ENERGY ENGINEERING MANAGEMENT CURRICULUMS FOR ACADEMIA AND INDUSTRIES IN DEVELOPING COUNTRIES

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Abstract *— It is extremely rare to find employees with energy management skills or other required background information within an organization at the start of an energy management program. This paper presents major skills and subordinate skills required by personnel involved in the energy management process. A separate subordinate skill analysis is presented for business managers and energy professionals. These subordinate skill analysis can be used to develop specific learning activities for each group. Energy education does not have to be delivered in a classroom environment. Day to day activities of each of the above group can be modified to teach skills and to enhance energy awareness. Finally, the outcome of an energy management program is subjected to the culture of the country and the organization in which the program is launched. Energy management programs must be tweaked to align with such variations so that the impact of the program is maximized.*

Index Terms — Academia, Curriculum, Energy Management, Industry.

INTRODUCTION

What is energy management? One definition is "the judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions [1]." Definitions may vary from one society to another depending on how the environmental concerns and economic benefits are valued. Regardless, there are many common aspects to all energy management programs. They include: monitoring and reporting energy use; reducing energy consumption through improved efficiency; finding new ways to increase returns from energy investments; improving power quality; reducing brownouts and curtailments; finding new ways to include renewable energy; and enhancing distributed power generation.

For some countries, energy management is a new concept, while others have been doing it for many years. When national or provincial governments subsidize the utility companies, or when there are inadequate metering capabilities, the energy management efforts do not receive proper attention, or are very difficult to implement. On the other hand, it is unwise to pay whatever the utility provider bills a business, due to one's lack of understanding of energy consumption of that business. In some countries, the energy costs of a product may be higher than the labor costs for the same product. Understanding the energy consumptions of an organization by managers, engineers, and all facets of the work force benefits the entire business.

ENERGY MANAGEMENT PROGRAMS

How can businesses initiate energy management programs when there are limited knowledgeable workforces to implement them? This is a challenge faced by many countries. Until colleges and universities start offering course in energy areas, short courses involving specific areas can be developed to help businesses and industries. Energy management always involves a team effort. The team includes the management of an organization, a steering committee with a leader, an energy manager or engineer, who has a comprehensive understanding of the discipline, and many other employees in the organization.

The employees must be well educated, in order to enhance the management system; otherwise, even a very expensive program would do little to conserve energy. Skills required by the employees vary according to their involvement in the process. For example, the upper management needs enough information to make business decisions and future planning. The energy management steering committee also requires education in electrical and mechanical systems. All of the organizations workers should know the objectives of the program, and what their rolls are. Well-trained energy managers are always in great demand, and innovative methods are required to increase the awareness of energy management among each level of the organization.

SKILLS FOR MANAGERS

The commitment of management is essential for making any energy program successful. When the managers have some level of understanding related to terminology and methodology presented in an executive summary of an energy management proposal, the proposals that contain energy management opportunities (EMOs) may receive favorable judgment, and support.

Some EMOs require rescheduling of work hours, production line start-up times, and allocation of new resources. Managers must coordinate and approve such activities. Some EMOs focus on improving air quality, work environment, and safety. Managers should be aware of

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government regulations related to occupational safety and health. In fact, some energy management activities are started in an effort to avoid litigation associated with safety or health related issues. A manager with understanding of the above issues can make informed judgments about proposed EMOs.

Economic analysis and/or lifecycle costs of each proposed EMO is a must. No energy management initiative should start prior to this step. Just because there is little need for new material, retrofits, and equipment for certain energy saving efforts does not mean the effort is without a cost component. Whenever an existing system is changed, there is impact. Workers are involved in any adaptation, automatically adds labor costs. When an EMO needs capital investment, viability of the investment should be clear. Acquisition costs, utilization costs, and disposal costs of new equipment must also be taken in to consideration. Return of investments using simple payback period methods and others such as discounted cash flow, must be examined according to the accepted business practices within the organization.

One of the problems with energy use in commercial sector and industrial sector continues to be poor accountability. Since energy consumption is considered as a fixed cost in most industries, no one person is responsible for the energy use. One solution is to sub-meter each department within the industry, and give responsibility to each. In order to accomplish this, managers should be aware of the benefits and drawbacks of such actions, and instantiate programs to reward departments for improving their own energy efficiency.

