprehensive energy management program (CCEMP).

Resources for the Future. *Energy, Ltd.: An Overview and Interpretation of Energy in America's Future –* the Choices Before Us. Washington, 1979.

Advance publication of overview of comprehensive study of technical, economic, institutional, environmental and health and safety aspects of alternative energy futures. 65 pp.

Resources for the Future. *Annual Report 1978*. Washington, 1978.

A report on the work of Resources for the Future, whose purpose it is to advance research and education in the development, conservation, and use of natural resources and the improvement of the quality of the environment. 103 pp.

Resources for the Future. *Resources for the Future 1979 Publications*. Washington, 1979.

A list of all publications of the RFF Foundation. 35 pp.

Sawyer and Knowles. *Energy and Employment*. Seattle, WA, 1979.

The report discusses the impacts on employment as a result of increased energy price and/or a possible curtailment of energy. It also answers the question "Can employment and growth occur without proportionate increases in energy use?" 75 pp.

Seattle/King County Municipal League. Municipal League Report, "Regional Power Planning, Municipal League Conclusions and Recommendations. Seattle, WA, 1978.

League's recommendations to Seattle City Council on regional plan for electrical energy planning and conservation. 10 pp.

Amith, V. Kerry. *Regulating Energy: Indicative Planning or Creeping Nationalization?* Resources for the Future, Washington, 1978.

The economic and social impacts of regulating energy. 40 pp.

Sorenson, Gary W. *Energy, Growth and Employment: The Question of Linkages*. Seattle, WA.

A study dealing with the relationship between energy and employment in the Puget Sound region. This study is closely related to the study done by Sawyer and Knowles.

Toledo Metro Area Council of Governments. *Comprehensive Community Energy Management Planning in a COG Environment and Modeling the Base Data*. 1979.

This paper summarizes the steps which the Toledo COG went through to become "involved" in energy management. Appendices have schematics of models and data organization techniques. 12 pp.

Urban Institute. *Travel Behavior and Energy Consumption for Space Heating and Cooling*. Washington, 1979.

The above topics are chapters from a soon to be released study on "The effects of alternative patterns of urban development." 255 pp.

Summaries of discussions which involved every imaginable interest group on the energy scene. A good source of background information on many energy issues. 127 pp.

U.S. Executive Office, Office of the White House Press Secretary. *Fact Sheet on the President's Program*. Washington, 1979.

This press release summarizes the Carter energy policy proposals from A to Z. 28 pp.

U.S. General Accounting Office. *Region at the Crossroads – The Pacific Northwest Searches for New Sources of Electric Energy*. Washington, 1978.

This report discusses options for the Pacific Northwest in meeting its electric energy needs through the year 2000 and the BPA's role in meeting these needs. 135 pp.

U.S. Department of Housing and Urban Development. *Economic Evaluation of Total Energy*. Washington, 1973.

The objective of this study was to develop economic evaluation guidelines which could be used by the private and public sectors as a "screening tool" to determine the applicability of total energy systems for residential developments. 480 pp.

U.S. Department of the Interior. *The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System (Including Its Participation in the Hydro-Thermal Power Program – Summary Report*. Portland, OR, 1977.

Discusses BPA's "Role EIS," supply forecasting, alternative energy sources, role of BPA, tables estimating Pacific Northwest electric power requirements 1980-1995, energy politics and policies. 54 pp.

U.S. Department of Transportation. *Transportation Energy Contingency Planning: Local Experience*. Washington, 1979.

This report presents a brief summary and excerpted portions of six energy contingency plans from Memphis, Seattle (METRO), Los Angeles, Washington, D.C., Dallas-Forth Worth, and Minneapolis-St. Paul. 161 pp.

University of Kentucky, College of Business and Economics. *Growth and Change*. Lexington, KY, 1979.

Proceedings of a conference on regional energy problems and national energy policies. 142 pp.

Washington Public Interest Research Group. *Electricity: Forecasts and Alternatives for the Pacific Northwest: A Public Interest Perspective*. 1977.

A study of future need for electricity in the Pacific Northwest, including section on forecasting and alternatives, with tables. Emphasis on conservation. Includes bibliography. 40 pp.

