Energy Management

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Chapter 1

Designing, Initiating, and Managing an Energy Management System

1.0 ENERGY MANAGEMENT

The words *energy management* mean different things to different people, so perhaps the first objective is to define the term. To us, energy management is

> The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions

Therefore, any management activity that affects the use of energy falls under the overall guise of energy management. This is a rather broad intrepretation as it covers many areas of an enterprise's activities from product and equipment design through product shipment. It also must include waste disposal activities as many energy management opportunities can occur there. Without this *whole systems* viewpoint, many important activities will be overlooked or suboptimized.

We've already stated that the primary objective is to maximize profits or minimize costs. Some alternative statements or subobjectives are the following:

1. To conserve energy, thereby reducing costs
2. To cultivate good communications on energy matters
3. To develop and maintain effective monitoring, reporting, and management strategies for wise energy usage
4. To do research and development to find new and better ways to increase returns from energy investments
5. To develop interest in and dedication to the energy management program from all employees

6. To reduce the impacts of curtailments, brownouts, or any interruption in energy supplies

This list could continue, but these six seem to be of primary importance and enough for the purposes here. However, we should elaborate somewhat on objective 6. Curtailments occur when a major supplier of an energy source is forced to reduce shipments or allocations (sometimes drastically) because of severe weather conditions and/or distribution problems. This happens in the case of natural gas where industry is given the advantage of relatively inexpensive gas but on an interruptible basis. That is, residential customers and others on noninterruptible schedules have priority, and those on interruptible schedules receive what is left over. This residual is normally sufficient, but periodically curtailments of gas deliveries are necessary.

Even though they don't occur frequently, the cost associated with curtailments is so high (sometimes complete shutdown is necessary) that management needs to be alert in order to minimize the negative effects. There are several ways of doing this, but the one most often employed is the storage and use of a secondary or standby fuel. No. 2 fuel oil is often stored on site and used in boilers capable of burning either natural gas (primary fuel) or fuel oil (secondary fuel) when curtailments are imposed. Naturally, the cost of equipping boilers with dual fire capability is high, as is the cost of storing the fuel oil. These costs, however, are miniscule compared to the cost of forced shutdown. Other methods of planning for curtailments include production scheduling to build up inventories for curtailment-likely periods of time, planned plant shutdowns, or vacations during curtailment-likely periods, and contingency plans whereby certain equipment, departments, etc., will be shut down so critical areas can keep operating. All these activities are part of energy management.

Please note from the preceding discussion that energy conservation is an important part of energy management but that there is much more to energy management than just conservation. Curtailment-contingency planning is certainly not conservation, and neither is load shedding or power factor improvement in electrical energy management (to be discussed). To concentrate solely on conservation would preclude some of the most important activities—often those with the largest savings opportunity.

1.1 WHY?

1.1.1 Economics

The American free enterprise system operates on the necessity of profits (budget allocations in the case of nonprofit organizations), so any new activity can be justified only if it is cost effective; that is, the net result must show a profit improvement or cost reduction greater than the cost of the activity. Energy management has proven time and time again that it is cost effective.

Energy cost savings of 5–15% are usually obtained quickly with little to no required capital expenditure when an aggressive energy management program is launched. Eventual savings of 30% are common and savings of 50, 60, and even 70% have been obtained. All this is for retrofit activities. New buildings designed to be energy efficient often operate on 20% of the energy normally required (80% savings). In fact, we can boldly state that for most manufacturing and other commercial organizations *energy management is one of the most promising profit improvement-cost reduction programs available today.*

1.1.2 National Good

There are other reasons energy management programs are so vitally needed today. One of the most important is that energy management helps the nation face some of its biggest problems. Perhaps some statistics will make that point.*