In some developing countries, solar energy is abundant. Managers should be aware of such technologies and how they can be exploited or incorporated in to their systems. By organizing conferences and seminars related to specific types of technology, many companies can benefit. For example, an investigation or pilot study in the area of solar thermal collectors may benefit many industries that require hot water for their manufacturing processes. A study investigating the potentials of desiccant cooling may improve the efficiency of commercial buildings that require cooling in the summer or throughout the whole year.

Some countries have a national energy policy; others don't. Most countries do have some form of regulations related to energy use, brownout periods, and environmental protection. One country may have a higher priority for saving energy and preventing environmental pollution, instead of cost effective manufacturing processes. Whatever the focus is, managers should align their energy management efforts with the national priorities, because there may be government incentives and subsidiaries to facilitate those efforts.

Understanding of how energy is billed is another important skill managers should have. In some counties, energy bills are very simple, while in others it can be quite complex. A simple billing structure may include a fixed rate for every kWh of use, and a fixed rate for every kW of demand. A complex bill may include a ratchet clause, where the company has to pay a percentage of the maximum electrical demand for the previous eleven months too even if the facility exceeds an accepted level one time. Energy bills are not always accurate. Such knowledge can help managers decipher mistakes and save money for the organization.

In summary, a list of major skills needed by managers of an energy organization should include the following:

1. Understand energy terminologies, units, and conversions
2. Understand safety and health regulations
3. Understand impact of production rescheduling
4. Understand energy billing
5. Perform economic analysis and life cycle costing
6. Organize seminars and workshops for employees

To master these skills, a series of subordinate skills are required. Figure 1 below depicts the breakdown of those skills into a series of subordinate skills.