Washington Public Interest Research Group. *The Future of the Aluminum Industry in the Pacific Northwest*. Seattle, 1978.

University of Washington and Washington State Energy Office. Olympia, WA, 1977.

Part 1: A Glossary of Institutions

Part 2: A Glossary of Technical Terms

U.S. Congress, Senate Committee on Energy and Natural Resources. *Pacific Northwest Electric Power Supply and Conservation Act; Hearing on S. 2080*. 95th Congress, 2nd Session, August 24-25, 1978.

Testimony that was received during the hearings of the Committee on Energy and Natural Resources regarding the Northwest power bill.

U.S. Department of Energy. *The National Energy Act*. Washington, 1978.

An information kit that summarizes the National Energy Act – conservation, coal conversion, utility rate reform, natural gas and tax credits. 45 pp.

U.S. Department of Energy. *Managing the Social and Economic Impacts of Energy Development*. Washington, 1977.

The investigation of strategies for calculating the "social costs" of energy development and compensating communities and individuals who bear the brunt of continued efforts to exploit energy resources in the United States. 52 pp.

U.S. Department of Energy. *Bonneville Power Administration Proposed FY 1980 Program – Final Environmental Impact Statement*. Washington, 1979.

The final EIS covering BPA's FY 1980 proposed programs. 250 pp.

U.S. Department of Energy. *EIA Publications Directory*. Washington, 1979.

The first directory of publications published under the auspices of the Energy Information Administration (EIA). In this issue can be found descriptions of

MANAGING ENERGY MANAGEMENT

TABLE OF CONTENTS

PRIORITIZATION METHODS

3.1 Simple Payback Analysis

Energy conservation opportunities which reduce energy costs without sacrificing product quality are generally acceptable, but they must compete with other investments. A three year simple payback is a standard criteria for evaluating investments, found from surveying over 120 Oregon commercial facility managers. An energy conservation opporturnity which pays back in less than three years is usually worth examining closer. In this way, simple paybacks are used for screening energy conservation options.

A simple payback can be defined as the amount of time required for the savings generated by an option to equal the cost of implementing the option. For example, a payback of two years indicates that the total dollar savings at the end of two years is equal to the cost of implementing the option. Two factors are needed for calculating the simple payback: the initial cost of the option, and the net annual savings. The simple payback expressed as a formula would be:

$$\text{Simple Payback} = \frac{\text{Initial Cost}}{\text{Net Annual Savings}}$$

The initial cost of the measure can be broken into the materials cost and the implemetation cost. The materials cost can be obtained by calling several manufacturer's representatives. It should be noted that two costs can be obtained in this way: the list price and the contracter's cost. The difference between these costs can be as much as 100 percent. For this reason, it is important that the correct cost be used. If the work is to be done inhouse, and only a few of the items will be purchased, the list price must be used. However, if the work will be contracted out, or a considerable quantity of the items will be purchased, the contractor's cost may be used. When calling a manufacturer's representative, it would be a good idea to ask for the names of people at other companies who have installed this equipment.

These references can provide valuable information. For example, the initial cost of their project can be used to estimate the cost of your project, but you should carefully compare the size and complexity of the two projects, and allow for inflation if a considerable length of time has elapsed between them. Any problems that they encountered can be discussed, and by asking them how they would have done it differently can provide some valuable input. In addition, you can ask the name of the contractor that they used, and if they would use them again. This type of information from several references will help you evaluate your project.

The cost of implementing the energy conservation opportunity includes the design costs, administration costs, training costs and the labor to install the equipment. Design costs should be included when the complexity of the measure mandates that an engineer develop drawings and specifications for bidding. Design costs range from 5 to 10 percent of the capital costs. Administration costs are proportional to the complexity of the measure. These costs include contract procurement, approval of invoices, inspection of work, and evaluation of change orders. The administration costs increase when financing or funding is applied for through a governmental agency. Training your personnel in the operation of the energy saving equipment adds to the total project cost. Training costs include the contractor's time and materials, as well as the cost of your personnel's time. This is usually well worth the expense, since it increases the energy savings through optimized system use. The cost to install the equipment can be estimated using one of the several cost estimating manuals. Other resources include asking the manufacturer's representative, or the references that you called, or calling a contractor that installs the equipment.

