CHAPTER 1
INTRODUCTION

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1.1 BACKGROUND

Mr. Al Thumann, Executive Director of the Association of Energy Engineers, said it well in the Foreword. “The energy ‘roller coaster’ never ceases with new turns and spirals which make for a challenging ride.” Those professionals who boarded the ride in the late 70’s and stayed on board have experienced several ups and downs. First, being an energy manager was like being a mother, John Wayne, and a slice of apple pie all in one. Everyone supported the concept and success was around every bend. Then, the mid-80’s plunge in energy prices caused some to wonder “Do we really need to continue energy management?”

Sometime in the late 80’s, the decision was made. Energy management is good business but it needs to be run by professionals. The Certified Energy Manager Program of the Association of Energy Engineers became popular and started a very steep growth curve. AEE continues to grow in membership and stature.

About the same time (late 80’s), the impact of the Natural Gas Policy Act began to be felt. Now, energy managers found they could sometimes save significant amounts of money by buying “spot market” natural gas and arranging transportation. About the only thing that could be done in purchasing electricity was to choose the appropriate rate schedule and optimize parameters (power factor, demand, ratchet clauses, time of use, etc.—see Chapter 18 on energy rate schedules).

With the arrival of the Energy Policy Act of 1992, electricity deregulation moved closer to reality, creating the opportunity of purchasing electricity from wherever the best deal could be found and to wheel the electric energy through the grid. Several states moved toward electrical deregulation, with some successes. But there were also some failures that made the energy industry pause and reflect. The prospect of electric deregulation and sharing grid infrastructure caused utilities to change their business view of their portion of the grid. Investment in expanding or upgrading this infrastructure became risky business for individual utilities, and so most chose to maintain the existing grid systems they owned, with a wait-and-see approach. Through electricity trading that manipulated pricing, problems with implementation changed the electric deregulation movement trend from slow to stop. Since good business relationships are good for all, some revisions to the EPACT-92 deregulation provisions may be necessary to see greater acceptance, and to sustain the concept in practice. To regain the confidence of the consumers, a greater degree of oversight of the business practices and the sharing of the vital US grid infrastructure may be necessary. This need is further accentuated by concerns of security and reliability of our nation’s electrical grid, spurred by national events in September 2001 (9-11) and August 2003 (Blackout). Even with the bumps as electricity deregulation was first tried, wider scale electric deregulation remains an exciting concept and energy managers are watching with anticipation. As new skills are learned and beneficial industry relationships are created, the prospects of larger scale deregulation will improve.

However, EPACT-1992’s impact is further reaching. If utilities must compete with other producers of electricity, then they must be “lean and mean.” As Mr. Thumann mentions in the Foreword, this means many of the Demand Side Management (DSM) and other conservation activities of the utilities are being cut or eliminated. The roller coaster ride goes on.

In 2005, the Bush Administration enacted the Energy Policy Act of 2005. This Act provides new opportunities and incentives for energy improvements in the country, including strong incentives for renewable energy sources and net metering. It is hoped that the tax incentives provided under this Act will become tools for the private sector to spur change with the free enterprise system. Similar in style to individual utility incentive programs, the Act’s success will depend largely on the ability of private firms, such as consultants, ESCOs and
Performance Contractors, to find partnering solutions to connect the program funding mechanism and the customer points of use. EPACT-2005 also updates the federal energy improvement mandates with a newer, stricter, baseline year (2003) and a new timeline for energy reduction requirements. The federal building segment remains an excellent target for large-scale improvement, as well as setting the all-important high visibility example for private industry to follow.

The Presidential Executive Orders mentioned in Chapter 20 created the Federal Energy Management Program (FEMP) to aid the federal sector in meeting federal energy management goals. The potential FEMP savings are mammoth and new professionals affiliated with federal, as well as state and local governments have joined the energy manager ranks. However, as Congress changes complexion, the FEMP and even DOE itself may face uncertain futures. The roller coaster ride continues.

FEMP efforts are showing results. Figure 1.3 outlines the goals that have been established for FEMP and reports show that the savings are apparently on schedule to meet all these goals. As with all such programs, reporting and measuring is difficult and critical. However, that energy and money is being saved is undeniable. More important, however, to most of this book’s readers are the Technology Demonstration Programs and Technology Alerts being published by the Pacific Northwest Laboratories of Battelle in cooperation with the US DOE. Both of these programs are dramatically speeding the incorporation of new technology and the Alerts are a great source of information for all energy managers. (Information is available on the WEB).

As utility DSM programs shrink, while private sector businesses and the federal government expand their needs for energy management programs, the door is opening for the ESCOs (Energy Service Companies), Shared Savings Providers, Performance Contractors, and other similar organizations. These groups are providing the auditing, energy and economic analyses, capital and monitoring to help other organizations reduce their energy consumption and reduce their expenditures for energy services. By guaranteeing and sharing the savings from improved energy efficiency and improved productivity, both groups benefit and prosper.

Throughout it all, energy managers have proven time and time again, that energy management is cost effective. Furthermore, energy management is vital to our national security, environmental welfare, and economic productivity. This will be discussed in the next section.

1.2 THE VALUE OF ENERGY MANAGEMENT

Business, industry and government organizations have all been under tremendous economic and environmental pressures in the last few years. Being economically competitive in the global marketplace and meeting increasing environmental standards to reduce air and water pollution have been the major driving factors in most of the recent operational cost and capital cost investment decisions for all organizations. Energy management has been an important tool to help organizations meet these critical objectives for their short term survival and long-term success.

The problems that organizations face from both their individual and national perspectives include:

- Meeting more stringent environmental quality standards, primarily related to reducing global warming and reducing acid rain.

Energy management helps improve environmental quality. For example, the primary culprit in global warming is carbon dioxide, \( \text{CO}_2 \). Equation 1.1, a balanced chemistry equation involving the combustion of methane (natural gas is mostly methane), shows that 2.75 pounds of carbon dioxide is produced for every pound of methane combusted. Thus, energy management, by reducing the combustion of methane can dramatically reduce the amount of carbon dioxide in the atmosphere and help reduce global warming. Commercial and industrial energy use accounts for about 45 percent of the carbon dioxide released from the burning of fossil fuels, and about 70 percent of the sulfur dioxide emissions from stationary sources.

\[
\begin{align*}
\text{CH}_4 + 2 \text{O}_2 & = \text{CO}_2 + 2 \text{H}_2\text{O} \\
(12 + 4*1) + 2(2*16) & = (12 + 2*16) + 2(2*1 + 16) \\
(1.1)
\end{align*}
\]

Thus, 16 pounds of methane produces 44 pounds of carbon dioxide; or 2.75 pounds of carbon dioxide is produced for each pound of methane burned.