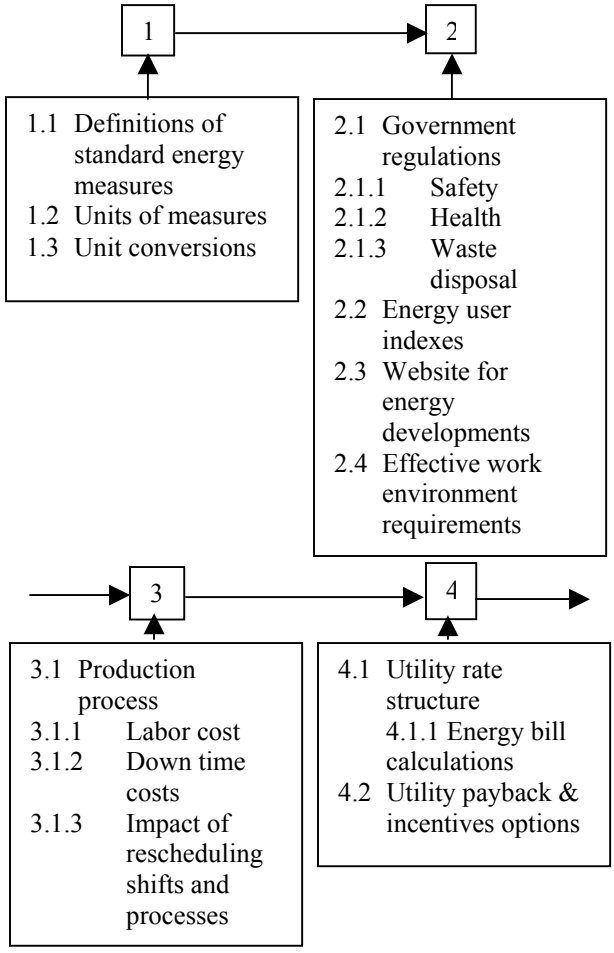

FIGURE. 1
SUBORDINATE SKILL ANALYSIS FOR MANAGEMENT

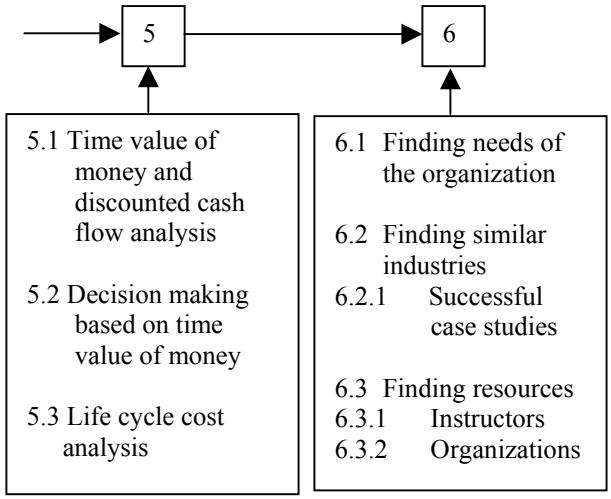

FIGURE. 1 (Continued)
SUBORDINATE SKILL ANALYSIS FOR MANAGEMENT

SKILL FOR ENERGY MANAGER OR ENGINEER

The energy manager is the key figure in all energy management initiatives. The person should have a technical background in the electrical and mechanical systems found in the organization. Those with technical abilities can be trained to become valuable energy manager.

An energy manager should be able to identify the energy-saving opportunities in a commercial or industrial facility. Energy may be purchased or generated locally. Energy may be consumed by lighting systems, a major portion of commercial facilities, air conditioning equipment, electric motors, steam generation, etc. By conducting specific energy audits energy managers finds energy saving opportunities.

An effective energy manager requires the following major skills:

1. Understand energy terminologies, units, and conversions
2. Locate and apply energy statistics
3. Understand energy use in commercial buildings
4. Understand energy use in industry
5. Perform economic analysis and life cycle costing
6. Perform energy audits
7. Integrate renewable energy sources

Each of the above major skill requires a series of subordinate skills. Figure 2 summarizes subordinate skill analysis for energy engineers or mangers [2].