If the work will be contracted out, a minimum of 20 percent should be added to cover the contractor's overhead and profit (O & P). This percentage will vary with the local economic climate. For instance, if the contractor has too much work, he may raise the percent of O & P to cover the costs of hiring additional personnel or purchasing equipment. On the other hand, if there is very little work, the contractor may lower the percent of O & P to avoid laying off personnel or to keep idle equipment busy. This percent of O & P is difficult to estimate, for this reason, it is recommended that several contractors be called to ask for budget estimates on the work involved.

The second element in the simple payback analysis, the net annual savings, includes the energy savings, the projected energy cost, and the annual increase or decrease in maintenance costs. Many resources can be used to estimate the amount of annual energy savings. These resources include the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) handbooks, trade journals, consultants and vendors. The use of vendor supplied energy savings should be verified by asking for references of similar installations, or by one of the above resources. The projected energy cost is an estimate of what the Utilities will be charging for the energy over the life of the equipment. A conservative estimate would be 120 percent of the current energy costs. Finally, the annual increase or decrease in maintenance costs must be considered. For example, changing from incandescent to fluorescent lights reduces maintenance costs, because fluorescent lights do burn out as quickly as standard light bulbs. A heat recovery project, on the other hand, will usually increase the maintenance costs, because the equipment will have to be cleaned regularly to maximize the thermal transfer. These increased maintenance costs can be large enough to negate the energy savings, and therefore, must be considered. The net annual savings can be expressed by the following formula:

NET ANNUAL SAVINGS = (ENERGY SAVINGS) X (PROJECTED FUEL COST) - (CHANGE IN ANNUAL MAINTENANCE COST)

The simple payback analysis is one of the easiest methods of evaluating energy conservation opportunities, but it can not be used to decide between two similar projects which have different effective lifetimes. For example if one piece of machinery pays back in one year, but only lasts five years, and another piece of machinery pays back in three years, but lasts twenty years, which is the most economical? The simple payback analysis alone does not answer this question. Another disadvantage of this method is that it "fails to consider the time value of money, the impact of inflation, or the differential escalation (the difference between the general rate of inflation and the higher rate of inflation expected to affect energy prices in general)."

3.2 RETURN ON INVESTMENT ANALYSIS

The rate of return on investment analysis, often referred to as ROI, measures the efficiency in using available resources. Since the available resources are limited, management must try to get the most out of those resources that are available. The ROI can be defined as "...the interest rate at which the present worth of the cash flows on a project is zero." This analysis accounts for the effective life of the equipment, and is commonly used to evaluate alternatives. The return on investment is the interest rate for which the following equation is true:

$$(\text{PRESENT WORTH OF NET SAVINGS}) - (\text{INITIAL COST}) = 0$$

The procedure for finding the interest rate is an iterative process. First, the energy savings, maintenance costs, depreciation expenses, and income tax payments are estimated over the life of the equipment. If appropriate, a salvage value is also estimated. Then the present value of these items is calculated. The present worth considers the time value of money for future investments and savings. It can be calculated using the following formula:

$$PW = (\text{FUTURE CASH FLOW}) \times \frac{1}{(1 + i)^{N}}$$

Where: i = interest rate

N = number of years in the future

The present worth factor can also be found in tables that have been calculated for different interest rates and number of years. A copy of these tables and an example of how to use them can be found in any engineering economics book. The ROI has the advantage of comparing investments with different life expectancies. A return on investment greater than the current interest rate is considered an acceptable project for funding.

A simplified ROI analysis, called return on capital, is often used as a first cut in the evaluation of energy conservation opportunities. This analysis, sometimes referred to as ROC, does not consider the time value of money. The return on capital analysis can be expressed by the following formula:

$$ROC = \frac{(\text{NET ANNUAL SAVINGS}) - (\text{INTEREST PAYMENTS})}{(\text{INITIAL COST})}$$

The interest payment is included if funds are being borrowed to pay for the initial cost of the project.