Energy management reduces the load on power plants as fewer kilowatt hours of electricity are needed. If a plant burns coal or fuel oil, then a significant amount of acid rain is produced from the sulphur dioxide emitted by the power plant. Acid rain problems then are reduced through energy management, as are \( \text{NO}_x \) problems.

Less energy consumption means less petroleum field development and subsequent on-site pollution.
Less energy consumption means less thermal pollution at power plants and less cooling water discharge. Reduced cooling requirements or more efficient satisfaction of those needs means less CFC usage and reduced ozone depletion in the stratosphere. The list could go on almost indefinitely, but the bottom line is that energy management helps improve environmental quality.

- Becoming—or continuing to be—economically competitive in the global marketplace, which requires reducing the cost of production or services, reducing industrial energy intensiveness, and meeting customer service needs for quality and delivery times.

Significant energy and dollar savings are available through energy management. Most facilities (manufacturing plants, schools, hospitals, office buildings, etc) can save according to the profile shown in Figure 1.1. Even more savings have been accomplished by some programs.

- Low cost activities first year or two: 5 to 15%
- Moderate cost, significant effort, three to five years: 15 to 30%
- Long-term potential, higher cost, more engineering: 30 to 50%

**Figure 1.1 Typical Savings Through Energy Management**

Thus, large savings can be accomplished often with high returns on investments and rapid paybacks. Energy management can make the difference between profit and loss and can establish real competitive enhancements for most companies.

Energy management in the form of implementing new energy efficiency technologies, new materials and new manufacturing processes and the use of new technologies in equipment and materials for business and industry is also helping companies improve their productivity and increase their product or service quality. Often, the energy savings is not the main driving factor when companies decide to purchase new equipment, use new processes, and use new high-tech materials. However, the combination of increased productivity, increased quality, reduced environmental emissions, and reduced energy costs provides a powerful incentive for companies and organizations to implement these new technologies.

Total Quality Management (TQM) is another emphasis that many businesses and other organizations have developed over the last decade. TQM is an integrated approach to operating a facility, and energy cost control should be included in the overall TQM program. TQM is based on the principle that front-line employees should have the authority to make changes and other decisions at the lowest operating levels of a facility. If employees have energy management training, they can make informed decisions and recommendations about energy operating costs.

- Maintaining energy supplies that are:
  - Available without significant interruption, and
  - Available at costs that do not fluctuate too rapidly.

Once again, the country is becoming dependent on imported oil. During the time of the 1979 oil price crisis, the U.S. was importing almost 50% of our total oil consumption. By 1995, the U.S. was again importing 50% of our consumption. Today (2003) we are importing even more (approximately 54%), and the price has dramatically increased. Thus, the U.S. is once again vulnerable to an oil embargo or other disruption of supply. The major difference is that there is a better balance of oil supply among countries friendly to the U.S. Nonetheless, much of the oil used in this country is not produced in this country. The trade balance would be much more favorable if we imported less oil.

- Helping solve other national concerns which include:
  - Need to create new jobs
  - Need to improve the balance of payments by reducing costs of imported energy
  - Need to minimize the effects of a potential limited energy supply interruption

None of these concerns can be satisfactorily met without having an energy efficient economy. Energy management plays a key role in helping move toward this energy efficient economy.

### 1.3 THE ENERGY MANAGEMENT PROFESSION

Energy management skills are important to people in many organizations, and certainly to people who
perform duties such as energy auditing, facility or building management, energy and economic analysis, and maintenance. The number of companies employing professionally trained energy managers is large and growing. A partial list of job titles is given in Figure 1.2. Even though this is only a partial list, the breadth shows the robustness of the profession.

For some of these people, energy management will be their primary duty, and they will need to acquire in-depth skills in energy analysis as well as knowledge about existing and new energy using equipment and technologies. For others—such as maintenance managers—energy management skills are simply one more area to cover in an already full plate of duties and expectations. The authors are writing this Energy Management Handbook for both of these groups of readers and users.

Twenty years ago, few university faculty members would have stated their primary interest was energy management, yet today there are numerous faculty who prominently list energy management as their principal specialty. In 2003, there were 26 universities throughout the country listed by DOE as Industrial Assessment Centers or Energy Analysis and Diagnostic Centers. Other Universities offer coursework and/or do research in energy management but do not have one of the above centers. Finally, several professional Journals and Magazines now publish exclusively for energy managers while we know of none that existed 15 years ago.

The need for energy management in federal facilities predates the U.S. Department of Energy. Since 1973, the President and Congress have called on federal agencies to lead by example in energy conservation and management in its own facilities, vehicles and operations. Both the President and the Congress have addressed the issue of improving energy efficiency in federal facilities several times since the mid-1970’s. Each new piece of legislation and executive order has combined past experiences with new approaches in an effort to promote further efficiency gains in federal agencies. The Federal Energy Management Program (FEMP) was established in the early 1970’s to coordinate federal agency reporting, analysis of energy use and to encourage energy conservation and still leads that effort today. Executive Order 13123, Greening the Government Through Efficient Energy Management, signed by President Clinton in June 1999, is the most recent directive for federal agencies. A brief summary of the goals of that executive order is given in Figure 1.3. In addition to the goals, Executive Order 13123 outlined several other requirements for federal agencies aimed at improving energy efficiency, reducing greenhouse gases and other emissions, increasing the use of renewable energy, and promoting federal leadership in energy management.

Like energy management itself, utility DSM programs have had their ups and downs. DSM efforts peaked in the late 80s and early 90s, and have since retrenched significantly as utility deregulation and the movement to retail wheeling have caused utilities to reduce staff and cut costs as much as possible. This short-term cost cutting is seen by many utilities as their only way to become a competitive low-cost supplier of electric power. Once their large customers have the choice of their power supplier, they want to be able to hold on to these customers by offering rates that are competitive with other producers around the country. In the meantime, the other energy services provided by the utility are being reduced or eliminated in this corporate downsizing effort.