- It took 50 years (1900–1950) for total annual U.S. energy consumption to go from 4 million barrels of oil equivalent per day to 16 million. It took only 20 years (1950–1970) to go from 16 to 32. (That trend is continuing, but we have slowed the rate recently.)
- With only 5% of the world's population, the United States consumes about $33\frac{1}{3}$% of its energy and also produces about $33\frac{1}{3}$% of the world's gross national product (GNP). The fact remains, though, that some nations such as Japan, West Germany, and Sweden produce the same or more GNP per capita with significantly less energy than the United States.
- Domestic oil production peaked in 1970, while domestic gas production peaked in 1974. Deregulation has improved our domestic production in the short run, but in the long run we will face continued decreasing domestic output.
- Prices per barrel for imported crude have rapidly escalated from $3.00 in the early 1970s to $12 in 1973–1974 and $32.00 in 1980.
- The United States has been a net importer of oil since 1947. In 1970 the bill for this importation was only $3 billion; by 1978 it was $42 billion; by 1979, $60 billion; and by 1980, $80 billion, even though the volume imported was less than in 1979. This has severely damaged our trade balance and weakened the dollar in national markets.
- Oil production in the Soviet Union (still not a net importer) is expected to peak in the early 1980s and the North Sea's fields will decline in output by 1984. Also, many emerging countries are dramatically increasing their consumption and are making demands for their share.

There are no easy answers, as the following demonstrate:

* The statistics here come from numerous sources, mostly governmental publications. Some also come from R. Stobaugh and D. Yergin, *Energy Future* (see the Bibliography).

- Many look to coal as the answer. Yet coal contains sulfur whose emissions damage human lungs and form acid rain that defaces buildings and kills life in lakes. Apparently this problem is just beginning. Coal, like other fossil fuels, develops large amounts of CO_2. Carbon dioxide tends to trap heat on the earth's surface, creating a greenhouse effect. The total effects are unknown but could involve substantial warming of the polar regions and creation of deserts in much of our country.
- Synfuels require strip mining, large costs, and demands for water in areas where there is little.
- Solar-generated energy (whether electricity through photovoltaics or thermal) is very expensive and has interesting legal problems; e.g., who owns the solar rights?
- Biomass energy is also expensive, and any sort of monoculture would require large amounts of land. Some fear total devastation of forests. At best, biomass can provide only a few percentage points of our total needs without large problems.
- Wind energy has technological "noise" and aesthetic problems that probably can be overcome, but again it is very expensive.
- Alcohol production from agricultural products raises perplexing questions about the use of food products for energy when large parts of the world are starving.
- Fission has the well-known problems of waste disposal, safety, and a short time span with existing technology. Without breeder reactors we will soon run out of fuel, and of course breeder reactors dramatically increase the production of plutonium—a nuclear bomb raw material.
- Fusion seems to be everyone's panacea or hope for the future, but many claim that we don't know the area well enough yet to predict its problems. When available commercially, fusion may very well have its own style of environmental-economical problems.

The preceding discussion paints a rather bleak picture. We don't mean to be alarmists, but our nation and the world are facing severe energy problems. There appears to be no simple answer.

Time and again energy management has shown that it can reduce energy costs (and consumption) subtantially. This freed energy can be used elsewhere so one energy source not already mentioned is energy management. In fact, energy available from energy management activities has proven to be the most economical source of "new" energy in most situations. Now, energy management can't solve the nation's problems, but *perhaps it can buy enough time and ease the strain on our environment so that we can develop new sources.*

1.1.3 Emotional

We all want to leave behind a world that is a little better than what we found when we arrived. Energy management allows us to feel like we have at least tried. Usually, energy management activities are more gentle to the environment than large-scale energy production and certainly lead to less consumption of scarce and valuable resources.

We feel energy management's time has come. The world will see a dire need for adequately trained engineers in the field of energy management. In fact, there are a large number of jobs available today. This text will help you prepare for your future career, which will be exciting and definitely challenging.