3.3 LIFE CYCLE COST ANALYSIS

Life cycle cost analysis is an accurate method for prioritizing energy conservation opportunities with different effective lives. It was adopted by U.S. government agencies in the 60's as a means of enhancing the cost effectiveness of equipment procurement. This method incorporates the time value of money over the effective life of the energy conservation measure. This analysis assumes that the equipment will be replaced with exactly the same equipment at the end of the effective or useful life. The first step in this analysis is to find a common period of study using the effective lives of the alternatives. For example, if one option has an effective life of 5 years, another has an effective life of 10 years, and the last alternative has an effective life of 15 years, a common period of time of 30 years is used. This assumes that 6 of the first option, 3 of the second, and 2 of the last alternative are purchased during this period. The next step is to calculate the present value of all of the cash flows during the study period. Use the present worth tables included in Appendix D. Energy savings are subtracted, and expenses are added. The alternative with the smallest present worth over the period of study is the best investment. Life cycle cost analysis allows an alternative to be selected based on the minimum cost over the life of the investment instead of just the first cost.

E.2 Analysis: Cost Reduction vs. Added Sales

This appendix demonstrates a method for analyzing the relative effect on profitability that two alternatives may have:

i. Invest in energy cost reduction projects;

ii. Invest in increased sales.

Although increasing sales seems to be most consistent with the entire purpose of the business (provide goods and services to a customer), remembering that the real purpose is to provide the stockholders with maximum value may lead to selecting the energy cost reduction route.

Because the mathematics get involved, the most attractive choice often is not intuitive. Rigorous analysis will assure an economically sound choice and contribute to overall project and business success.

Before proceeding with an explanation of the financial analysis, there are a few qualitative points for discussion. How do other cost reduction programs compare with energy cost reduction? In many aspects the two alternatives can be treated as very similar. Financially, the analytical procedure is the same for both and their comparison to increasing sales is similar.

The primary differences, if they exist, will be:

i. What is the overall life of the savings? Often energy cost reductions are effective for the life of the physical plant. This is not usually the case for other cost reduction efforts.

ii. Energy is likely to become an increasingly scarce commodity. The implication here is that, unlike most financial analyses, the effects of inflation may not affect all components of the analysis equally. Energy costs may climb at a disproportionate rate thus making the energy cost cutting option more attractive long term.

iii. Energy cost reduction efforts may have long term survival effects for the business. As energy resources become more scarce, the less energy a business requires, the less the risk of loss of ability to produce due to rationing or other factors that might limit availability.

Table E.1 is a comparison of two income statements. The example used in the table shows how the effects differ for a $300 cost reduction and a $300 increase in sales.

The basic concept is as follows:

> The generation of additional sales will cause an increase in costs for three primary reasons:
> 1. The incremental cost to produce an increment of output;
> 2. The possible cost of increased promotional activity;
> 3. The additional income tax due to added before tax income.
>
> The reduction of energy expense will cause an increase in costs for primarily two reasons:
> 1. The depreciation charge due to capital investment;
> 2. Increased income tax due to added net income.

In order to carry out the example, assumptions about exactly how much each of the above factors affects expenses had to be made. Care must be taken whenever this analysis is performed to confirm the assumptions for each factor.

Table E.1
COMPARATIVE INCOME STATEMENT:
RELATIVE PROFITABILITY of INVESTMENT IN ADDITIONAL SALES v.s. UTILITY COST REDUCTION

ASSUMPTIONS:

(1) Significant economies of scale or major capital investment are not a factor. The incremental cost of sales percent assumes that the fixed cost base does not significantly change, only variable costs rise as a sales increase. This is a conservative assumption. For this analysis fixed costs are assumed to be 30% of the total initial case cost of sales expense.

(2) Change in energy expense does not affect sales level or other expenses.

(3) For the sake of comparison a 45% cost of sales is assumed in the initial cases.

(4) Added annual depreciation charge due to investment in energy reduction project is based on straight line depreciation, a 10 year project life and for this example the ratio of annual savings to investment of one to one.