This reduction in electric utility incentive and rebate programs, as well as the reduction in customer support, has produced a gap in energy service assistance that is being met by a growing sector of equipment supply companies and energy service consulting firms that are willing and able to provide the technical and financial assistance that many organizations previously got from their local electric utility. New business opportunities and many new jobs are being created in this shift away from utility support to energy service company support. Energy management skills are extremely important in this rapidly expanding field, and even critical to those companies that are in the business of identifying energy savings and providing a guarantee of the savings results.

- Plant Energy Manager
- Utility Energy Auditor
- State Agency Energy Analyst
- Consulting Energy Manager
- DSM Auditor/Manager
- Building/Facility Energy Manager
- Utility Energy Analyst
- Federal Energy Analyst
- Consulting Energy Engineer

Figure 1.2 Typical Energy Management Job Titles
Thus, the future for energy management is extremely promising. It is cost effective, it improves environmental quality, it helps reduce the trade deficit, and it helps reduce dependence on foreign fuel supplies. Energy management will continue to grow in size and importance.

1.4 SOME SUGGESTED PRINCIPLES OF ENERGY MANAGEMENT

(The material in this section is repeated verbatim from the first and second editions of this handbook. Mr. Roger Sant who was then director of the Energy Productivity Center of the Carnegie-Mellon Institute of Research in Arlington, VA, wrote this section for the first edition. It was unchanged for the second edition. Now, the fourth edition is being printed. The principles developed in this section are still sound. Some of the number quoted may now be a little old; but the principles are still sound. Amazing, but what was right 18 years ago for energy management is still right today. The game has changed, the playing field has moved; but the principles stay the same).

If energy productivity is an important opportunity for the nation as a whole, it is a necessity for the individual company. It represents a real chance for creative management to reduce that component of product cost that has risen the most since 1973.

Those who have taken advantage of these opportunities have done so because of the clear intent and commitment of the top executive. Once that commitment is understood, managers at all levels of the organization can and do respond seriously to the opportunities at hand. Without that leadership, the best designed energy management programs produce few results. In addition, we would like to suggest four basic principles which, if adopted, may expand the effectiveness of existing energy management programs or provide the starting point of new efforts.

The first of these is to control the costs of the energy function or service provided, but not the Btu of energy. As most operating people have noticed, energy is just a means of providing some service or benefit. With the possible exception of feedstocks for petrochemical production, energy is not consumed directly. It is always converted into some useful function. The existing data are not as complete as one would like, but they do indicate some surprises. In 1978, for instance, the aggregate industrial expenditure for energy was $55 billion. Thirty-five percent of that was spent for machine drive from electric motors, 29% for feedstocks, 27% for process heat, 7% for electrolytic functions, and 2% for space conditioning and light. As shown in Table 1.1, this is in blunt contrast to measuring these functions in Btu. Machine drive, for example, instead of 35% of the dollars, required only 12% of the Btu.

In most organizations it will pay to be even more specific about the function provided. For instance, evaporation, distillation, drying, and reheat are all typical of...
the uses to which process heat is put. In some cases it has also been useful to break down the heat in terms of temperature so that the opportunities for matching the heat source to the work requirement can be utilized.

In addition to energy costs, it is useful to measure the depreciation, maintenance, labor, and other operating costs involved in providing the conversion equipment necessary to deliver required services. These costs add as much as 50% to the fuel cost.

It is the total cost of these functions that must be managed and controlled, not the Btu of energy. The large difference in cost of the various Btu of energy can make the commonly used Btu measure extremely misleading. In November 1979, the cost of 1 Btu of electricity was nine times that of 1 Btu of steam coal. Table 1.2 shows how these values and ratios compare in 2005.

One of the most desirable and least reliable skills for an energy manager is to predict the future cost of energy. To the extent that energy costs escalate in price beyond the rate of general inflation, investment paybacks will be shortened, but of course the reverse is also true. A quick glance at Table 1.2 shows the inconsistency in overall energy price changes over this period in time. Even the popular conception that energy prices always go up was not true for this period, when normalized to constant dollars. This volatility in energy pricing may account for some business decisions that appear overly conservative in establishing rate of return or payback period hurdles.

Availabilities also differ and the cost of maintaining fuel flexibility can affect the cost of the product. And as shown before, the average annual price increase of natural gas has been almost three times that of electricity. Therefore, an energy management system that controls Btu per unit of product may completely miss the effect of the changing economics and availabilities of energy alternatives and the major differences in usability of each fuel. Controlling the total cost of energy functions is much more closely attuned to one of the principal interests of the executives of an organization—controlling costs.

NOTE: The recommendation to control energy dollars and not Btus does not always apply. For example, tracking building energy use per year for comparison to prior years is best done with Btus since doing so negates the effect of energy price volatility. Similarly, comparing the heating use of a commercial facility against an industry segment benchmark using cost alone can yield wild results if, for example, one building uses natural gas to heat while another uses electric resistance; this is another case where using Btus yields more meaningful results.
A second principle of energy management is to control energy functions as a product cost, not as a part of manufacturing or general overhead. It is surprising how many companies still lump all energy costs into one general or manufacturing overhead account without identifying those products with the highest energy function cost. In most cases, energy functions must become part of the standard cost system so that each function can be assessed as to its specific impact on the product cost.

The minimum theoretical energy expenditure to produce a given product can usually be determined en route to establishing a standard energy cost for that product. The seconds of 25-hp motor drive, the minutes necessary in a 2200°F furnace to heat a steel part for fabrication, or the minutes of 5-V electricity needed to make an electrolytic separation, for example, can be determined as theoretical minimums and compared with the actual figures. As in all production cost functions, the minimum standard is often difficult to meet, but it can serve as an indicator of the size of the opportunity.

In comparing actual values with minimum values, four possible approaches can be taken to reduce the variance, usually in this order:

1. An hourly or daily control system can be installed to keep the function cost at the desired level.
2. Fuel requirements can be switched to a cheaper and more available form.
3. A change can be made to the process methodology to reduce the need for the function.
4. New equipment can be installed to reduce the cost of the function.

The starting point for reducing costs should be in achieving the minimum cost possible with the present equipment and processes. Installing management control systems can indicate what the lowest possible energy use is in a well-controlled situation. It is only at that point when a change in process or equipment configuration should be considered. An equipment change prior to actually minimizing the expenditure under the present system may lead to oversizing new equipment or replacing equipment for unnecessary functions.