1.2 DESIGNING AN ENERGY MANAGEMENT PROGRAM

1.2.1 Management Commitment

The most important single ingredient for the successful implementation and operation of an energy management program is commitment to the program by top management. Without this commitment, the program will likely fail to reach its objectives.

Actually, there are two situations that are likely to occur with equal probability. In the first, management has decided that energy management is necessary and wants a program implemented. This puts you in the *response* mode. In the second, you might decide to convince management of the need for the program so you are in the *aggressive* mode. Obviously, the most desirable is the response mode as much work has been circumvented, but a large number of programs have been started through the aggressive mode. Let's consider these one at a time.

In a typical scenario of the response mode, management has seen rapidly rising energy prices and/or curtailments and has heard of the results of other energy management programs and then has initiated action to start the program. In this case, commitment already exists, and all that needs to be done is to cultivate that commitment periodically and to be sure the commitment is evident to all affected by the program. We will discuss this more when demonstrating the commitment.

In the aggressive mode, an engineer may have noted that energy costs are rising dramatically and that sources are less secure. Also, that engineer may have taken a course in energy management, attended professional conferences on the subject, and/or read papers. At any rate, the engineer is now convinced there is need for a program and all that remains is to convince management and obtain their commitment.

Management is convinced best through facts and statistics. Sometimes the most startling way to show the facts is through graphs such as Figure 1-1. Note that different goals of energy cost reduction are shown. This graph can be done in total for

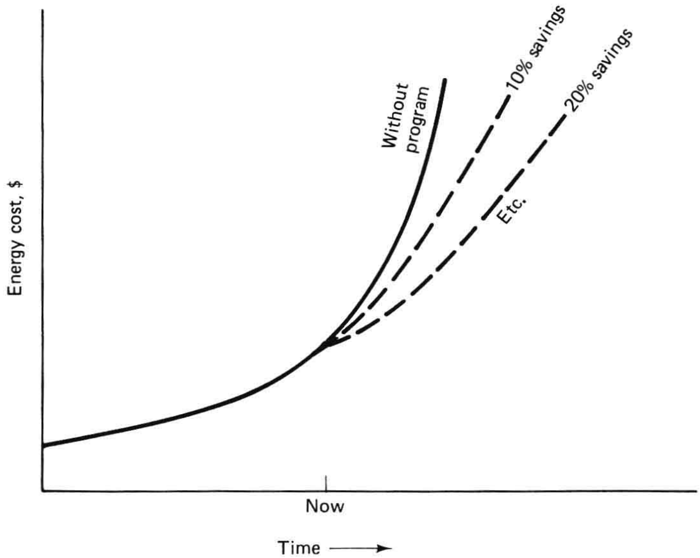

Figure 1-1 Energy costs—past and future.

all energy sources, or several graphs can be used, one for each source. The latter is probably better as savings goals can be identified as to energy source. It is important to have accurate data. Past figures can use actual utility bills, but future figures call for forecasting. Local utilities can help here, as can the various departments of energy at state levels.

Be sure to follow this quickly with quotes on programs from other companies showing these goals are realistic. Other company experiences are widely published in the literature, or results can be obtained through direct contacts with the energy manager in each company. Typical cost avoidance figures are shown in Table 1-1, but be careful. As time progresses and the technology matures, these figures tend to move up. For example, only a short time ago few people believed that an office building could reduce energy consumption by 70% or that manufacturing plants could operate on half the energy previously required, yet both have occurred recently.

The argument for an energy management program could then talk about the likelihood of energy curtailments or brownouts and what they could mean to the company. This could be followed by a discussion of what the energy management program could do to minimize the impacts of curtailments and brownouts.

Finally, the presentation should discuss the competition and what they are doing. Very good statistics on this can be obtained from trade and professional

TABLE 1-1 TYPICAL ENERGY SAVINGS OVER WHAT WOULD HAVE BEEN

Low cost, no cost changes	5-10%
Dedicated programs (3 years or so)	25-35%
Long-range goal	40-50%