INCREMENTAL EFFECT of an ADDITIONAL DOLLAR of SALES

	INITIAL CASE (3)		SALES INCREASE: 3%		INCREMENTAL CHANGE	
	AMOUNT	PERCENT of SALES	AMOUNT	PERCENT of SALES	AMOUNT	PERCENT CHANGE
SALES	$10,000		$10,300		$300	3%
LESS: COST of SALES (1)	4,500	45.0%	4,595	44.6%	95	2%
GROSS MARGIN	5,500	55.0%	5,706	55.4%	206	4%
LESS: ADM, MKTG, ENGR	3,000	30.0%	3,090	30.0%	90	3%
OPERATING INCOME BEFORE TAXES	2,500	25.0%	2,616	25.4%	116	5%
LESS TAX: 50%	1,250	12.5%	1,308	12.7%	58	5%
NET OPERATING INCOME	$1,250	12.5%	$1,308	12.7%	$58	5%
TOTAL EXPENSES	8,750	87.5%	8,992	87.3%	$242	3%

INCREMENTAL EFFECT of an ENERGY EXPENSE DOLLAR SAVED

	INITIAL CASE (3)		ENERGY COST CUT: 30%		INCREMENTAL CHANGE	
	AMOUNT	PERCENT of SALES	AMOUNT	PERCENT of SALES	AMOUNT	PERCENT CHANGE
SALES	$10,000		$10,000		$0	0%
LESS: ENERGY EXPENSE (2)	1,000	10.0%	700	7.0%	(300)	-30.0%
ADDED DEPR. (4)			30	0.3%	30	N/A
ALL OTHER EXPENSE	6,500	65.0%	6,500	65.0%	0	0.0%
OPERATING INCOME BEFORE TAXES	2,500	25.0%	2,770	27.7%	270	10.8%
LESS TAX: 50%	1,250	12.5%	1,385	13.9%	135	10.8%
NET OPERATING INCOME	$1,250	12.5%	$1,385	13.9%	135	10.8%
TOTAL EXPENSE	8,750	87.5%	8,585	85.9%	(165)	-1.9%

Figure E.1 extrapolates the results of Table E.1 over a range of cost reductions and increased sales. Within the region where the financial assumptions used are valid, (ie. sales costs increase at the assumed rates and energy costs fall at the assumed rate) the relationship between revenue increase and after tax profit is linear. Care must be taken not to extend conclusions beyond the limits of the model for an individual case.

Figure E.2 demonstrates the sensitivity of return on investment to changes in the ratio of annual energy cost savings to initial investment, while holding the other factors constant. In the example used in Table E.1, the ratio is $300 annual savings to $300 initial investment for a ratio of 1:1. The after tax annual profit in this example is $135. Computation of Return On Investment (ROI) is discussed in Appendix E.1.

Figure E.2 will help you determine the point at which investment in energy cost reduction is no longer attractive to your organization. This is often referred to as the hurdle rate. This point is the return on investment rate below which investment in the project is less profitable than some other use of the capital or too expensive compared to the cost of borrowing the money.

A thorough analysis of how the various assumptions stack up for each case must be carried out before using the model presented here. However, with the proper care, the model will assist the energy cost reduction project manager in selling the program to management as a viable part of the overall business strategy.