The third principle is to control and meter only the main energy functions—the roughly 20% that make up 80% of the costs. As Peter Drucker pointed out some time ago, a few functions usually account for a majority of the costs. It is important to focus controls on those that represent the meaningful costs and aggregate the remaining items in a general category. Many manufacturing plants in the United States have only one meter, that leading from the gas main or electric main into the plant from the outside source. Regardless of the reasonableness of the standard cost established, the inability to measure actual consumption against that standard will render such a system useless. Submetering the main functions can provide the information not only to measure but to control costs in a short time interval. The cost of metering and submetering is usually incidental to the potential for realizing significant cost improvements in the main energy functions of a production system.

The fourth principle is to put the major effort of an energy management program into installing controls and achieving results. It is common to find general knowledge about how large amounts of energy could be saved in a plant. The missing ingredient is the discipline necessary to achieve these potential savings. Each step in saving energy needs to be monitored frequently enough by the manager or first-line supervisor to see noticeable changes. Logging of important fuel usage or behavioral observations are almost always necessary before any particular savings results can be realized. Therefore, it is critical that an energy director or committee have the authority from the chief executive to install controls, not just advise line management. Those energy managers who have achieved the largest cost reductions actually install systems and controls; they do not just provide good advice.

As suggested earlier, the overall potential for increasing energy productivity and reducing the cost of energy services is substantial. The 20% or so improvement in industrial energy productivity since 1972 is just the beginning. To quote the energy director of a large chemical company: “Long-term results will be much greater.”

Although no one knows exactly how much we can improve productivity in practice, the American Physical Society indicated in their 1974 energy conservation study that it is theoretically possible to achieve an eightfold improvement of the 1972 energy/production ratio. Most certainly, we are a long way from an economic saturation of the opportunities (see, e.g., Ref. 10). The common argument that not much can be done after a 15 or 20% improvement has been realized ought to be dismissed as baseless. Energy productivity provides an expanding opportunity, not a last resort. The chapters in this book provide the information that is necessary to make the most of that opportunity in each organization.

References
3. JOHN G. WINGER et al., Outlook for Energy in the United States
2.1 INTRODUCTION

Some years ago, a newspaper headline stated, “Lower energy use leaves experts pleased but puzzled.” The article went on to state “Although the data are preliminary, experts are baffled that the country appears to have broken the decades-old link between economic growth and energy consumption.”

For those involved in energy management, this comes as no surprise. We have seen companies becoming more efficient in their use of energy, and that’s showing in the data. Those that have extracted all possible savings from downsizing, are now looking for other ways to become more competitive. Better management of energy is a viable way, so there is an upward trend in the number of companies that are establishing an energy management program. Management is now beginning to realize they are leaving a lot of money on the table when they do not instigate a good energy management plan.

With the new technologies and alternative energy sources now available, this country could possibly reduce its energy consumption by 50%—if there were no barriers to the implementation. But of course, there are barriers, mostly economic. Therefore, we might conclude that managing energy is not a just technical challenge, but one of how to best implement those technical changes within economic limits, and with a minimum of disruption.

Unlike other management fads that have come and gone, such as value analysis and quality circles, the need to manage energy will be permanent within our society.

There are several reasons for this:

- Most manufacturing companies are looking for a competitive edge. A reduction in energy costs to manufacture the product can be immediate and permanent. In addition, products that use energy, such as motor driven machinery, are being evaluated to make them more energy efficient, and therefore more marketable. Many foreign countries where energy is more critical, now want to know the maximum power required to operate a piece of equipment.
- Energy technology is changing so rapidly that state-of-the-art techniques have a half life of ten years at the most. Someone in the organization must be in a position to constantly evaluate and update this technology.
- Energy security is a part of energy management. Without a contingency plan for temporary shortages or outages, and a strategic plan for long range plans, organizations run a risk of major problems without immediate solutions.
- Future price shocks will occur. When world energy markets swing wildly with only a five percent decrease in supply, as they did in 1979, it is reasonable to expect that such occurrences will happen again.

Those people then who choose—or in many cases are drafted—to manage energy will do well to recognize this continuing need, and exert the extra effort to become skilled in this emerging and dynamic profession.

The purpose of this chapter is to provide the fundamentals of an energy management program that can be, and have been, adapted to organizations large and small. Developing a working organizational structure may be the most important thing an energy manager can do.

2.2 ENERGY MANAGEMENT PROGRAM

All the components of a comprehensive energy management program are depicted in Figure 2-1. These components are the organizational structure, a policy, and plans for audits, education, reporting, and strategy. It is hoped that by understanding the fundamentals of managing energy, the energy manager can then adapt a good
working program to the existing organizational structure. Each component is discussed in detail below.

2.3 ORGANIZATIONAL STRUCTURE

The organizational chart for energy management shown in Figure 2-1 is generic. It must be adapted to fit into an existing structure for each organization. For example, the presidential block may be the general manager, and VP blocks may be division managers, but the fundamental principles are the same. The main feature of the chart is the location of the energy manager. This position should be high enough in the organizational structure to have access to key players in management, and to have a knowledge of current events within the company. For example, the timing for presenting energy projects can be critical. Funding availability and other management priorities should be known and understood. The organizational level of the energy manager is also indicative of the support management is willing to give to the position.

2.3.1 Energy Manager

One very important part of an energy management program is to have top management support. More important, however, is the selection of the energy manager, who can among other things secure this support. The person selected for this position should be one with a vision of what managing energy can do for the company. Every successful program has had this one thing in common—one person who is a shaker and mover that makes things happen. The program is then built around this person.

There is a great tendency for the energy manager to become an energy engineer, or a prima donna, and attempt to conduct the whole effort alone. Much has been accomplished in the past with such individuals working alone, but for the long haul, managing the program by involving everyone at the facility is much more productive and permanent. Developing a working organizational structure may be the most important thing an energy manager can do.