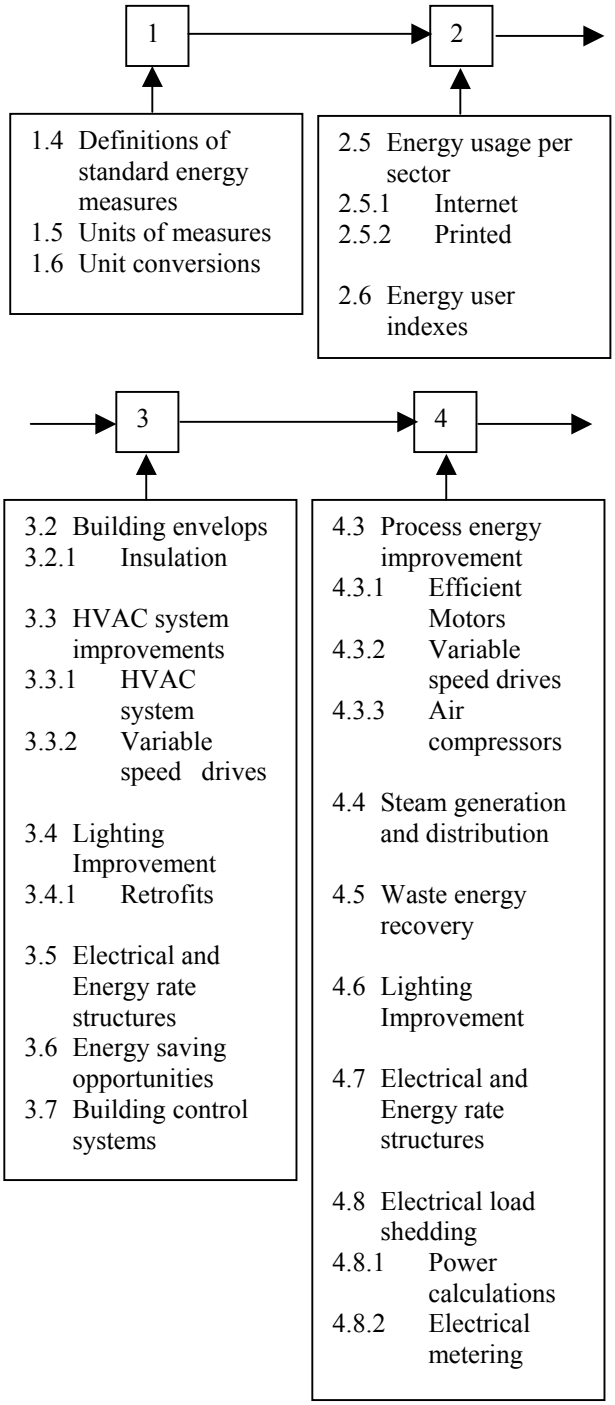

FIGURE. 2
SUBORDINATE SKILL ANALYSIS FOR ENRGY PROFESSIONALS

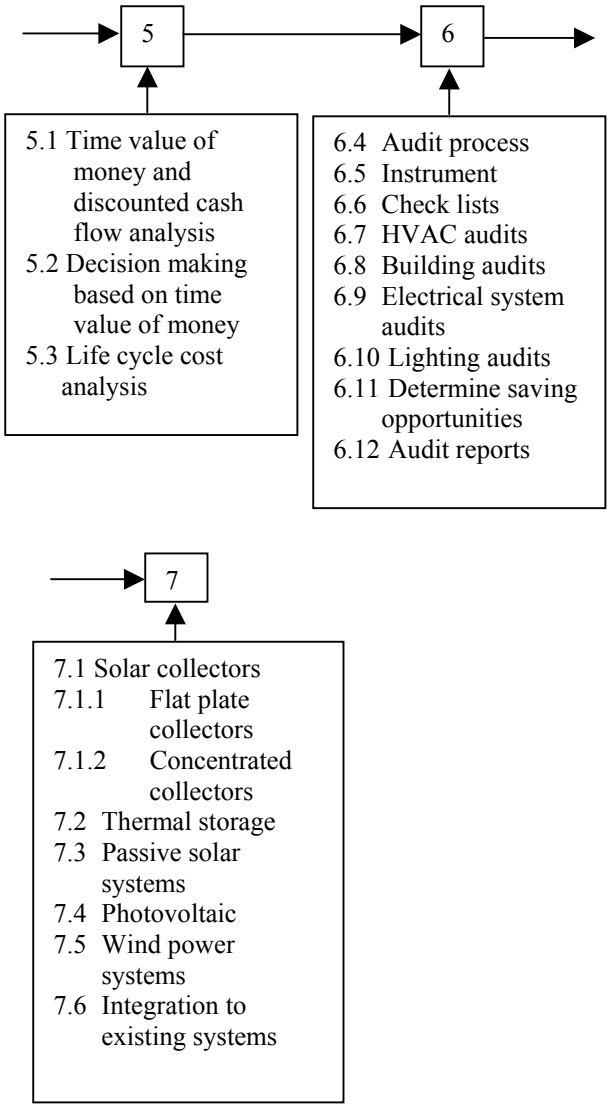

FIGURE. 2 (Continued)
SUBORDINATE SKILL ANALYSIS FOR ENRGY PROFESSIONALS

INFORMATION FOR EMPLOYEES

Employees in general can contribute energy saving efforts if they are well informed. They should know what the goals of their energy management efforts are, how it affects their work environment, and how they can contribute. Management should not wait until the final decisions are made to inform workers. Regular worker input is necessary, especially when energy audits are conducted. If the goal is to change existing lighting in a work area, worker opinion of current lighting and concerns about safety due to poor visibility are essential. Pamphlets describing energy initiatives can be distributed if a meeting of all employees cannot be called. Large posters spread across the facility can also remind the workers of ongoing efforts. It is also crucial to provide feedback to employees about the progress and success of these actions once they are implemented.

Some workers may need more detailed instructions than others. Operators who are in charge of a process of a system should be educated to evaluate and report any unexpected or unsuitable consequences due to changes that were made to accommodate EMOs. These workers should be aware of what the acceptable variations are. For example, if an across-the-line motor starter is replaced by a variable speed drive, the current meter will not indicate the inrush current that is inherited in typical induction motors. Simple efficiency changers such as which light should not be on during specific time of the day should be posted to keep workers informed.

OTHER ISSUES

The management of organizations and the energy managers in developing countries should also pay attention to metering methods and meters employed by their utility companies. Some countries have age-old power distribution system where little or no attention has been given to the metering aspects recently. Some meters are too old. Some meters records power consumption inaccurately when harmonics are present [3]. Certain new retrofit used to replace old ones with the expectation of saving energy may introduce harmonics to the power grid. It is paramount to verify the metering system or install their accurate meters before initiating energy management projects.

Finally, energy management is an applied field. One can learn some of these skills while conducting preliminary energy audits. Required checklists, record sheet, and actions to be taken are well documented and available to public through various organizations in the United States. For example, through US Department of Energy (DOE) and National Lighting Bureau in Washington, DC one can access different types of audit documents.

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