Figure E.1

PROFIT GENERATING COMPARISON
ADDED SALES or REDUCED ENERGY EXPENSE

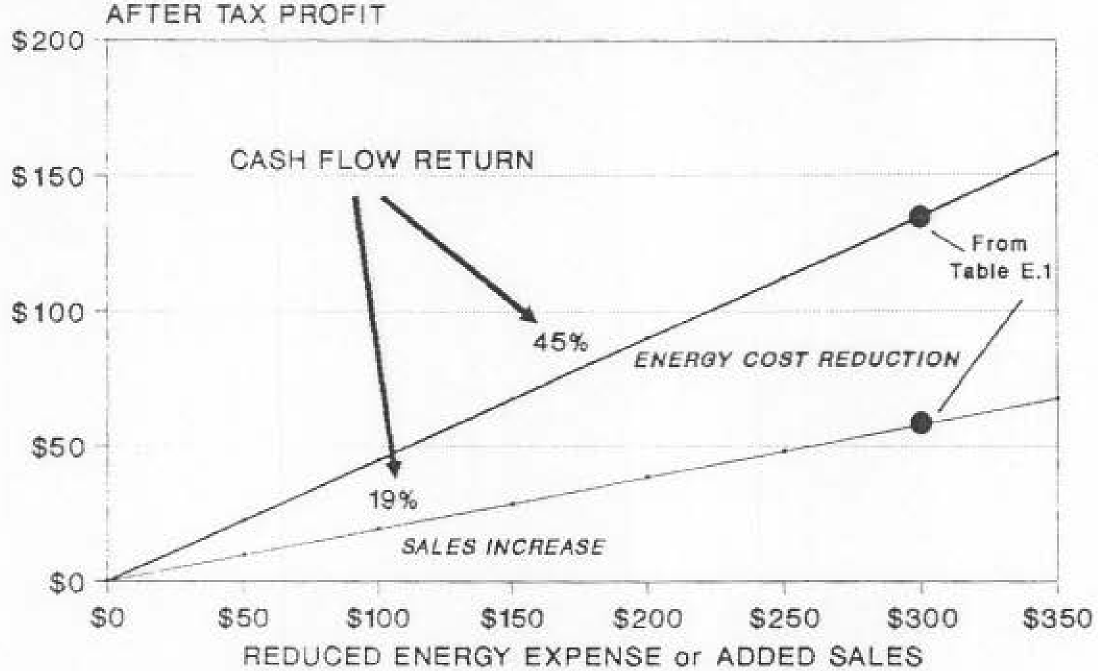
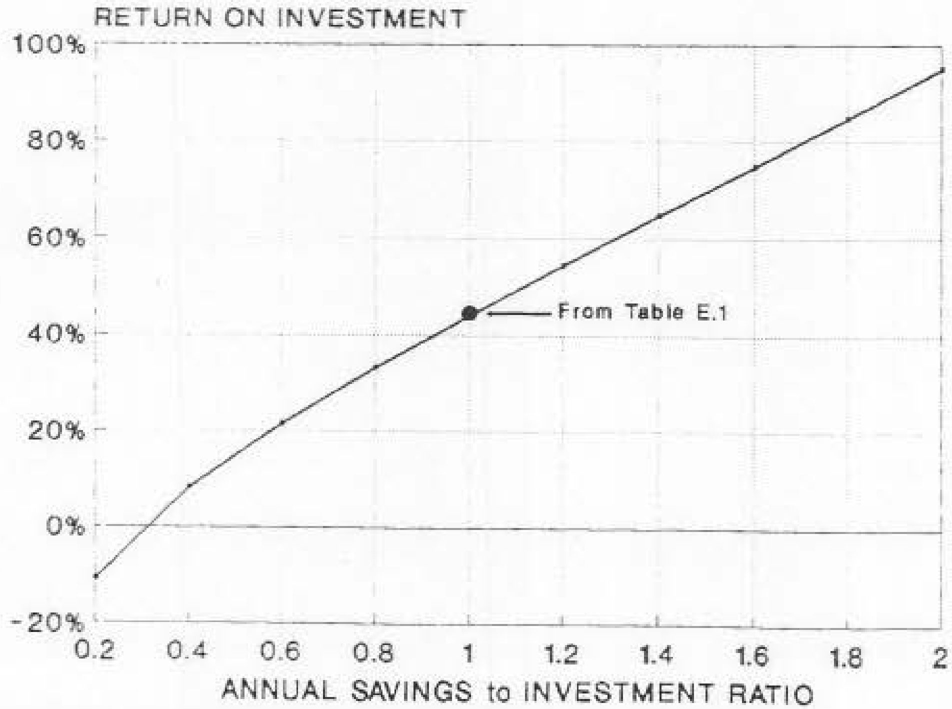


Figure E.2

SENSITIVITY OF RETURN ON INVESTMENT:
THE INVESTMENT TO SAVINGS RATIO



ASSUMES: 45% COS. 30% ENERGY EXPENSE CUT