The role and qualifications of the energy manager have changed substantially in the past few years, caused mostly by EPACT-1992 requiring certification of federal energy managers, deregulation of the electric utility industry bringing both opportunity and uncertainty, and by performance contracting requiring more business skills than engineering. In her book titled “Performance Contracting: Expanded Horizons,” Shirley Hansen give the following requirements for an energy management:

- Set up an Energy Management Plan
- Establish energy records
- Identify outside assistance
- Assess future energy needs
- Identify financing sources
- Make energy recommendations
- Implement recommendations

![Energy Management Program](image.png)

Figure 2.1
- Provide liaison for the energy committee
- Plan communication strategies
- Evaluate program effectiveness

Energy management programs can, and have, originated within one division of a large corporation. The division, by example and savings, motivates people at corporate level to pick up on the program and make energy management corporate wide. Many also originate at corporate level with people who have facilities responsibility, and have implemented a good corporate facilities program. They then see the importance and potential of an energy management program, and take a leadership role in implementing one. In every case observed by the author, good programs have been instigated by one individual who has recognized the potential, is willing to put forth the effort—in addition to regular duties—will take the risk of pushing new concepts, and is motivated by a seemingly higher calling to save energy.

If initiated at corporate level, there are some advantages and some precautions. Some advantages are:

- More resources are available to implement the program, such as budget, staff, and facilities.
- If top management support is secured at corporate level, getting management support at division level is easier.
- Total personnel expertise throughout the corporation is better known and can be identified and made known to division energy managers.
- Expensive test equipment can be purchased and maintained at corporate level for use by divisions as needed.
- A unified reporting system can be put in place.
- Creative financing may be the most needed and the most important assistance to be provided from corporate level.
- Impacts of energy and environmental legislation can best be determined at corporate level.
- Electrical utility rates and structures, as well as effects of unbundling of electric utilities, can be evaluated at corporate level.

Some precautions are:

- Many people at division level may have already done a good job of saving energy, and are cautious about corporate level staff coming in and taking credit for their work.
- All divisions don’t progress at the same speed. Work with those who are most interested first, then through the reporting system to top management give them credit. Others will then request assistance.

2.3.2 Energy Team

The coordinators shown in Figure 2-1 represent the energy management team within one given organizational structure, such as one company within a corporation. This group is the core of the program. The main criteria for membership should be an indication of interest. There should be a representative from the administrative group such as accounting or purchasing, someone from facilities and/or maintenance, and a representative from each major department.

This energy team of coordinators should be appointed for a specific time period, such as one year. Rotation can then bring new people with new ideas, can provide a mechanism for tactfully removing non-performers, and involve greater numbers of people in the program in a meaningful way.

Coordinators should be selected to supplement skills lacking in the energy manager since, as pointed out above, it is unrealistic to think one energy manager can have all the qualifications outlined. So, total skills needed for the team, including the energy manager may be defined as follows:

- Have enough technical knowledge within the group to either understand the technology used by the organization, or be trainable in that technology.
- Have a knowledge of potential new technology that may be applicable to the program.
- Have planning skills that will help establish the organizational structure, plan energy surveys, determine educational needs, and develop a strategic energy management plan.
- Understand the economic evaluation system used by the organization, particularly payback and life cycle cost analysis.
- Have good communication and motivational skills since energy management involves everyone within the organization.
The strengths of each team member should be evaluated in light of the above desired skills, and their assignments made accordingly.

2.3.3 Employees

Employees are shown as a part of the organizational structure, and are perhaps the greatest untapped resource in an energy management program. A structured method of soliciting their ideas for more efficient use of energy will prove to be the most productive effort of the energy management program. A good energy manager will devote 20% of total time working with employees. Too many times employee involvement is limited to posters that say “Save Energy.”

Employees in manufacturing plants generally know more about the equipment than anyone else in the facility because they operate it. They know how to make it run more efficiently, but because there is no mechanism in place for them to have an input, their ideas go unsolicited.

An understanding of the psychology of motivation is necessary before an employee involvement program can be successfully conducted. Motivation may be defined as the amount of physical and mental energy that a worker is willing to invest in his or her job. Three key factors of motivation are listed below:

- Motivation is already within people. The task of the supervisor is not to provide motivation, but to know how to release it.
- The amount of energy and enthusiasm people are willing to invest in their work varies with the individual. Not all are over-achievers, but not all are lazy either.
- The amount of personal satisfaction to be derived determines the amount of energy an employee will invest in the job.

Achieving personal satisfaction has been the subject of much research by industrial psychologists, and they have emerged with some revealing facts. For example. They have learned that most actions taken by people are done to satisfy a physical need—such as the need for food—or an emotional need—such as the need for acceptance, recognition, or achievement.

Research has also shown that many efforts to motivate employees deal almost exclusively with trying to satisfy physical needs, such as raises, bonuses, or fringe benefits. These methods are effective only for the short term, so we must look beyond these to other needs that may be sources of releasing motivation.

A study done by Heresy and Blanchard [1] in 1977 asked workers to rank job related factors listed below. The results were as follows:

1. Full appreciation for work done
2. Feeling “in” on things
3. Understanding of personal problems
4. Job security
5. Good wages
6. Interesting work
7. Promoting and growth in the company
8. Management loyalty to workers
9. Good working conditions
10. Tactful discipline of workers

This priority list would no doubt change with time and with individual companies, but the rankings of what supervisors thought employees wanted were almost diametrically opposed. They ranked good wages as first.

It becomes obvious from this that job enrichment is a key to motivation. Knowing this, the energy manager can plan a program involving employees that can provide job enrichment by some simple and inexpensive recognitions.

Some things to consider in employee motivation are as follows:

- There appears to be a positive relationship between fear arousal and persuasion if the fear appeals deal with topics primarily of significance to the individual; e.g., personal well being.
- The success of persuasive communication is directly related to the credibility of the source of communication and may be reduced if recommended changes deviate too far from existing beliefs and practices.
- When directing attention to conservation, display the reminder at the point of action at the appropriate time for action, and specify who is responsible for taking the action and when it should occur. Generic posters located in the work area are not effective.
- Studies have shown that pro-conservation attitudes and actions will be enhanced through associations with others with similar attitudes, such as being part of an energy committee.
- Positive effects are achieved with financial incentives if the reward is in proportion to the savings,
and represents respectable increments of spendable income.

• Consumers place considerable importance on the potential discomfort in reducing their consumption of energy. Changing thermostat settings from the comfort zone should be the last desperate act for an energy manager.

• Social recognition and approval is important, and can occur through such things as the award of medals, designation of employee of the month, and selection to membership in elite sub-groups. Note that the dollar cost of such recognitions is minimal.

• The potentially most powerful source of social incentives for conservation behavior—but the least used—is the commitment to others that occurs in the course of group decisions.

Before entering seriously into a program involving employees, be prepared to give a heavy commitment of time and resources. In particular, have the resources to respond quickly to their suggestions.

2.4. ENERGY POLICY

A well written energy policy that has been authorized by management is as good as the proverbial license to steal. It provides the energy manager with the authority to be involved in business planning, new facility location and planning, the selection of production equipment, purchase of measuring equipment, energy reporting, and training—things that are sometimes difficult to do.

If you already have an energy policy, chances are that it is too long and cumbersome. To be effective, the policy should be short—two pages at most. Many people confuse the policy with a procedures manual. It should be bare bones, but contain the following items as a minimum:

• Objectives—this can contain the standard motherhood and flag statements about energy, but the most important is that the organization will incorporate energy efficiency into facilities and new equipment, with emphasis on life cycle cost analysis rather than lowest initial cost.

• Accountability—This should establish the organizational structure and the authority for the energy manager, coordinators, and any committees or task groups.

• Reporting—Without authority from top management, it is often difficult for the energy manager to require others within the organization to comply with reporting requirements necessary to properly manage energy. The policy is the place to establish this. It also provides a legitimate reason for requesting funds for instrumentation to measure energy usage.

• Training—if training requirements are established in the policy, it is again easier to include this in budgets. It should include training at all levels within the organization.

Many companies, rather than a comprehensive policy encompassing all the features described above, choose to go with a simpler policy statement.

Appendices A and B give two sample energy policies. Appendix A is generic and covers the items discussed above. Appendix B is a policy statement of a multinational corporation.

2.5 PLANNING

Planning is one of the most important parts of the energy management program, and for most technical people is the least desirable. It has two major functions in the program. First, a good plan can be a shield from disruptions. Second, by scheduling events throughout the year, continuous emphasis can be applied to the energy management program, and will play a major role in keeping the program active.

Almost everyone from top management to the custodial level will be happy to give an opinion on what can be done to save energy. Most suggestions are worthless. It is not always wise from a job security standpoint to say this to top management. However, if you inform people—especially top management—that you will evaluate their suggestion, and assign a priority to it in your plan, not only will you not be disrupted, but may be considered effective because you do have a plan.

Many programs were started when the fear of energy shortages was greater, but they have declined into oblivion. By planning to have events periodically throughout the year, a continued emphasis will be placed on energy management. Such events can be training programs, audits, planning sessions, demonstrations, research projects, lectures, etc.
The secret to a workable plan is to have people who are required to implement the plan involved in the planning process. People feel a commitment to making things work if they have been a part of the design. This is fundamental to any management planning, but more often that not is overlooked. However, in order to prevent the most outspoken members of a committee from dominating with their ideas, and rejecting ideas from less outspoken members, a technique for managing committees must be used. A favorite of the author is the Nominal Group Technique developed at the University of Wisconsin in the late 1980’s by Andre Delbecq and Andrea Van de Ven [2]. This technique consists of the following basic steps:

1. Problem definition—The problem is clearly defined to members of the group.
2. Grouping—Divide large groups into smaller groups of seven to ten, then have the group elect a recording secretary.
3. Silent generation of ideas—Each person silently and independently writes as many answers to the problem as can be generated within a specified time.
4. Round-robin listing—Secretary lists each idea individually on an easel until all have been recorded.
5. Discussion—Ideas are discussed for clarification, elaboration, evaluation and combining.
6. Ranking—Each person ranks the five most important items. The total number of points received for each idea will determine the first choice of the group.

2.6 AUDIT PLANNING

The details of conducting audits are discussed in a comprehensive manner in Chapter 4, but planning should be conducted prior to the actual audits. The planning should include types of audits to be performed, team makeup, and dates.

By making the audits specific rather than general in nature, much more energy can be saved. Examples of some types of audits that might be considered are:

- Motors
- Lighting
- Steam system
- Water
- Controls
- HVAC
- Employee suggestions

By defining individual audits in this manner, it is easy to identify the proper team for the audit. Don’t neglect to bring in outside people such as electric utility and natural gas representatives to be team members. Scheduling the audits, then, can contribute to the events that will keep the program active.

With the maturing of performance contracting, energy managers have two choices for the energy audit process. They may go through the contracting process to select and define the work of a performance contractor, or they can set up their own team and conduct audits, or in some cases such as a corporate energy manager, performance contracting may be selected for one facility, and energy auditing for another. Each has advantages and disadvantages.

Advantages of performance contracting are:

- No investment is required of the company—other than that involved in the contracting process, which can be very time consuming.
- A minimum of in-house people are involved, namely the energy manager and financial people.

Disadvantages are:

- Technical resources are generally limited to the contracting organization.
- Performance contracting is still maturing, and many firms underestimate the work required
- The contractor may not have the full spectrum of skills needed.
- The contractor may not have an interest in low/ cost no/cost projects.

Advantages of setting up an audit team are:

- The team can be selected to match equipment to be audited, and can be made up of in-house personnel, outside specialists, or best, a combination of both.
• They can identify all potential energy conservation projects, both low-cost/no-cost as well as large capital investments.

• The audit can be an excellent training tool by involving others in the process, and by adding a training component as a part of the audit.

Disadvantages of an audit team approach:

• Financing identified projects becomes a separate issue for the energy manager.

• It takes a well organized energy management structure to take full advantage of the work of the audit team.

2.7 EDUCATIONAL PLANNING

A major part of the energy manager’s job is to provide some energy education to persons within the organization. In spite of the fact that we have been concerned with it for the past two decades, there is still a sea of ignorance concerning energy.

Raising the energy education level throughout the organization can have big dividends. The program will operate much more effectively if management understands the complexities of energy, and particularly the potential for economic benefit; the coordinators will be more effective if they are able to prioritize energy conservation measures, and are aware of the latest technology; the quality and quantity of employee suggestions will improve significantly with training.

Educational training should be considered for three distinct groups—management, the energy team, and employees.

2.7.1 Management Training

It is difficult to gain much of management’s time, so subtle ways must be developed to get them up to speed. Getting time on a regular meeting to provide updates on the program is one way. When the momentum of the program gets going, it may be advantageous to have a half or one day presentation for management.

A good concise report periodically can be a tool to educate management. Short articles that are pertinent to your educational goals, taken from magazines and newspapers can be attached to reports and sent selectively. Having management be a part of a training program for either the energy team or employees, or both, can be an educational experience since we learn best when we have to make a presentation.

Ultimately, the energy manager should aspire to be a part of business planning for the organization. A strategic plan for energy should be a part of every business plan. This puts the energy manager into a position for more contact with management people, and thus the opportunity to inform and teach.

2.7.2 Energy Team Training

Since the energy team is the core group of the energy management program, proper and thorough training for them should have the highest priority. Training is available from many sources and in many forms.

• Self study—this necessitates having a good library of energy related materials from which coordinators can select.

• In-house training—may be done by a qualified member of the team—usually the energy manager, or someone from outside.

• Short courses offered by associations such as the Association of Energy Engineers [3], by individual consultants, by corporations, and by colleges and universities.

• Comprehensive courses of one to four weeks duration offered by universities, such the one at the University of Wisconsin, and the one being run cooperatively by Virginia Tech and N.C. State University.

For large decentralized organizations with perhaps ten or more regional energy managers, an annual two or three-day seminar can be the base for the educational program. Such a program should be planned carefully. The following suggestions should be incorporated into such a program:

• Select quality speakers from both inside and outside the organization.

• This is an opportunity to get top management support. Invite a top level executive from the organization to give opening remarks. It may be wise to offer to write the remarks, or at least to provide some material for inclusion.

• Involve the participants in workshop activities so they have an opportunity to have an input into the program. Also, provide some practical tips
on energy savings that they might go back and implement immediately. One or two good ideas can sometimes pay for their time in the seminar.

- Make the seminar first class with professional speakers; a banquet with an entertaining—not technical—after dinner speaker; a manual that includes a schedule of events, biosketches of speakers, list of attendees, information on each topic presented, and other things that will help pull the whole seminar together. Vendors will contribute things for door prizes.

- You may wish to develop a logo for the program, and include it on small favors such as cups, carrying cases, etc.

2.7.3 Employee Training

A systematic approach for involving employees should start with some basic training in energy. This will produce a much higher quality of ideas from them. Employees place a high value on training, so a side benefit is that morale goes up. Simply teaching the difference between electrical demand and kilowatt hours of energy, and that compressed air is very expensive is a start. Short training sessions on energy can be injected into other ongoing training for employees, such as safety. A more comprehensive training program should include:

- Energy conservation in the home
- Fundamentals of electric energy
- Fundamentals of energy systems
- How energy surveys are conducted and what to look for

2.8 STRATEGIC PLANNING

Developing an objective, strategies, programs, and action items constitutes strategic planning for the energy management program. It is the last but perhaps the most important step in the process of developing the program, and unfortunately is where many stop. The very name “Strategic Planning” has an ominous sound for those who are more technically inclined. However, by using a simplified approach and involving the energy management team in the process, a plan can be developed using a flow chart that will define the program for the next five years.

If the team is involved in developing each of the components of objective, strategies, programs, and action items—using the Nominal Group Technique—the result will be a simplified flow chart that can be used for many purposes. First, it is a protective plan that discourages intrusion into the program, once it is established and approved. It provides the basis for resources such as funding and personnel for implementation. It projects strategic planning into overall planning by the organization, and hence legitimizes the program at top management level. By involving the implementers in the planning process, there is a strong commitment to make it work.

Appendix C contains flow charts depicting a strategic plan developed in a workshop conducted by the author by a large defense organization. It is a model plan in that it deals not only with the technical aspects of energy management but also the funding, communications, education, and behavior modification.

2.9 REPORTING

There is no generic form to that can be used for reporting. There are too many variables such as organization size, product, project requirements, and procedures already in existence. The ultimate reporting system is one used by a chemical company making a textile product. The Btu/lb of product is calculated on a computer system that gives an instantaneous reading. This is not only a reporting system, but one that detects maintenance problems. Very few companies are set up to do this, but many do have some type of energy index for monthly reporting.

When energy prices fluctuate wildly, the best energy index is usually based on Btus; but, when energy prices are stable, the best index is dollars. However, there are still many factors that will influence any index, such as weather, production, expansion or contraction of facilities, new technologies, etc.

The bottom line is that any reporting system has to be customized to suit individual circumstances. And, while reporting is not always the most glamorous part of managing energy, it can make a contribution to the program by providing the bottom line on its effectiveness. It is also a straight pipeline into management, and can be a tool for promoting the program.

The report is probably of most value to the one who prepares it. It is a forcing function that requires all information to be pulled together in a coherent manner. This requires much thought and analysis that might not otherwise take place.

By making reporting a requirement of the energy
policy, getting the necessary support can be easier. In many cases, the data may already be collected on a periodic basis and put into a computer. It may simply require combining production data and energy data to develop an energy index.

Keep the reporting requirements as simple as possible. The monthly report could be something as simple as adding to an ongoing graph that compares present usage to some baseline year. Any narrative should be short, with data kept in a file that can be provided for any supporting in-depth information.

With all the above considered, the best way to report is to do it against an audit that has been performed at the facility. One large corporation has its facilities report in this manner, and then has an award for those that complete all energy conservation measures listed on the audit.

2.10 OWNERSHIP

The key to a successful energy management program is within this one word—ownership. This extends to everyone within the organization. Employees that operate a machine “own” that machine. Any attempt to modify their “baby” without their participation will not succeed. They have the knowledge to make or break the attempt. Members of the energy team are not going to be interested in seeing one person—the energy manager—get all the fame and glory for their efforts. Management people that invest in energy projects want to share in the recognition for their risk taking. A corporate energy team that goes into a division for an energy audit must help put a person from the division in the energy management position, then make sure the audit belongs to the division. Below are more tips for success that have been compiled from observing successful energy management programs.

- Have a plan. A plan dealing with organization, surveys, training, and strategic planning—with events scheduled—has two advantages. It prevents disruptions by non-productive ideas, and it sets up scheduled events that keeps the program active.
- Give away—or at least share—ideas for saving energy. The surest way to kill a project is to be possessive. If others have a vested interest they will help make it work.
- Be aggressive. The energy team—after some training—will be the most energy knowledgeable group within the company. Too many management decisions are made with a meager knowledge of the effects on energy.
- Use proven technology. Many programs get bogged down trying to make a new technology work, and lose sight of the easy projects with good payback. Don’t buy serial number one. In spite of price breaks and promise of vendor support, it can be all consuming to make the system work.
- Go with the winners. Not every department within a company will be enthused about the energy program. Make those who are look good through the reporting system to top management, and all will follow.
- A final major tip—ask the machine operator what should be done to reduce energy. Then make sure they get proper recognition for ideas.

2.11 SUMMARY

Let’s now summarize by assuming you have just been appointed energy manager of a fairly large company. What are the steps you might consider in setting up an energy management program? Here is a suggested procedure.

2.11.1 Situation Analysis

Determine what has been done before. Was there a previous attempt to establish an energy management program? What were the results of this effort? Next, plot the energy usage for all fuels for the past two—or more—years, then project the usage, and cost, for the next five years at the present rate. This will not only help you sell your program, but will identify areas of concentration for reducing energy.

2.11.2 Policy

Develop some kind of acceptable policy that gives authority to the program. This will help later on with such things as reporting requirements, and need for measurement instrumentation.

2.11.3 Organization

Set up the energy committee and/or coordinators.

2.11.4 Training

With the committee involvement, develop a training plan for the first year.
2.11.5 Audits
Again with the committee involvement, develop an auditing plan for the first year.

2.11.6 Reporting
Develop a simple reporting system.

2.11.7 Schedule
From the above information develop a schedule of events for the next year, timing them so as to give periodic actions from the program, which will help keep the program active and visible.

2.11.8 Implement the program

2.12 CONCLUSION

Energy management has now matured to the point that it offers outstanding opportunities for those willing to invest time and effort to learn the fundamentals. It requires technical and management skills which broadens educational needs for both technical and management people desiring to enter this field. Because of the economic return of energy management, it is attractive to top management, so exposure of the energy manager at this level brings added opportunity for recognition and advancement. Managing energy will be a continuous need, so persons with this skill will have personal job security as we are caught up in the downsizing fad now permeating our society.

References

Appendix A

ENERGY POLICY

Acme Manufacturing Company
Policy and Procedures Manual
Subject: Energy Management Program

I. Policy
Energy Management shall be practiced in all areas of the Company’s operation.

II. Energy Management Program Objectives
It is the Company’s objective to use energy efficiently and provide energy security for the organization for both immediate and long range by:

- Utilizing energy efficiently throughout the Company’s operations.
- Incorporating energy efficiency into existing equipment and facilities, and in the selection and purchase of new equipment.
- Complying with government regulations—federal, state, and local.
- Putting in place an Energy Management Program to accomplish the above objectives.

III. Implementation
A. Organization
The Company’s Energy Management Program shall be administered through the Facilities Department.

1. Energy Manager
The Energy Manager shall report directly to the Vice President of Facilities, and shall have overall responsibility for carrying out the Energy Management Program.

2. Energy Committee
The Energy Manager may appoint and Energy Committee to be comprised of representatives from various departments. Members will serve for a specified period of time. The purpose of the Energy Committee is to advise the Energy Manager on the operation of the Energy Management Program, and to provide assistance on specific tasks when needed.

3. Energy Coordinators
Energy Coordinators shall be appointed to represent a specific department or division. The Energy Manager shall establish minimum qualification standards for Coordinators, and shall have joint approval authority for each Coordinator appointed.

Coordinators shall be responsible for maintaining an ongoing awareness of energy consumption and expenditures in their assigned areas. They shall recommend and implement energy conservation projects and energy management practices.
Coordinators shall provide necessary information for reporting from their specific areas. They may be assigned on a full-time or part-time basis; as required to implement programs in their areas.

B. Reporting
The energy Coordinator shall keep the Energy Office advised of all efforts to increase energy efficiency in their areas. A summary of energy cost savings shall be submitted each quarter to the Energy Office.

The Energy Manager shall be responsible for consolidating these reports for top management.

C. Training
The Energy Manager shall provide energy training at all levels of the Company.

IV. Policy Updating
The Energy Manager and the Energy Advisory Committee shall review this policy annually and make recommendations for updating or changes.

Appendix B

POLICY STATEMENT

Acme International Corporation is committed to the efficient, cost effective, and environmentally responsible use of energy throughout its worldwide operations. Acme will promote energy efficiency by implementing cost-effective programs that will maintain or improve the quality of the work environment, optimize service reliability, increase productivity, and enhance the safety of our workplace.

Appendix C

![Diagram with Objective and Strategies]
Figure 2.3

STRATEGY

PROGRAMS

MAINTENANCE

PROGRAM

Develop maintenance plan
Develop preventive maintenance plan

MODERNIZATION

Computerize data and analyze trends
Evaluate EMCS
Start a steam trap survey
Review insulation opportunities

OPERATIONS

Develop an operating procedures manual for major energy using pieces of equipment
Examine operational schedules for potential energy savings

TRAINING

Develop training plans for:
- operating procedures
- maintenance
- EMCS
- steam traps
- other technical topics

CONTINGENCY PLANNING

Develop a contingency plan for electric and gas utility cutback
Determine alternative energy source
Establish a shutdown procedure

Figure 2.4

STRATEGY

PROGRAMS

PLANT

PROPERTY

EVALUATION

Develop an audit program
Develop a plan for updating inefficient equipment
Establish proper size for equipment, such as motors

MEASUREMENT

Establish permanent instrumentation for energy measurements
Procure necessary portable instruments
Develop an energy reporting and evaluation program

CONTROL

Assure proper functioning of existing controls
Develop a low cost/no cost program for controls
Evaluate and install EMCS where economically feasible

ENERGY

ORGANIZATIONAL

EFFICIENCY

Enhance stability of energy council
Amend the energy management organizational structure as necessary for increased efficiency
Establish a corporate level energy management team to assist lower organization
Figure 2.7

STRATEGY

PROGRAMS

STABILIZE FUNDING

RETURN SAVINGS TO CUSTOMER

FUNDING UTILIZATION

SHORT TERM FUNDING

ECONOMIC ANALYSIS TRAINING

ACTIONS

Identify and prioritize future projects
Develop long-range budget

Develop a formula for sharing savings
Advertise and implement

Establish funds for a test program for verification of energy savings
Establish a fix-it-fund

Establish a training program to teach:
- accounting procedures
- life cycle cost
- energy cost determination and analysis